Collection of National Reports!

Universities as workplaces
for male and female researchers
in Europe

UPGEM Understanding Puzzles in the Gendered European Map

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Coordinator's foreword

In 2004, six partners-to-be in five European countries, Estonia, Italy, Poland, Finland and Denmark, formed a Consortium with the aim of gaining a better understanding of the basic question: why do statistical data show that we find more female physicists in the Southern and Eastern part of Europe compared to the Northern part? On the basis of primarily qualitative data, this question has been dealt with in the UPGEM project. Though our main question is a very specific question, which takes only *one* academic field (viz. physics) as the object of study, we believe it can open up for many interesting questions relating to wider issues of the relation between gender, science and culture in academic work life.

This publication is a collection of five National Reports from Denmark, Estonia, Finland, Italy and Poland based on studies of more than 20 physics institutes as workplaces in the involved partner countries. Each report can be read in its own right as a deep analysis of a particular workplace culture that makes it more or less difficult or rewarding for women and men to pursue an academic career path. At the end of the project (September 2008), a cultural analysis that addresses our basic question from a contrastive perspective will be published at www.upgem.dk.

Apart from the research assistants, a number of people in each of the partner countries deserve to be thanked, but as Coordinator I would like to thank the UPGEM-partners first. They have followed the project closely and contributed to its success in numerous ways. They have been patient, tolerant and sympathetic to the challenges of coordinating the work of many different people across national cultures to form a coherent analysis: Dr. Endla Lõhkivi, Philosophy of Science, University of Tartu, Estonia; Professor Anna Maria Ajello, Faculty of Psychology 2, University of Sapienza, Italy; Dr. Kristina Rolin, Department of Social and Moral Philosophy, Helsinki School of Economics and Professor Yrjö Engeström as well as Lecturer Merja Helle, Center for Activity Theory and Developmental Work Research, University of Helsinki, Finland and Professor Elżbieta H. Oleksy, Director of the Women's Studies Centre, Universty of Łódź, Poland (see Appendix A for more information about partnerships and assistants).

I also wish to give a warm thank to all of the assistants, who have worked hard to provide the best possible data and analyses presented in

this publication. The assistants behind this publication have demonstrated great collaborative spirit and engagement in the research work that was a new field and challenge for many of them (in alphabetical order):

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The very close collaboration in this project has been challenging and complicated but always inspiring, and any point of discussion has driven the project forward to better research and analysis.

Thank you to all who helped in this process.

Cathrine Hasse,
Coordinator

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General Introduction

Are universities workplaces like any other? In 1942, the sociologist Robert Merton formulated a set of ideals for these particular workplaces (see note 5, pages 47 and 48). Scientists explained to Merton that science should be governed by norms which emphasize humility, willingness to share and openness to all scientists, irrespective of gender, skin colour or social status, who will benefit the development of an objective science. Even in Merton's own writings these norms were described as ideals (Merton 1942). Many years later, a senior physicist told the anthropologist Sharon Traweek that Merton's description corresponded to 'an adolescent fantasy' (Traweek 1988, 80). Through numerous studies, the field of science and technology studies (STS) has shown that science is formed in the amalgamation of human desires, exclusions and prize fighting, rather than a transparent system that rewards the skilful, competent and masterful with high honours and positions. In the words of Pierre Bourdieu: "The 'pure' universe of even the 'purest' science is a social field like any other, with its distribution of power and its monopolies, its struggles and strategies, interests and profits, but it is a field in which all these *invariants* [original italics] take on specific forms" (Bourdieu 1999, 31).

The title 'Draw the Line' refers to several aspects of the research behind this publication. The first is the very fact that women and men chose to draw the line at the many problematic working conditions in the publicly funded academic organisations and leave their research career. In some cases it seems to be a specific problem for women that they are burdened with the responsibility of drawing the line when male colleagues make a pass at them.

Another aspect is the timeline of their career path from childhood till today which the physicists were asked to draw during the interviews.

The title itself also refers to the conditions of the study. We as researchers draw analytical lines when we select and analyse the empirical material. In each country, the researchers have drawn their lines for the local analysis, in accordance with our general guidelines. Thus the basic question of why we find more women employed as physicists in southern and eastern European countries is not discussed

from a comparative perspective in this publication. This will be dealt with in the subsequent publication where new cultural analytical lines will be drawn in the material.

This publication is probing deep into the specificities which shape human beings' professional career paths in the academic world of physics at different universities in four European countries. We are not discussing the quality or validity of the scientific results in physics but the conditions for those who do the work. In the Mertonian ideal, scientific communities should not compete but share scientific results. Though this view may be shared by some of the scientists in our study, we generally find that universities are very competitive workplaces. And unlike private enterprises where companies compete against each other to make the best research results, it seems that as universities become more competitive, scientists compete increasingly more against each other than other research groups in the same field. This particular condition underlines the necessity of social skills for the individual aiming for a scientific career. Scientific skills are not enough, one must also have the support of mentors and develop a 'feel for the game' (Bourdieu 1990, 59). This seems to be the case in most scientific workplaces, but some seem to have found ways to form a more collaborative environment.

In the everyday work life, most researchers fight, in many ways, for funding and positions. Some loose the battle others win. Take, for instance, two PhD-students who both earn a PhD-degree. Ten years later, one has left not only academia but research all together. The studies behind this publication have found examples of people who are trained and skilled as academic researchers but who work as designer, musician, driver or school teacher. Why does one, but not the other, move on to a professorship? Does it purely depend on scientific competence? Is it a preference for male or female colleagues? Is it a coincidental, drifting process, which seems to be determined more by being in the right place at the right time than by strong competition between colleagues? Is it tactical skills and the ability to please one's superiors? Or, in the worst case, is it the ability to win through the means of hidden competition such as slander or destruction of research material?

In this publication, the reader will meet some of these career paths in a collective story of the inside of university as workplace.[1] We all like to think that selection mechanisms are righteous and fair. Yet, in this study, this is clearly not the experience of many of the researchers. Around 40% of the physicists we have interviewed have left academia (these physicists are called 'leavers'), and many of the physicists still working at universities (named 'stayers') consider leaving.

Even though our study, along with many other STS-studies, find that social forces can lead to unjust treatment and bias in science, they can also, as pointed out by Helen Longino, lead to more transparent and fair discussions of background assumptions (Longino 2002). In this publication, the reader will find examples of what we define as 'best practice' and 'happy stayers'; but, our main purpose has been to identify reasons for leaving – and especially reasons for why female physicists chose to leave an academic career despite having the same formal qualifications as their male colleagues.

The background for the focus on female scientists is manifold. Even though the ratio between men and women at the onset of their university careers as students might be more or less equal, the closer we get to top-positions the wider the *gap* between the number of male and female scientists. Graphically, this can be represented in the form of a diagram shaped like a pair of scissors. From these 'scissors diagrams' we know that women are not moving up through the echelons of scientific careers in the same numbers as their male counterparts. This is a fact that has been well established in a number of studies, notably the SHE-figures, the Helsinki Group Reports, and the ETAN- and ENWISE Reports (see e.g. www.cordis.europa.eu). The gender balance is lacking to a greater or lesser extent in all the European countries.

It has been argued that the skewed gender balance is influenced by masculine ideologies (Keller 1985, Wertheim 1995, Rolin 1999), which permeate scientific practices. These ideologies define particular ways of *doing science* which, in our view, are intertwined with particular ways of *doing gender* (West and Zimmerman 1987).

[1] For the sake of the physicists' anonymity we have not included the more skewed career paths.

Some claim that to understand why we find few women in science, we have to look into why we find few girls in the science classes in high school. There is some truth in this. The number of women in academic positions in science does, more or less, seem to follow the number of girls in science education in high school. By probing into the everyday work life of physicists many general issues appear which may shed light on why we find few women scientists at top-level positions as well as few girls interested in natural science. As mentioned earlier, this issue will be developed further in the later UPGEM publication, where we will focus more on the cultural differences between the countries in this study. One explanation that is presented here is our discussion of stereotypes.

Science rests on tacit assumptions on what women and men can and should do in science. In all the national reports presented here, the researchers have found masculine connotated stereotypes like ‘the playful boy’, ‘the high priest’ and, in Estonia, ‘the blacksmith’. They all seem to hinder women from being able to identify with the stereotypical image of a physicist. Thus, it could be speculated that female scientists have a harder time making a career in a science like physics because they do not fit the gendered stereotypes. The National Reports touch upon this issue. It could also be argued that female scientists in a working environment that is strongly influenced by masculine ideology are seen more as females than scientists and that this can act as a subtle exclusion mechanism.

Another reason to look closer at the working conditions for women in academia is that they seem to be hit harder by the discrepancy between the explicitly expressed assumptions about transparent and fair selection mechanisms and the many scientists’ experience of disguised mechanisms that result in unfair conditions of their everyday work life and poorer possibilities to climb the career ladder. The tacit mechanisms strike the men and women in our research as deeply problematic, but they seem to hit the women harder than the men.

Our studies have found that women in the partner countries are still the main caretakers of children and it is often seen as a specific set-back for female scientists that they have to leave before the late afternoon meetings or choose not to go on long trips abroad etc. Moreover, it is found further problematic because research work in physics is described

as especially difficult work, which requires very long work hours, many long trips abroad and not much possibility to combine work and family life. Even though these conditions are general across all the physics institutes in our study, we do find 'pockets' or groups that *do physics* differently and thus contradict the otherwise seemingly 'facts of life in physics'.

The aspects of academic career paths that can be found in all the European countries in our study could be defined as characteristics of "physics as culture". They cut across national borders. We also find aspects which seem to be of a more 'local' nature; these could be called "physics in culture". What is presented in this publication are discussions of reasons for leaving or staying in academia. We generally focus on the mentioned reasons for leaving, which can be interpreted as a combination of factors that pull or push people out of the academic work life.[2] The push factors are pushing competent physicists out of academia against their will and in spite of a general 'love for physics'. The pull factors are connected to the push factors in so far that they make the physicists leave the academic work life because they offer various possibilities outside of academia that are more rewarding than those within. In the National Reports the following push and pull factors are discussed:

Push factors

- Competition
- Stereotypical identity
- Lack of self-esteem
- Political changes
- Lack of career perspectives
- Low pay + short term contracts
- Work motivational problems
- Bad working environment (conflicts, harassment)

[2] In the cultural analysis that will be published later in 2008, these factors will be further discussed. The terms push-pull have been inspired by debates on brain-drain and migration studies. In the way we use the concepts, push points to situations that forces the individual to change the situation, while pull defines factors that entice the individual in a new direction.

- Insufficient organization of workplace
- Mobility requirements

Pull factors

- Family responsibility
- New job possibilities (i.e. in industry or business)
- Better pay
- Better career options

The brief story of the UPGEM-project

This publication is the result of more than 24 persons' work over two years in five European countries. Six senior researchers and 18 research assistants (four in Poland, four in Italy, two in Estonia, one in Finland and five in Denmark) have worked either fulltime or part-time to realize this publication (see Appendix A).

During a six week Innovation Seminar in Denmark, they produced, among other things, an interview guide (see Appendix B). During the course of the project, they have also gathered 239 interviews in all (see Appendix C), produced approx. 500 pages of field notes, analysed the interviews on the basis of 34 hypotheses (see Appendix D) that were drawn up jointly at a working seminar in Estonia. Finally, they have produced a number of information boxes presented at the UPGEM homepage: www.upgem.dk.[3]

The consortium behind the project consists of six project partner institutions in five different European countries: Estonia, Italy, Poland, Finland and Denmark.

The partners are selected according to two criteria:

[3] The information boxes offer an overview of the following themes: 1) History of Social Changes from 1968 and onward, 2) University Contracts 3) Educational Systems, 4) Rules for maternity/paternity/parental leave, 5) Changes in the (gendered) labour market, 6) Local history of women's emancipation, 7) Local politics on gender action plans.

1) *Criterion of geography:* to cover university physics departments distributed along the north/south and the east/west axes of the European map.
2) *Criterion of expertise:* to combine the different scientific competences needed to make this kind of in-depth qualitative study – the competences are within psychology, anthropology, qualitative methods, philosophy, gender studies, science studies and workplace research.

It was assumed that this mix of geographical and professional skills would be the best way to address the very complex and complicated questions of both cultural diversity and gender-differences in academic workplaces. In March 2005, three years ago, the six partners received the first notice that the European Commission would open up for negotiation for the UPGEM project. In January 2006, a group of assistants were hired and met for a six week Innovation seminar in Denmark to plan the concrete execution of the project and gain a common understanding of our different background and how they could contribute to the project. During this seminar, through lectures, group work and discussions, the assistants and partners developed methods and theoretical understandings of concepts like 'gender', 'culture', 'physics', 'STS' (Science and Technology Studies) and Academia as a workplace. They formed the questions in the interview guide which were to guide the research in the respective countries and ensure some kind of coherence in the cultural complexity (see Appendix B). After the first seminar, the work with the actual interviewing began in each of the five countries. During the gathering of the empirical data the assistants were informed about and discussed each other's work through State of the Art (SOA)-letters. These letters told local stories of how the interviewing was proceeding and about the stories told to the researchers by the physicists. They also took up ethical problems and exchanged good tips about how to deal with fieldwork in academia. In the second phase of the project, the SOA-letters were exchanged for Skype meetings where the assistants, if the acoustics allowed, could exchange news and discuss various project issues. Yet, the most intense periods of information sharing were at the Nowa Strona conference in Poland in August-September 2006 and on the three subsequent working seminars in Estonia (December 2006), Finland (July 2007) and Italy (November 2007) following the first seminar in Copen-

hagen (January-February 2006). During these seminars, numerous issues were taken up. One of the most pertinent concerned our definitions of 'stayers' and 'leavers'. Is a leaver a person who has left academia all together or a person who has left physics research? In each of the National Reports these issues are discussed on a local basis, and in later cultural analysis of the UPGEM data the definition will be dealt with in a comprehensive argument. The same applies to our long intensive discussions about 'culture' and the relation between national culture, physics culture and the local institute culture. At the seminars, we also had time for extensive discussions about the coding of the interviews (approximately 10,000 pages of raw data in all). We used the software Atlas.ti to systematize the data and we developed 34 code-labels (see Appendix D) which captured the hypotheses we found relevant to discuss in a contrastive perspective. The analytic coding of the interviews has resulted in 16,048 coded quotations on which we build our analysis together with field notes and general publicly available information. In practice, it has been impossible to touch upon and discuss each of the 34 hypotheses individually in these National Reports. Consequently, the Consortium has decided that each report must touch upon seven general themes, which relate to a cluster of the codes/hypotheses. It has been entirely up to the local teams how to weigh and analyse the themes. The seven themes are: A) Change in universities 1960-today, B) Career path, C) Workplace environment, D) Family, E) Mobility, F) Future and G) Identity.

During the course of the project some assistants left and others took over. Some were asked to leave, some were on short-term contracts, some found other job possibilities, some fell in love, some had children; they all contributed to the constant development of the project – and the project *has* developed.

From being a project mainly focusing on women and women's (lack of) career possibilities, the project has increasingly been focusing on the general workplace conditions in academia for men as well as women. It has been argued that gender studies often implies a particular interest in women, but in UPGEM we have found that a focus on women must also include a focus on men – consequently we find it more fruitful to offer a general discussion of what guides and influences human beings in their academic work life.

In the following analyses, we present the reader with a rare and profound insight into both positive and negative aspects of academic work life.

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UPGEM National Report
Denmark

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1. Introduction

In Denmark the public sector will need to recruit a considerable number of researchers over the next years. The need will be most eminent in and after the period 2010–2015 where 18% of the total number of researchers is expected to retire (Danish Ministry of Science 2003). In the natural sciences, only 4% of all professors in 2003 were women, and even though the number of female students is much higher for the humanities we only find 12% female professors here (Ståhle 2003). For some reason, the Danish university appears to be a workplace where women do not make careers to the same extent as men. Politicians will find it important to understand why academia cannot attract and hold on to competent researchers when the country will be judged, increasingly in the future, on its performance in a knowledge economy. The UPGEM project, and subsequently the Danish report, is a result of the worry concerning problems of attracting and developing researchers' knowledge competence – especially that of female researchers.

Politicians tend to describe women as an 'untapped' resource (Lane 1999; Rabo 1997; Ivie & Ray 2005; Rees 2002), but this report will show that the issue goes far deeper than just solving the problem of how to engage more women at universities and subsequently 'tap' their resources. In our analysis of Danish universities as workplaces, we take, as the other UPGEM reports, physicists who work at or have left institutes of physics as the point of departure for an in-depth examination of universities as workplaces. We find that many of the women we have interviewed, and a few of their male colleagues, who are on a career track in academia do not feel comfortable at their workplace and consider leaving even though they have the formal competences to pursue an academic research career.

Competence and excellence is, in our analysis, defined in relation to the specific context. In fact, there is no commonly accepted definition of competence (Rychen et al. 2000) or excellence (Brouns & Addis 2004). The requirement of the universities to audit and measure competences has increased with their transition from being 'public co-operations' to 'commercial co-operations' (Shore & Wright 1999, Wright 2005). At

universities as workplaces, explicit achievements, such as the annual number of publications, have been defined as one of the transparent selection mechanism which identifies competence and decides who should be awarded. These explicit achievements are well known to our informants. In academia, competence or excellence is often seen as a salient and publicly acknowledged proficiency an individual acquires or possess and which is recognized and acknowledged by leaders as well as colleagues. However, our findings question the notion that career paths solely follow a transparent acknowledgement and recognition of competence in the Danish university system. As noted by Margo Brouns and Elisabetta Addis in a report on gender and excellence: "[T]he mechanisms that appear to prevent women scientists from achieving excellence partially overlap with the mechanisms that prevent women from rising at any step of the academic ladder" (ibid.: 8). Though universities try to introduce improved transparent rules, regulations and reward systems to ensure that the most excellent and competent researchers reach top-positions, we find that selection mechanisms have more to do with activities of everyday life than with acknowledgement of excellence.[1]

Activities in everyday life can be theorised as cultural-historical activity systems as described by Yrjö Engeström (Engeström 1987, 1993, 2000)[2], and activity theory has proven beneficial in the analysis of university work environment (Gold, Holt & Thorpe 2007). This analytical tool can unfold the normative spaces in our social experiences; the unit of analysis is not the specific actions or words of individuals but the activity understood as the relation between subjects, objects of activity and

[1] Gender research often refers to excellence, and workplace research refers to competence. We use these concepts interchangeably in this report though we aware they may be dealt with differently in the respective research fields.

[2] We do not have space to unfold the theory behind Engeström's expansive methodology nor have we in practice been able to venture into the first steps of this framework towards an expansive development of the workplace. We have tried to identify contradictions and limits in the activity of being an academician – a physicist – in the Danish cultural context. We have not, as it would have been done in a thorough activity theoretical approach, made a rigorous and detailed analysis of the whole activity system of academia, nor have we tried to expand the learning of the physicists in academia by introducing new mediation, which could expand how academia is done.

communities. Each of these is mediated by rules (including social norms), artefacts (technology/tools, symbols, including language) and divisions of labour (horizontal as well as vertical hierarchical divisions). We argue that the selection mechanism of employees' competences at universities is very much situated in activity systems driven by inner contradictions. One of the characteristics of activity systems is that though they are driven by deeply communal motives they are also internally contradictory and in constant movement (Engeström 2000).

In the interviewed physicists' statements we find both references to the communal aspects of the activity of 'doing physics' and the inner contradictions that are, theoretically speaking, supposed to drive the activity forward. The inner contradictions can be of two types; primary and secondary (Engeström 1993: 72). In physics, for example, physicists may experience a constant latent tension between their roles as cost efficient producers and basic researchers. When a strong novel aspect is introduced into one of the mentioned components of the activity system, e.g. a public demand for more useful science/physics, the entire system acquires a new quality, which then gives rise to secondary contradictions between this new component and the existing components of the system. Such secondary contradictions could be a demand for different qualities in the physicists – qualities that may clash with the qualities of the established physicists in the activity system. In this process, the physicists may experience contradictions as overwhelming double binds that cannot be eliminated or fixed. Double binds are dilemmas where all available alternatives are equally unacceptable and thus lead to frustration (Bateson 1972: 206 *ff*). Consequently, some may choose to leave the activity system, while others may find solutions to the tensions on a local basis, which may gradually affect the entire activity system. Put differently, double binds and contradictions can constitute fruitful and necessary driving forces in pushing the activity forward (Engeström 2000: 960). At the same time it is important to remember that the decision to leave is never simply an individual decision. Individual career tracks must be seen as integral to the entire activity system, and it is from this perspective we argue that activity systems create boundaries between those who are accepted and those who are not accepted at the workplace (i.e. the community). Such boundaries may be the explicit or implicit regulations and norms (i.e.

the rules) of how physicists shall act e.g. at meetings. The system also sets up boundaries for both the horizontal division of tasks between the members of the community and the vertical division of power and status (i.e. division of labour) (Engeström 1993: 67).

The impact of gender on this division of power and status and the activity system as such has not been discussed extensively within activity theory. When looking into the aspect of gender and inner exclusion mechanisms, the notion of boundaries is important to combine with the theory of activity systems. On the basis of the present empirical data, we wish to initiate a discussion of how gender sensitive boundaries can be seen as integrated in the including and excluding selection mechanisms of members of a community.

In our view, a boundary-making activity system 'constitutes simultaneously the context of behaviour and the ways in which cognition can be said to be distributed in that context' (Cole & Engeström 1993: 13). Therefore, boundaries can be seen as created internally as a cultural collectiveness, which leads to 'self-evidence' in how people in activities speak about and judge actions in everyday life. We perceive the physicists' utterances to be culturally connected storylines of what is to be expected and of the self-evident boundaries that can found in a particular setting (Holland et al. 1998). The meaning and judgement of acts, characters and events in everyday life is figured against a storyline of self-evident normativity, which is not prescriptive but 'significant as a backdrop for interpretation' (ibid.: 54). Thus, when the components of the activity system are changed (internally or externally), new boundaries appear creating contradictions, which can lead to a questioning of the self-evident backdrop. Though the report itself is of a more descriptive kind, we shall use this framework of analysis in our conclusions of physics institutions as workplaces.

Our aim is not to present answers in the form of cookbook recipes of how to solve the problems of the lack of women in academia. Rather we wish to unfold complexities, uncertainties and paradoxes to which there are no ready-made answers. We maintain that these complexities, which are often self-evident and therefore unquestioned, go largely unnoticed by management and policymakers. Our hope is that enunciating the problems will point to new roads, so that universities can learn how to

utilize hitherto unacknowledged competences by creating new contexts for workplace processes, when taking everyday life into consideration.
We shall try to identify reasons for the dissatisfaction with universities as workplaces, and we have built up the analysis around the following themes: Academic structure and change, career paths, identity, workplace environment, work and family life reconciliation, best practice and reasons for leaving academia. Under each of these themes we discuss quotations from the physicists.

1.1 Method of Analysis

The quotations can be longer or briefer descriptions of experiences, norms and attitudes in everyday life at the workplace. By looking at the connections between these various quotes, the physicists' words come to constitute narratives both within the individual physicist's professional life story and as a shared or collective narrative describing the activity. In these narratives we can identify the self-evident boundaries and contradictions forming the course of career paths at Danish universities. We are fully aware that certain characteristics of physics are particular to natural science; however, as the informants largely talk of values and attitudes, we assume these narratives may be descriptive of other disciplines within academia in Denmark.

For the Danish analysis we have, in line with the other UPGEM researchers, mainly gathered data in form of interviews and have then used the software programme Atlas.ti for the analysis of the huge amount of data comprised in the interviews. The software allows one to label quotes with codes set up by the researchers. The quotations used in the analyses below are selected on the basis of these codes made collectively in the UPGEM research team (see the General Introduction for a description of the UPGEM collaboration). We have, however, used this programme as a tool rather than as a method in itself (the toolkit implies making sub-codes on sub-codes, but we have drawn out codes to be analysed in relation to general themes).

The UPGEM-project's methodology sets up a number of fixed analytical a priori 'boundary creating' categories as the point of depar-

ture for the analysis. These categories are *culture*, *male*, *female* and two categories that are labelled '*stayers*' and '*leavers*'. In everyday life we understand these categories as dynamic rather than fixed, because they are formed by the local contexts, wherefore their relevance must emerge from analysis rather than be taken for granted. In this Danish national report, we have been focusing on the themes emerging in the coded quotations before looking at the interplay between these themes and our 'fixed' a priori categories of stayers and leavers, male and female.

The fixed categories can be seen as examples of what Jerome Bruner (1986) refers to as a paradigmatic mode of thought where one operates with categorisations and abstract references. The quotations, however, constitute what he calls the narrative mode, where one operates with stories and experiential references. Basically, narratives can be dealt with in three ways in research (Ewik & Silbey 1995). Narratives can be 1) the direct object of study or 2) the means to study something else like gender roles (Polkinghorn 1988). They can also, as it is the case here, be 3) constructed by the researchers themselves; the beginning, middle and end are constructed by putting together strings of statements from the field. Organisational structures can, for example, be revealed by piecing together personal accounts (Ewik & Sibley 1995: 205). In the following analysis and outline of work life and changes in academia, we will put together the quotes like pieces in a puzzle and thereby employ the narratives in the second and third sense. The narratives will be used in the conclusion to discuss the self-evident boundaries we find in the quotes with an emphasis on gender differences and differences in stories told by physicists who stay in research in academia (stayers) and those who have left (leavers).

We are aware that we do not present a generalizable account of everyday life in academia. We acknowledge that the qualitative analysis is not about generalisation or repetition but the validity gained from being close to everyday life (Davies 1999)[3]. When encountering

[3] Validity refers to the correctness of the findings. But even though the UPGEM research may not be fully reliable, in the sense that full repeatability is ensured, the research can be argued to have a high level of correctness in the sense that it offers an accurate account of the complexities of the cultural context (c.f. the physics activity) that is shared by the particular interviewee in the research project. That repeatability may not ensure correctness is e.g. illustrated by Charlotte Aull Davies' classical case of a

complexities in everyday life, the analyst sets up the boundaries of relevance and it is in the analysis that the quotes we select appear as collective intricate stories. This makes this report our story as much as the physicists' story. We hope the boundaries we set up will interact with the boundaries we identify in the physicists' narratives.

Because we from a cultural historical approach find parallels between the individual and the collective in activities, we interpret these narratives as descriptions of the self-evident activity and its inherent contradictions. Instead of viewing the physicists' narratives as individual (and incomparable) descriptions of experiences or claiming that they share exactly the same knowledge and therefore tell exactly the same story, we see the collective aspect of the activity in physics functions as 'distributed cognition' (Engeström & Cole 1993). In line with the activity theoretical framework, we regard the academic life stories told to us by the physicists to be both individual recollections and culturally distributed stories learned through the individuals' every-day interaction with material and symbolic cultural artefacts. As these artefacts become internalised as self-evident, they become a backdrop tool mediation of narratives of what constitutes the activity as physicists and what constitutes contradictions in the activity. This practise-oriented approach focuses on what people tell us about their everyday life rather than giving 'a metaphysical transcendental account of de-contextualized reality' (Nicolini, Gherardi & Yanow 2003: 12).

Our interest in the physicists' narratives springs from their emergence in collective activities rather than their formation as mental processes in the minds of individual members of the organisation. Our interest is thus not to form 'wholes' out of each individual life-story, but rather how piecing the physicists' narratives together can analytically form 'whole' activities. By a careful analysis of the quotes selected in Atlas.ti, we are able to trace collective patterns of what we call narratives from a Danish physicist activity.

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thermometer that "consistently records the temperature of boiling water under standard atmospheric conditions as 97ºC. This measurement is reliable, but not valid" (Davies 1999: 85).

1.2 The Empirical Data

In Denmark, 41 physicists were interviewed from an interview guide made collectively in the UPGEM research project (see Appendix B). The distribution of interviewees is 19 physicists employed in academia (the stayers) and 22 physicists who have left academia as a workplace (the leavers). The gender distribution is 25 women and 16 men.

The informants were randomly chosen from groups that were accessible through e.g. websites from physics institutions providing records of names of employees as well as records of PhD graduates from physics institutes which have been used in tracking leavers on the internet etc. We have, however, also made extensive use of the word of mouth-method. This method was particularly useful when it came to identify leavers, who are not as easily found as physicists figuring at university homepages. We have discriminated on the two parameters of sex (male-female) and current position in or outside academia (stayers and leavers). Some may criticize us for operating with 'leavers' as it somehow implies that they are lost cases. This is not our intention at all. We have chosen 'academia' – state financed universities – as our point of departure, and it is from this perspective we, as researchers, have chosen to make an analytical boundary between those who stay in academia and those who leave for (in most cases more satisfying) jobs outside academia. The physicists' identity has been anonymized, and they have all been given a so-called P(hysicist) number, which we will employ in the following analysis. We also list whether the interviewee is male (M) or female (F) and whether the person is a stayer (S) or a leaver (L).

Originally, DK was supposed to make 36 interviews but landed on 41 which are all used in this analysis of the national cultural context. The higher number of interviews comes down to various reasons. One is poor sound quality of some of the interviews and another is an initial fear of not being able to get enough female informants as Denmark has very few female physicists. However, getting access to female informants turned out to be relatively unproblematic. For that reason the Danish empirical material now has an overweight of female informants. The Danish interviews have been made by six different researchers and the majority have been made by two short term employed assistants who

have not been involved in the analysis of the material. The authors of this report have made 4, 3 and 1 interviews respectively. This division of labour has the advantage of the authors being less biased towards the material in the analysis, while the drawback is difficulties with the contextualisation of the physicists' quotes.

Regarding insight into the contextualisation of the physicists' everyday lives, the interviewers obtained this by being positioned explicitly as "interviewers" – we did, contrary to many activity theoretical studies – *not* work together with the informants to discover disturbances (see Engeström 1993). All of the interviewers have been influenced by the meeting with the field. We have also felt that we influenced the physicists we met through the research. As persons relating to other persons, we, as researchers, affect the field we study, and the informants influence us as we become *engaged* in their field (Strathern 1987, 1991; Okely & Callaway 1992; Okely 1996). Long-term fieldwork by one person instead of interviews made by different researchers would obviously have changed the data on which this analysis rests. Nevertheless, our personal immersion and engagement in the field has helped us understand the informants' narratives to a certain extent. We shall never come to fully understand the dimensions of what we outline as physicists' activities. In the end, we withdraw from the field as *radical others* (Hastrup 1995), but now the field lives on inside our analysis. It is from this position analytical fields are constructed.[4]

Since the Danish team consists of a group of researchers (interviewers and analysts) who do not share the same theoretical background, we believe that we, to some extent, have avoided the classical trap of seeing the world through one theory rather than experiencing it. Even so, our different personal backgrounds and preferences are also mirrored in the report. It includes the awareness of how our own theoretical background is co-constructing the field in a relational meeting. The Danish anthropologist Kirsten Hastrup has argued that

[4] Vered Amit (2000) took up this discussion – but in our view, immersion does not rule out construction as argued by Amit (ibid.: 6). We regret that we were not able to immerse ourselves more and for longer time in the activity of physicists as we are convinced this would lead to a deeper understanding of the collective backdrop on which the quotes in our interviews are to be understood.

"[f]ieldwork is situated between autobiography and anthropology. It connects an important personal experience with a general field of knowledge." (1992: 117).

When contacting potential interviewees, we encountered few refusals; only one woman and three men declined to participate. The woman explained she had already taken part in several scientific research projects related to gender and physics, and in her opinion "*it is not always an advantage to have such a big focus on women's position in the field of physics"*. Two of the men declined due to lack of time, and the third male cancelled the interview appointment because he did not believe he could contribute to research on women in physics since he was a man.

The Danish interviewees who are employed in academia (i.e. the stayers) come from the following research institutions from some of the biggest institutes in Denmark: The Niels Bohr Institute (University of Copenhagen), the Department of Physics and Astronomy (University of Aarhus) and Risø National Laboratory (Technical University of Denmark). The distribution of gender and position in academia appears in Table 1 (see the Appendix).

The interviewees' narratives describe everyday working life in various fields of physics in Denmark. These fields are applied physics, astrophysics, biophysics, geophysics, high-energy physics, nanophysics, nuclear physics, theoretical physics and physical chemistry.

The interviewed physicists who are no longer working as researchers in academia (i.e. leavers) have left in favour of employment in a range of different trades and positions. These are research positions in various private companies and governmental research institutions, non-scientific positions at university hospitals, engineering in the oil business, teaching in high schools, academic administration and communicative administration at universities or private companies, consulting and project managing in engineering companies, and finally employment in self-established companies. Two of the interviewees were unemployed at the time of the interview. The distribution of gender and position outside academia is shown in Table 2 (see the Appendix).

The Danish interviewees represent age groups from the mid 20s to late 60s. Table 3 (see the Appendix) states the exact distribution of interviewees according to age group.

26 of the interviewed physicists have children while 15 do not. The group of physicists who have children consists of 13 women and 11 men. More leavers than stayers have children: 15 leavers have children as opposed to nine stayers. Of the group of female leavers, 12 out of 14 have children. The picture is quite different among the female stayers where only three out of 11 have children.

With regards to the male leavers five out of eight have children. For the male stayers the picture is very different from the one of female stayers: Six male stayers have children and two do not (see Table 4 in the Appendix).

2. Academic Structure and Changes

One of the 34 Atlas.ti codes is *Change* and it concerns changes in physics as a discipline. By connecting the fragmented quotes (145 in all on Change) of past and present life at physics institutes, it is possible to create 'collective narratives' of how physics has changed as a discipline in Denmark since the 1930s.

Though none of the physicists tell the 'entire' story of the changes, it is possible to make a coherent account of the changes in physics in academia by piecing the many quotes together like pearls on a string, consequently forming a narrative. In this narrative (a narrative in the third sense as described by Ewik and Silbey 1995), it appears that physics in Denmark has been influenced especially by politics. In the history of physics in Denmark, as it is told in the interviews, external factors like the cold war and specific persons have influenced the development of physics as a discipline. In the 1920s and 1930s, Danish physics was dominated by Niels Bohr, whom the interviewed physicists still refer to as a '*genius – who knew how to associate with the right people* (P69/MS). In the 1950s, 1960s and 1970s, new institutions (like Risø) were built and the physics institutes were given huge grants. Several of the physicists agree that the economic success of Danish physics in this long prosperous period is related to external circums-

tances such as the international focus on the atom bomb and nuclear power in general and that physics was greatly respected (P69/MS, P53/MS, P82/ML). In the heydays of physics, a lot of new people were suddenly hired which affects physics even today:

> *[A]ll physicists know that back in the 70's there were happy days at the Danish national Physics Institutes because back then you hired everyone who wanted a job.* (P59/ML)

> *I do think that the respect that used to be there in the 1960s and 1970s, one that probably can be traced back to the 1950s and maybe the 40s, the one where nuclear physics is the grand one, you know, my god we have nuclear scientists […]. That was something surrounded by respect because of the aura of Niels Bohr.* (P82/ML)

Since the 1980s, the respect for physics as a science has declined. From being a very independent science allowed to concentrate largely on basic research it has become more and more directly politicised and bureaucratic. That physics had been thriving on the cold war became especially clear when the wall fell.

> *There was a big crisis in physics in the '90s. […]Russia had broken down, the cold war was over […] and a crowd of proficient physicists came from Russia at the same time and they came into the market. So the '90s were completely – physicists were worth less than scrubbing-brushes.* (P51/MS)

In the 1990s, a whole generation of physicists might have been lost:

> *At that time there were many at my age that were stuck in the system and could not get a job. And applied for very different jobs. And not everyone got a job. So they are working in other jobs now.* (P58/MS)

In the time of crisis in the 1990s up to the beginning of 21st Century it was very difficult to get a job.

> *And applicants were crowding in for these more soft positions for which I was also applying. I had been in these unemployment periods, and [...]*

> *positions were scarce. There were 31 applicants for the position I got at the institute, for a research position in climatic research. It is unheard of. There are 31 people who get enrolled a year at the department!* (P67/FL)

During the last decade (and especially since the new Act on Universities, May 2003) the universities in Denmark have increasingly been managed by governmentally imposed legal restrictions on how to structure and manage academia. Today Danish universities are among the most politicized in Europe when it comes to management of universities (Karran 2007). For some physicists this leads to an increasing disabling of research and creative development.

> *[T]he "new public management" takes over and it is a mix of "new public management" and old-fashioned government hierarchy. Instead of using competent people who have a sense and a feeling about it. […] and then the entire feedback process becomes worse and worse. I think it has got worse.* (P51/MS)

With a recent introduction of the so-called 'fusion-universities-model', the governmental and political top-down management has been combined with an almost total lack of collegial influence by the academics themselves. An international survey among mainly European countries shows that the Danish Universities Act 2003–2007 is quite unique in a European context (Øllgaard 2007) and falls below most other European countries in terms of academic freedom (Karran 2007).

The physicists in our sample are generally well aware of these developments and experience the influence of politicians in their everyday life as problematic. Several refer directly to political initiatives to press researchers for faster and more usable results and less money to finance research and even for pressing physics into specific areas and leaving others.

> *[I]n November 2001 we got another government, and there were major cutbacks on all centres […] All these centres and everything that was developed during the social democratic government were closed.* (P67/FL)

> *Something has happened. Quite concretely, the new university law has given a much more formal top-down organisation. […] I do think that the management structure of the university is going to hell. And it has become much worse. Very hierarchical.* (P51/MS)

New management style has also meant that elder physicists have been forced to leave the workplace.

> *Well, it seemed like they were pushing older people out, they did not try to keep them updated. Instead of quietly saying to them "you have to do more research" […] There is some ethics in it, too, what kind of place of work is it if you just get rid of people who are a bit too old and too slow.*
> *Interviewer: How did it affect you?*
> *How it affected me? It was really uncomfortable. Once the university was a nice place of work, the salary was not high, but – freedom and everything. But now the salary is low and the work conditions – you have to perform all the time.*
> *Interviewer: It became harder?*
> *Much harder.* (P90/FL)

Today, however, there has been a renewal of staff, which is connected to new ways of understanding physics.

> *Interviewer: So the new persons employed have another attitude?*
> *Yes. And other interests. […] New fields come into existence and others die out.* (P53/MS)

Often researchers describe how they have to fight for the same research funds or the same offices, which can lead to a bad atmosphere and even quarrelling. It is seen as a problem that people generally do not know what actually goes on at universities.

> *The political discourse about the universities, not just us, but generally, is about spoiled students and they have too much and they have ample money and it costs too much. They increase the grants, but then they increase the grants with one hand, and make the universities pay tax or rent for the buildings they accommodate with the other, so that in reality the universities end up paying much more than they did before. It is very depressing*. (P60/FL)

In the time after 1968 there was a slogan from inside the university demanding that you should do "research for the people", i.e. research which is useful to the common people (P53/MS); but, today the politicians have made up slogans like "*From research to invoices*" (P56/MS, P63/FS). It is still about a pressure for the *usefulness* of research but now the pressure comes from *outside* the university and many physicist worry that it will lead to a reduction in the basic research which may – and may not – lead to new, interesting uses over time. One example of this development is the ice-core experiments carried out (under the guidance of physicist Villy Dansgaard) as purely basic, and in the late 60s apparently, useless research (P68/FS & P69/MS). Many years later, the once useless work on ice-core isotopes was connected to climate changes and during the past 15 years, with focus on the importance of this knowledge to the issue of global warming, the field of ice-core research has grown into one of the most successful stories of Danish physics.

Today, the definition of 'usefulness' is to a large extent decided by politicians and administrators, and the physicists fear this approach may prove to be counterproductive. One issue the physicists bring up is the new demand for 'earning' your own funding and measuring the work done in terms of 'useless' publications.

> *Sometimes you are around those people where you have the feeling that they are only doing their research to get paid. And if they can do a good publication, it does not really matter whether you can use it for anything. There is not really any motivation. My problem is also that the reward is in how many publications you get. And I am driven by curiosity and getting publications is of course nice, but it is the time in the laboratory when you see everything fall into place that is the thing for me.* (P62/FS)

Researchers underline, though, that it is not the case that total managerial control has been introduced and that they also greet the new demand for usability welcome (P81/FL, P90/FL, P51/MS, P55/FS & P56/MS), and that they are still able to do basic research. They see it as their job to do basic research and leave the 'invoice-physics' to other researchers outside of universities.

> *Profitable projects can be done in other places as well. The state does not have to support the university because of that. But of course we should also, I mean, it does not do any harm to do something useful […] There was another time, after '68, where the young people, especially the students, had the slogan "research for the people". The research had to be useful to the people. The common people, […] but [today] they are mostly talking about the industry, when they say society. But it may not be easy to distinguish between the two.* (P53/MS)

Even though the politicians press for more usable research, some physicists do not bow to their wishes (P55/FS). Even so, it is has become more of a battle to maintain basic research, and usefulness is generally perceived to be 'winning' (P68/FS, P51/MS, P81/FL & P55/FS). The physicists experience that 'usable' areas are preferred rather than more complex basic research areas.

> *In this area basic research is given a lower priority […]. Nanophysics and bio physics and genetic engineering are given a higher priority. That is the trend: it must close in on usability. And even though I do basic research, I do understand – I do not feel real bitterness about it. […] But there is a battle.* (P56/MS)

2.1 Scepticism of Science

Even though the physicists experience a turn towards more 'industry-friendly' research, the relationship between physics and society is in some ways experienced as more antagonistic than in the 1950s. Several physicists speak of the greater scepticism they meet and the general public lack of faith that research leads to any good. This they feel is unfair.

> *It is […] scepticism about the damage we do, chemicals for instance. [ironically:] It is a terrible thing with those chemicals. When we, for example, talk about pollution, and you identify small concentrations of different materials and they are found to be dangerous. Well, the very fact that you are able to see them is due to science itself. And science has progressed, and the methods have been improved.* (P53/MS)

> *[T]opics related to science are not popular. They are not associated with high status in the public space, within the media and so on. It is quite acceptable for a ballet dancer, or a painter, or a composer, who is very talented and very famous, to speak out in public and admit that they don't know the first thing about physics […]. [I]f a scientist speaks out and says that he or she spend their lives doing physics and find that beautiful, but that they don't know the first thing about ballet or opera, then they're out.* (P69/MS)

Physics has had a particularly hard time attracting students in Denmark perhaps due to this scepticism. Furthermore, it has had an exceptionally hard time attracting and interesting especially female students (Sjøberg 2004, Busch 2005, Hasse 2003, 2007a). This lack of interests is also evident when we compare the intake of female physicists in Denmark with most other university areas (Hasse 2002). Women in Denmark prefer to study areas within the humanities and health (Henningsen 1998a, 1998b). As mentioned, a severe crisis in physics was experienced in the 1990s. It was probably due to changes in the political climate because of a political decision to mainly reward institutes with a high intake of student and, as mentioned by some informants, because physics had been connected with the cold war.

Recently various changes sought to render physics more attainable for students, e.g. by trying to make it less lofty and more useful and thereby follow the same trend towards usefulness in teaching as we have seen in research.

> *There was an understanding at the physics department that these changes would be a positive incentive to the students. In retrospect I realise that I didn't think much about those changes when they were happening. I didn't consider that they were actually restructuring the whole way in which education in physics was thought about and conceived of.* (P75/ML)

In a way, the physicists describe it as a change in the very basic way physics is understood – from being a complex and abstract science to having become more concrete and useful.

> *There has been – and still is – this idea among a group of physicist that the more abstract the more refined. The way physics is taught at university today […] focus a lot more on utility in class as well as in scientific research. [Earlier] the theoretical work was most prestigious because it was the hardest to understand. I am not sure everybody agreed but that was the tendency. This physicist image has also influenced the way physics was taught in high school for a long time. A 'clean' experiment ridded of anything that had to do with the real world was the highest attainable. And that puts an immense distance between the pupil and the physics they needed to learn. That has changed. But a lot of the former values still remain.* (P76/FL)

One big change in education, which is only mentioned by female physicists, is the larger intake of women:

> *[I]n the beginning of the 80ies […] it was really highly debatable whether women should be allowed in field work. Opinion was very much against. […] Women would only cause tensions and problems. […] There was great resistance toward it. And that has changed in the time I have been here. […] It has become standard and ordinary. That has changed during the past 20 years.* (P68/FS)

2.2 Towards a Bureaucratic Science

For many physicists the worst change concerns an increasing burden of administration of science. This includes more work spent on tiresome fights for funding and time wasted on reporting (P69/MS, P51/MS & P60/FL).

> *It gets harder and harder to get money, and you have to use a bigger and bigger amount of time to get money from the EU and private funds. It is a waste of time for a researcher. Normally, as a young researcher you work and work and work and then you get your own group and then you can do your research. Now people are ending up using all their time in administration and applying for money. That is depressing. That is not physicists specifically, but the general conditions for research in Denmark. I am not a great fan of that* (P60/FL).

The physicists regard a lot of the changes in the academic structure as a nuisance, which mainly benefits the bureaucrats. One physicist even claims that physics would do a lot better if they fired all bureaucrats, but he also acknowledges the fact that this cannot be done (P51/MS). The academics seem to feel powerless when bureaucrats make decisions to be followed by the researchers. It is not always easy to pinpoint whom 'bureaucrats' refer to, but it often seems to be the administrators of the universities.

New structures

In some universities, the physicists have experienced many time-consuming changes in the academic structure mainly concerning the development from sub-disciplines organised in independent departments to a more flexible and changeable group-structure organized in one department. These changes affect their daily lives negatively as they have to spend a lot of time on negotiations for offices, secretaries etc. Amalgamation causes problems.

> *At that time the institute was about to be divided into research groups. You simply abolished the original sub-units of the institute so the places could be used and given to other groups. […] And we have moved, some from one group to the other.* (P53/MS)

> *And when somebody leaves, who is to take over the offices? And how many people can they accommodate? That is just a part of everyday life in there because the budget is so tight. And I do not find that very charming*. (P60/FL)

The focus on groups is also found in the acknowledgements that group-work (and accordingly administrative and social skills) become more and more important for getting research funding. Physics is changing because it becomes more expensive to found research as groups get bigger – even in fields where there has been no tradition of big groups. In fact, it is not uncommon to have several hundred people in a research group.

> *I think the two most important tendencies have probably been that – and they are actually related, because ultimately it has something to do with*

> *the financing of research – that the groupings that do physics become larger and larger. […] I think one of the dangers is, at least for new people in a field that they can easily drown in the crowd. It is hard to find out what you have accomplished yourself, and what the others in the group have done. [I]t has simply become more expensive and heavier a lot of what is going on, and therefore it also takes much larger groups, where people become like a small wheel in the big machine rather than an independent researcher.* (P66/MS)

2.3 The Rise and Fall of Disciplines

Today, many physicists work in completely new fields and previously dominating fields are declining. The recurrent story is that nuclear and later particle physics were, for long, the most important areas in the field, but now more interdisciplinary and 'useful' areas take over. Going back in history we see that because of the cold war, physics seemed to have enjoyed a much higher prestige than it does today.

> *At that time there were nuclear physics and energy physics at the university and nothing else. There was not anything else. Actually, there was nothing else at all.* (P51/MS)

This had to do with the power play during the cold war as well as the development of nuclear power, and the political decision, at that time, not to invest in this kind of energy also had a deep impact on nuclear physics.

> *That we chose not to have nuclear power may not have had a major impact in a global perspective. Nothing new has happened since then, we tried fusion technology but nothing really came of that while solid-state physics and later within biotechnology, bio-physics and nanotechnology industries pop up which eventually develops into a major area. [I]f you choose a career within high-energy physics you will discover that you have very limited options. Very few get permanent positions and if you don't get that you cannot make use of your capabilities. […] You have lots more options as a biophysicist. The older disciplines are starting to get exhausted even though nuclear scientists claim that there are still lots of uncovered areas, they will have a hard time.* (P78/ML)

A male associate professor describes the impact of historical changes this way:

> *It is rather a negative development, because the subject of physics had extremely much prestige at that time in the 50ies and 60ies, because of the nuclear bomb. It was a shock and a magnificent thing to the world in 1945. And suddenly you became aware that physics could be amazingly important and very crucial, and Niels Bohr was seen as a God at that time, and that has gradually subsided now that physics is a more normal subject. Now its importance is on the increase again and getting political attention. Because the politicians think that if you go for technical and scientific studies, the economy will better. And we thrive because of this economically. Nanotechnology is a good example. […] It is a hot issue now. And a lot of money is put into that.* (P53/MS)

Today hardly anyone works with nuclear physics (P51/MS & P53/MS). Some of the new areas like nanotechnology and bio-physics enjoy a strong prosperity thanks to political intervention. Though physicists claim not to be bowing to political trends, one of the most noticeable changes is that new areas of what is considered more industry-friendly useful research keep popping up and attract new people. These new areas are generally characterized by breaking down the boundaries between disciplines within physics and between physics and neighbouring disciplines.

> *Traditional physics experienced its years of glory in the 30s and the 60s with the A-bomb that really brought it on the map. […] Since then it has become less prestigious within the world of physics as well as outside. As a discipline it is not as fertile as it used to be, new fields have cropped up, chaos in the eighties, complexity, and nanotechnology must be a hybrid between physics and chemistry and biophysics lies somewhere between physics and bio-chemistry and they have become fields of equal standing.* (P78/ML)

> *[A]lot of the new sciences, like for instance chaos, attack very real issues as opposed to elementary particle physics. […] Nanophysics is not that abstract and it is a fairly new field and very cross-disciplinary. The centre of action is very often [found] in a combination of scientific*

> *disciplines like chemistry, biology and physics and other natural sciences.* (P76/FL)

Researchers who want to make careers have to keep up with the changes by changing fields, too.

> *I have changed fields a couple of times now. So I do not really know. The field I am in now is relatively new […] There are probably other – new opportunities come into existence every day. So yes, I would have to say there is an increasing tendency to change now than there was at that time.* (P51/MS)

New generations of physicists share an interest in these subjects, and some feel that the 'old' generations have been blocking for younger researchers' career possibilities. Thus we can assume physics will face even bigger changes when the 'older' generation retires in a few years and new competencies are required.

> *The big bunch of physicists that are now 60 years old shows that it's not all of them who are still competent. There are some who wouldn't stand a chance if they should get an equivalent job today. And also today you turn down a lot of very intelligent young researchers because there's a lot of the old physicist who do not want to give up their job position before they get their retirement pay. And that's a pity. And that's something that scares young scientists.* (P59/ML)

The physicists' collective narrative is homogenous when it comes to the story of the rise and fall of nuclear physics, but while some believe the respect for physics as such is declining others see a new and more interdisciplinary physics rising. For the latter group of physicists, things have improved in the past five years and again external politics have had a decisive influence. When the wall broke down in 1989 the politicians' will to support the particular areas within physics connected to weapon development also seemed to diminish. In 2001, a lot of physicist activities in centres relating to the environmental area were closed down by politicians. New political initiatives from 2003 onwards have placed physics in a much more favourable position by pumping huge amounts of state funding

into particular selected areas, improved possibilities for funding and better salaries, and this change has also been noticed among the academic staff.

> *I got the first permanent position when I was 41. But that was a time of crises. It is all different now for the young people. I think there are some jobs now. In this new area here, I think there are some good chances for the young people. And you do not have to wait a long time to get it.* (P51/MS)

Some of the physicists, even those who benefit from the political decisions to promote nanotechnology, speculated whether this is just a "trend" which is founded more in politics than in physics. They talk of '*old boys in physics*' who support the '*hype'* of nanotechnology to get funding from the *'Money of the North See Oil'* (P90/FL, P80/ML).

> *I do not know if you remember, but it was to be spent on research in nanotechnology. And they needed to find out how it was to be distributed, so all the leaders sat down and found out what was most important. And it is totally impossible […].* (P90/FL)

> *[T]he dotcom bubble that burst, which was the new technology that was supposed to save the world economy, then there was the telecom bubble, which was the next big stake, and then nanotechnology came about as one of the next things, which were supposed to take over. And people had difficulties accepting the hype that suddenly came with it.* (P80/ML)

All fields within in physics are changing concurrently with new technological innovations.

> *Yes it has changed. All fields have changed, especially those with a lot of data handling, which has something to do with computer technology. […] It is hard to imagine how it would have been without computers.* (P88/FL)

With these changes in fields, new people with competences enter the system, and the new fields (such as nanotechnology and medical physics) seem to attract women in particular.

2.4 Summary of Academic Structure and Changes

Changes in academic work life have not only been ruled by internal factors decided by the scientists themselves as scientists have often claimed in their "ideal" descriptions of science.[5] On the contrary, the field of physics seems to be very sensitive to political changes that make some fields flourish and others wither away. In the period of the cold war, nuclear physics had its heydays, but when political priorities change so can the popularity of fields. In the beginning of the 21st Century, environmental research was closed down by the politicians, but successive to the recognition of climate changes, climate research flourished. The new interdisciplinary physics emerging today seems to be tied up with a political wish for 'invoice-research' with a high degree of immediate usefulness. Male stayers, especially those with high seniority, relate more negatively to these changes in academia than do the female stayers. The male stayers generally have much more to say about changes than the female stayers or as well as the male and female leavers. Taking into account the physicists' hierarchical position and their age, it seems that these factors, rather than gender or 'leaver' status, are decisive for their knowledge of and attitude towards the historical changes and closer understanding of the power games in academia. One clear difference between male and female physicists is, however, that women seem less focussed on the "big" political issues and look more into "personally relevant" changes in the local environment. They are also much more focused on the changes relating to the emergence of more and more women into academia.

[5] As described by Robert Merton in his description of the scientific CUDOS norms: Communism, Universalism, Disinterestedness, Organized Scepticism – which were the scientists' ideal descriptions of science. The ideal scientist would practice on equal terms with all scientists around the world regardless of gender, race etc., and the designation of excellence in science would be based on a value free universal sharing of knowledge all over the world, where selection was only based on an organized scepticism of scientific results and a disinterestedness in worldly matters (Merton 1942).

3. Career Path

What makes somebody interested in physics? Is it typically a family member who awakes the curiosity? Does the interest spring from certain childhood games or educational books? Or is it rather encouragement from teachers and later mentors who directs you?

The interviews in our data hold detailed information about the physicists' narrative of their professional lives from the time of school till their present position. Unfortunately, the scope of this publication does not allow us to go into depth with all aspects of these life stories.

3.1 Getting into Physics

In the following, we will look at some of the factors the physicists have pointed to as motivating for getting into physics. We will also touch upon recurring factors that are perceived to be influential in becoming an academic physics researcher. These factors will be looked upon in relation to our a priori categories along the dimensions of gender and status as stayer or leaver.

Family members

Previous studies (e.g. Leslie et al. 1998) have found that women entering into male-dominated fields such as physical sciences are likely to have parents, particularly a father, in that field, too. With respect to the field of engineering, Leslie et al. (1998) reports "that women who become engineers are likely to have fathers who are engineers and that they are likely to marry engineers" (ibid.: 259). Based on such findings as well as comparable findings for Danish physicists (Hasse 2001, 2007), it was decided to include questions concerning the sources of interest for physics in the UPGEM interview guide, in order to disclose the relation for the male and female physicists between being related to a physicist and the interest in physics science.

The Danish data also shows a connection between the female physicists' interest in and choice of physics as their career and the educational and professional background of their parents – typically the

father. The majority of the interviewed female physicists have been inspired to study physics and to pursue a career in physics by their father. It appears their father's occupation often served to exemplify that physics is a possible career, as one of the female physicist explains:

> *My father is a physicist and a majority of the women in here have a connection to physics that way around. […] I doubt that I would have considered that [i.e. being a physicist] at all in different circumstances.* (P68/FS)

The following quotation from another female interviewee indicates that support and encouragement from family or other close relatives (who know the field) may play an important role.

> *I have received a lot of support from home, my dad is also a physicist and he has always supported me and said "of course you can do it, and you should just continue and try", and that helped a lot the first few years I was studying.* (P64/FL)

However, although "physicist fathers" or other family members seem to initiate their daughters' interest and entry into physics, we do not find indications that they optimise their daughters' chances of staying in academic research. In fact, the number of "physicist fathers" is relatively even among female leavers and stayers, with a slight majority among the leavers.

Interestingly, among the male interviewees, the presence of a physicist in the near family does not come up as a particularly motivating factor for getting interested in physics nor in terms of embarking on a career as a physics researcher.

> *I would say at age 10–15 […] I had really gone many steps beyond the point where my parents are pointing things out to me. I was studying things on my own. For my own sake, and not because my parents were encouraging this in any way. I was really fascinated by theses things.* (P84/MS)

In fact, very few of the male interviewees have close family members who are physicists. Moreover, a number of the male interviewees are the first academics in their family. 50% of the 16 male physicists have

broken away from their social heritage. This circumstance is less apparent among the female interviewees, where only approx. 20% (of the 24 females in the survey) have a non-academic family background. Put differently, when comparing along the gender dimension, more of the male interviewees have, in comparison to their female counterparts, lived out what many define as a nerdy interest and decided to make a research career of this interest, even though they come from families with no tradition of studying. Nonetheless, these male physicists do generally not express a feeling of lacking support from their family in their choice of study. In fact, none of the interviewees make noteworthy references to their family background when describing their professional life stories after the acquired master degree.

Childhood play

Instead of pointing to family as a source of inspiration, the male interviewees tend to refer to a childhood curiosity to understand the workings of the world. Common for many of the males, this curiosity originates from an urge to go "*underneath the surface and laying bare the underlying mechanisms of everything"* (P69/MS*)*, and is typically mentioned in references to childhood play.[6] Others find it difficult to point to a specific source, but note that the interest is "*something that came from within"* (P84/MS). Finally reading interesting books or playing with technical devices have also contributed to spurring their interest.

> *As a boy I had no trouble taking a clock apart to see how it worked and then putting it back together, with a couple of parts left that is, but that has always excited me. I have always read a lot about it.* (P69/MS)

Compared to the narrated life stories of the female interviewees, the males' narratives about the attraction to and exploration of physics comprise more joyful terms such as *exciting* (P69/MS), *fascinating* (P84/MS, P69/MS, P80/ML, P59/ML & P56/MS), *fantastic* (P75/ML, P78/ML & P84/MS), *beautiful* (P56/MS, (P69/MS), and *love* (P59/ML, P69/MS, P84/MS & P87/ML). Put together they convey a great passion

[6] Comparable results have been found important in other studies of physicists' childhood play (Hasse 2001, 2007).

for the field they are working in as adults today. We will return to the issue of love for physics in the section concerning *Identity*.

Poor teachers

Regarding sources of inspiration outside the family, the females typically point to positive experiences in high school, i.e. that they were good students and managed to get good grades in maths and physics. Few mention the positive influence of their physics teacher, but in most cases the opposite is the case; a bad teacher almost turned them completely off physics.

> *My primary school physics teacher was terribly boring. I did not like physics at all […] I was terrified of physics just like all the other girls in my class. […] Right, well I attended upper secondary school, and I had a brilliant physics teacher. And that made me interested in physics. Before upper secondary school, I had not had any particular interest in physics. So she inspired me to study physics. And I started university right after graduating from secondary school.* (P74/FL)

Such statements confirm a recent study on the impact of the relation between the physics schoolteacher and the pupils' interest and motivation for the field (Sinding 2007). In fact, the issue of the poor physics teacher in school, primary as well as high school, has come up in almost all of the Danish interviews. A renowned female physicist explains that the university departments see a clear connection between high schools with competent and inspiring physics teachers and the degree of attendance at universities:

> *[W]hen we say we can see that students come to our course from a certain secondary school, they come from the schools where the good teachers work; those that enjoy teaching the subject and are able to motivate their students and keep up with what's happening in the field. […] For many years, I have helped making a course for second year students at secondary schools. Again, it's specific secondary school students who come for that. An investigation was made at some point about it, and it found a clear connection between the teachers and the students who participated in this supplementary training; it's the active and interested physics teachers.* (P71/FS)

At university level, a good (i.e. an approachable and friendly) teacher also seems to be important for the female students' successful studies, possibly because they place comparatively greater emphasis on the feeling of being accepted or belonging.

> *I was impressed because there was a lecturer who I had not had [...] I remember we were celebrating a birthday in the assembly hall, and he sits down and he knows all our names by heart. It was great! I think he saved me. Otherwise I would never have passed. I was so impressed!* (P67/FL)

Unfortunately, the problem of incompetent and/or problematic teachers seems to haunt the females at university level, too. Though it is not all of the Danish interviewed female physicists who are discriminated against because of their gender, four different female physicists tell of university teachers who apparently believe that women are either incapable of doing or understanding physics, or will not make good physicists:

> *I don't know whether it was my sex or my looks but I have tried being discriminated against by one particular person at [university affiliation]. He was known to believe that women did not make good physicists and I experienced that. As a consequence I chose not to do his course because I did not want to be judged by such a simple person, so I did a different course instead in order to not get bad grades on my report card […] It is actually a very central course compared to what I am working with and I would have liked to have done the course […].* (P54/FS)

The issue of poor teachers, both in high school and at university, is repeating itself in the interviews with the male physicists, but for some of these interviewees the incompetent high school teacher is referred to as a driving force in deciding to continue to study physics at an advanced level:

> *It is quite funny, but it was because I had an incompetent physics teacher in high school. I thought I might do better [laughing].* (P53/MS)

3.2 Embarking on a PhD

Despite the fact that many of the physicists tell stories about personal experiences with de-motivating physics teachers, all our interviewees have chosen to pursue their interest and study physics at university. Naturally, a Master in physics does not necessarily entail a wish of becoming a scientist. Yet, to study for a PhD degree is the first step towards a career in research. From a political stance, the purpose of a PhD is indeed to educate researchers as it is written in the Danish PhD Declaration:

> ***§ 1.*** *The PhD programme is a research education serving, in collaboration with the international research world, to educate researchers at an international level. The PhD degree is to be achieved primarily through guided, active execution research.* (Bekendtgørelse om PhD-uddannelsen og PhD-graden (2002)[7], authors' translation)

Consequently, an underlying assumption in this project was that the interviewees have a (strong) wish for pursuing a research career. However, the attitude among most of the Danish leavers in this sample contradicts the primary purpose of the PhD programme since an ambition of a long-term research career is not the motivation behind their PhD studies.

In Denmark, it is generally very difficult to obtain a research career particularly because the PhD scholarship requires much preparatory work and effort, and many are left to apply year after year. Hence, each year several qualified applicants are never given the chance to begin a research career because the competition for exactly these grants is extremely fierce. Therefore, it is with great surprise we find that many of the interviewees never considered research as a career option when

[7] After the completion of this report, a new PhD declaration has been enforced in Denmark. The new wording is as follows: *§ 1. The PhD programme is a research education which at international level qualifies the PhD student to independently manage research, development and teaching in the private and public sector where a broad knowledge of research is required. Subsection 2. The PhD degree is to be achieved primarily through guided research.* (Bekendtgørelsen om Phd – uddannelsen og PhD graden 2008).

applying for the PhD grant. It is equally surprising to find that many choose to leave academia in favour of a non-scientific job outside academia shortly after the degree is earned. One may wonder whether this is connected with the fact that, in the words of some of the interviewees in this group, they were not very enthusiastic about the PhD but accepted the scholarship because it was offered to them.

Getting a scholarship

Approximately ten of our interviewees seem to have been "persuaded" into a PhD programme. In fact, the use of the term *offer* is far from unique in this connection; that a PhD grant and the idea has been offered come up in the life stories of both the males and female interviewees:

> *I was offered a PhD which related directly to my master thesis […]*
> *Interviewer: So, you were offered the PhD?*
> *Yes, they offered it to me.* (P82/ML)

> *[I]t was probably my surroundings that thought that since I was so talented, of course I should do that. And it sounded very interesting to spend a few extra years on a project, and at the time I didn't know what I wanted to do after my studies, so it was very exciting to do a project and at the same time actually get paid for having fun!* (P86/FL)

Mentors appear to play an influential role in the career path of many of the physicists and particularly so in terms of getting a PhD scholarship. Many of the interviewed physicists (P60/FL, P80/ML, P90/FL, P74/FL, P55/FS, P62/FS, P65/FS, P71/FS, P85/ML, P78/ML, P82/ML & P84/MS) refer directly or indirectly to help from a mentor, typically a professor or associate professor, who 'discovered' them during their Master studies and decided to help them along by virtue of their involvement in a given research group or project.

> *Even PhD and Master Assignments are really the creations of others. You are in an environment were certain questions are interesting, and someone says: "How about taking this problem and work with it?" Then you take it, and do your job. And do it well.* (P87/ML)

Wasted expertise?

The relation to mentors can be described to as 'fathers' helping their 'children' along (P58/MS), but in the following quotation we see that this help sometimes seems wasted because the future PhD students have no intentions of becoming researchers:

> *[S]he mainly did her PhD because it was offered to her and she thought that it could be fun, but she had no illusions of a career within scientific research.*
> *Interviewer: Is there a difference between what you tell your colleagues and how you really feel?*
> *I know her well enough to know that she has never dreamt of doing scientific research, but doing a PhD means a steady job for three years after graduating, so if somebody wants to offer you that, you are likely to take it.* (P57/FS)

In other cases, the leavers seem to realise, during or after their PhD education, that they are specializing in a field, which they, for various reasons, do not find very attractive after all. Or that they are not willing to accept some of the conditions that come with a research career.

> *I realised that the field I was specialising in did not offer a particularly exiting scientific environment. […] I think there were about three groups in the world as a whole dealing with that at the time. […] That was probably what primarily put me off. […] and if I were to have embarked on a new field then, I would have been set back three years or more, because I had specialised so heavily in one field. […] it just didn't seem to be all that important to me anymore.* (P85/ ML)

> *I knew I wanted to do something else. […] Yes, I was quite sure. You could say, overall, if you wander around, being a little uncertain for personal reasons, then the idea of all that traveling and insecurity can become quite significant. And that's probably what happened with me.* (P87/ ML)

Again, one cannot help wondering whether such cases of belated realisation result from the fact that some of the physicists in reality carry out the idea of others and do so because it is a relatively easy way of securing three years of paid work. We will take up the question of wanting to be a researcher in the section *Identity*.

3.3 Mentors and Professors

The role of mentors and professors is somewhat interchangeable in terms of their impact on less experienced physicists' career path. Most professors function as mentors but not all mentors are professors, and in this respect we do find some differences between the two. We will first take a look at the narratives concerning mentors and secondly look at the accounts concerning professors and their perceived connection to the various selection mechanisms that form the career of interviewed physicists and their colleagues.

Mentors

Mentors are often synonymous with supervisors and here the Danish narratives about the professional relationships between supervisors and PhD students show that gender can play a role in the nature of this relationship.

> *I have heard people say that they supervise their female students differently compared to their male students. Male students just have to be pushed hard, girls you have to treat with care and nurse them a bit.* (P57/FS)

As in the case of getting a PhD, mentors can also facilitate the younger physicists' advancement up the career ladder by offering shortcuts to higher career position:

> *[Y]ou need a well-known study director, because they can get you jobs afterwards. He could. He grabbed the telephone and said "I have a young guy here who wants to do a post doc, he is yada yada yada". It is a lot more efficient than applying anonymously all kinds of different places. Or not anonymously, but if you merely send out those standard applications.* (P56/MS)

Mentors not only help you get positions, they are also teachers of all the informal competencies that are necessary to acquire in the process of becoming a physicist, but which can only be learned 'tacitly'.

> *How, for example, you become a manager of science, and how you deal with sometimes sticky issues with students who may not be performing or how you sell yourself in public and how you present your research programme in a way that makes people excited about it. Or how you can do something new and go against the current and do something that has not been done before.* (P84/MS)

However, some mentor(s) are described as more capable of helping younger physicists move further ahead in the system; these mentors have political insight and the right connections. If a prosperous physicist has not found such a mentor, he or she is often a weak player and may be more likely to leave the game, as mentioned by this female leaver:

> *So you mentor's position of power at the crucial point is decisive for the elimination mechanism. So you need people who are willing to stand up for you, who have political flair and who by incident happen to be in the position of power at the given time. And my mentors' positions at the time were not the best.* (P77/FL)

Overall, it is important that the younger physicist knows the right kind of powerful people (P66/MS, P80/ML, P77/FL, P73/MS); the mentors must have a promising network and the aspiring physicist must also be able to learn how to use these powerful networks. Two male leavers describe the situation as follows:

> *[T]here were opportunities of being introduced to scientific networks that I didn't take advantage of. I think that my supervisor at the time would probably have been very helpful in that respect had I been more open myself […] Obviously, I was wearing blinkers, but in that respect, I was not worse than most others were. In fact I was pretty well-functioning socially speaking compared to some others. I am simply saying that they could have done more to inform us of the possibilities available.* (P85/ML)

> *[I]t can be difficult for us researchers, who work together in small groups, to build alliances with the right people. And there is an alarming high degree of nepotism in this system. And it's all about having the right connections.* (P59/ML)

Professors

The Danish physicists do not perceive their professors to be as powerful as professors in e.g. Italy or Germany (P51/MS, P58/MS & P90/FL). Several describe the structure as flat; a sense of a strong formal hierarchy is generally absent (P55/FS, P61/FS, P57/FS, P62/FS, P63/FS, P70/FS and P78/ML), and the environment is not characterized by strong leadership, even though people generally know who makes the decisions in the end (P62/FS, P61/FS and P86/FL). Though PhD students sometimes feel left out of the decision-making structures, they are more involved in the everyday life at the institutes than they have previously been (P68/FS).

> *I think there is a very laid-back atmosphere among senior scientists and PhD students and people writing their thesis in general. Nobody seems to feel an urge to appear more important than they are among the people with permanent position as opposed to the rest of us, not in my group anyway. It is generally very informal.* (P54/FS)

It is acknowledged that the professors often lay out the general lines of research (P58/MS), but the physicists generally think of themselves as independent researchers.

> *Well in my group it is anarchy. People decide themselves what they want to do.* (P55/FS)

As in the case of mentors, professors can also influence the career paths of younger researchers in different ways. They can become sources of inspiration and through their personal appearance influence the kind of subjects the students end up studying (P53/MS, P80/ML & P79/FL). Friendly, personal relations between students and professors can also help career paths along. It may pave the way for students to come to study abroad, join conferences, obtain a PhD or a position (P55/FS, P53/MS & P60/FL). In other cases, students benefit from personal guidance (P70/FS).

As in many disciplines, it is very common for young Danish physics researchers to write articles together with the professor who is/was their supervisor (P71/FS & P83/FL), and it is often an advantage for young

researchers to 'learn the trade' of publishing from more experienced colleagues (P54/FS). However, the price of a close relationship may be that the younger aspirant feels obliged to cooperate uncritically with the supervisor (P59/ML) or that the relationship evolves into a competition because both parties become experts in the same area (P76/FL). And though professors often use their position to encourage and make young students flourish (P70/FS & P71/FS) the opposite can also be the case – even in situations where the less powerful has reached the level of associate professor (P76/FL).

Especially the younger female physicists seem to express awareness of how they are treated in everyday life situations at the institutes. As mentioned in *Getting into physics*, one female PhD student (P54/FS) gives an account of a discriminatory teacher at university. A female group leader also mentions that support and encouragement is important to all, but maybe more so to the female physicists than the males (P71/FS). Our narratives also reveal that some professors exploit the work of their students; however, it seems this is more common when Danish young researchers work with foreign high-status professors:

> *He is used to be able to fly in and say "can we look at that?", and then you are honoured that he wants to work with you, and then you end up doing all the work yourself. It is not an equal cooperation. It has not been very gratifying I think.* (P56/MS)

The road to becoming a professor is not an easy path to describe – a combination of high skills, timing and contacts is needed. Possibly for that reason, not all of the interviewees see this as a position they can obtain themselves (P58/MS).

> *There have, of course, been times when I have considered it, but I have realised at once that this and that person would apply as well and would be much more qualified. It would be meaningless to try out.* (P53/MS)

As this quotation also illustrates, fighting for a professorship involves competition. Thus, one must not be afraid of competing.[8] Others mention initiative, the ability to raise money and attract students as important competencies (P53/MS & P91/ML).

Nonetheless, it is difficult to define the exact competencies needed because the physicists do not always find the criteria for selecting individuals transparent; ulterior 'political' competition concerning which areas are next in line for a professorship is also essential, for instance (P59/ML & P84/MS).

Career advancements

As touched upon in the introduction, career mobility in academia is not always based on a transparent meritocracy (Brouns & Addis 2004). This finding is confirmed by the majority of the Danish interviewees, particularly the more experienced physicists who have more knowledge of the system. Their narratives clearly show that the selection mechanisms at the institutes in this survey are not solely based on formal competences but rest on an informal or even unjust system where individuals do not enjoy career promotion because of scientific qualifications but rather because they hold a seat in boards with (other) powerful people or are friendly with influential persons etc. The physicists refer to this affiliation based selection mechanism as a system of '*nepotism*' (P54/FS, P56/MS, P58/MS, P59/ML, P82/ML & P77/FL).

> *I think that there are other aspects that are problematic at university. It seems as if the people who get the permanent positions at university do not get their positions because of their professional qualifications […] There is some sort of strong nepotism going on. I cannot prove it of course, as these reasons never appear in the letters to the Dean requesting this particular candidate to get the job but I definitely had the feeling that these matters had been settled in advance, who the successful candidate would be.* (P54/FS)

[8] See the section *Workplace Environment* for a description of the competitive work environment.

> *Everything here is secret. Everything, everything is secret! And I do not know who made those rules but they are very strange rules! They enhance nepotism.* (P56/MS)

Put differently, networks are very important for candidates who seek a permanent position. Regarding candidates for a professorship, one's network and contacts appear to be even more crucial. A prospect for a professorship must be the obvious choice within a given subject area. In order to reach that position, i.e. to get ahead in the political and social network, it is important to know how to 'play the social game' (P74/FL, P75/FL & P77/FL). The consequence of lacking social competencies may be that a very individualistic, extremely intelligent scientist do not get a well-earned position.

> *And it is no secret that this can create many problems for people like [X] who is a great guy, extremely intelligent and very competent, but he is very political incorrect. […] So one can create problems for himself by backing the wrong horse and not cooperating with the people who sit in the right committees.* (P59/ML)

Selection mechanisms in academia that do not solely relate to physics competences but also social and personal qualities, and even the gender of the person, seem to favour some and exclude others:

> *There is no tradition for employing women in [a University in DK]. There has never been a woman in a permanent position in the physics department there. So I experienced this as a reason why I could not fit in there.* (P77/FL)

On the basis of the narratives of the professors in this data, it appears that once a person has won his or her way to a professorship he/she has no intentions of leaving academia – or research for that matter. However, they do consider leaving their home university in Denmark to work with research abroad for some years to seek new challenges and join more advanced research groups internationally.

Apart from one male stayer, the remaining seven male stayers have presently no intentions of leaving research in academia. With respect to the female stayers five of eleven still see themselves in academic

research ten years from now. The remaining part do consider the possibility of leaving academia due to various interwoven structural and social factors inherent in the organization of research careers in academia. In *Reasons for Leaving*, we will take a closer look at the concerns that may lead some of our stayers to leave academia and/or research in the future.

3.4 Summary of Career Path

The Danish data indicate a slight gender difference regarding the motivation for studying physics and taking up physics as a career, as more female physicists have been inspired to pursue a career in physics by a close family member, while a number of the men refer to an intrinsic interest. More male than female interviewees, however, have broken away from their (non-academic) social heritage. Danes have long been discussing the impact of school teachers on the low intake of students in physics, and our narratives suggest that more competent and approachable teachers would increase the number of female students in the physics departments.

Also, the female students' success with their studies seems to be more dependent on friendly teachers at the level of high school and university, while the male students seem less sensitive and even bring forth incompetent teachers as a driving force. A present Danish quantitative survey, *Women in Physical Science*, finds, for instance, that 34% of the participating women tick off support and encouragement from another researcher as sources of inspiration to study physics. Only 16% of the men mention the same sources (Svinth 2008). This emphasis on personal encouragement makes it all the more problematic that in our (relatively small) sample, four women have experienced being discriminated against and considered incompetent by teachers in school as well teachers, mentors and colleagues at universities.

We have also found that a researcher's career advancement depends on a complex combination of formal and informal competences. Most of the interviewed physicists have one or more mentor(s) who have been or are still helping them navigate through the tacit rules of physicists' activity. Many of the narratives point to the easy access to PhD scholarships in physics in Denmark. The material shows no clear signs of

gender discrimination in this matter, but we do find that slightly more leavers than stayers talk of this issue. Moreover, we find that some embark on a PhD without ambitions of working as a researcher. Consequently, one may ask whether the easy with which a PhD scholarship is won in physics adds to the risk of brain drain[9] within this discipline?

Finally, we have seen that knowing how to build and use a strong network is pivotal for career advancement – from the PhD grant to a permanent position and the professorship. It is very difficult to detect gender differences in these subtle selection mechanisms, but we do find that the male interviewees are more outspoken in their description of this tacit system of nepotism. However, we also find that more male stayers than female stayers are likely to actually stay in academic research.

4. Identity

This section will discuss the different attitudes to the Danish stereotypical image of a physicist as it is depicted in the public context. Moreover, we will go into narratives that describe the physicists' perception of their personal identity in relation to their professional identity. All of our interviewees clearly see themselves as physicists but not all of them see themselves as researchers.

4.1 Love for Physics

The interest in and joy of working with physics that is expressed by all of our interviewees when talking of getting into this field are reiterated when the physicists' narratives describe their stand on job satisfaction. To many of the interviewees, males and females, physics plays a great part in their lives – not only during the work day but also in terms of preferred reading in the evening or when going on holiday (P90/FL).

[9] For a discussion of brain drain see e.g. Blagojevic et. al (2003).

Having fun

An important aspect of this content is the physicists' (male as well as female) emphasis on having fun while working, as it is expressed by this female stayer:

> *I think it is fun and I have promised myself to quit the day I don't find it fun anymore.* (P54/FS)

In *Getting into physics* we saw that the males, to a higher extent than the females, tend to convey an intrinsic interest in and fascination with the fact that '*everything is physics*' (P53/MS). Although this attitude may also be found among the female physicists, the female leavers, especially, convey a more practical approach to their choice of career; an approach that takes job opportunities outside academia into consideration.

> *I researched what possibilities I had if I wanted to do something with physics and mathematics. And then there was Geophysics, which is, I don't suppose you could call it soft physics because it isn't, but more practical physics perhaps: practical and useful physics. And […] there were more possibilities afterwards.* (P72/FL)

Yet, most of our interviewees, irrespective of gender, agree that physics is fun! This feeling seems to stem from a deep felt passion for physics in itself, but also from the pleasure of discovering new things (P57/FS & P54/FS) and thus being stimulated. The stayers in particular describe this pleasure as rewarding. Physics research is defined as fun because it is creative (P83/FL) and allows one to play around (P81/FL, P87/ML & P73/MS).

Irrespective of field, gender, and status (as either leaver or stayer) the interviewed physicists seem to possess an insatiable professional curiosity. Generally our interviewees do not seem to have entered into physics in the hope of making revolutionary discoveries, but more to work with their field of choice and through the daily work satisfy their own curiosity.

> *I have chosen this exclusively because I find it a lot of fun. That was my approach when I started. It was not because I had dreams about making a difference. It was because I thought it was fun.* (P65/FS)

> *I have never had any false notion that someday I would make a crucial discovery. I never dreamed about or strove for something like that. I have been enough of a realist to acknowledge that I have a better chance of winning the lottery than making such a discovery.* (P69/MS)

In terms of job satisfaction, a sense of idealism and dedication shines through among the stayers especially, as can be seen in this female leaver's description of her former colleagues in academia:

> *I think this is something that is a bit taboo, but I think that they might have had that calling that has driven them to finish everything. I have changed, so there must be something about the academic dedication in terms of staying in the field.* (P83/FL)

All are well aware of the job opportunities outside academia and although they may appear tempting in terms of pay and work hours, drawbacks such as routinized research (P57/FS) and less independence (P90/FL & P61/FS) refrain a number of the stayers from considering leaving academia.

> *There are lots of great jobs in the business world which are nice places to be. […] And in that way it is a good thing that the salary is not that big [in academia] because you need to have the need to do it and the idealism. You should not stay in academics because of the pay. It ought to be because of the fun in it. It should not be because of the power. It has to be something else.* (P51/MS)

Being a physicist – and a researcher?

Another characteristic common to all of the Danish interviewed physicists is that they clearly see themselves as physicists. Strikingly, none of the leavers in this sample have left academia because they lost interest in physics or no longer considered physics fun. Even the group of leavers who prefer to work with administrative tasks expresses a continued passion for physics. But, as we saw in *Embarking on a PhD*, not all of our interviewees wish to work as researchers – despite the fact they hold a PhD degree in physics. Some know right from the outset or gradually realize that they cannot see themselves as researchers. The following two quotations from female leavers offer an insight into two

life stories; one where the offering of a PhD scholarship is questionable, the other where the requirements of innovation and creativity in academia turned out to be incompatible with her personality:

> *I was a little doubtful of my career, because I was rather confident that I would not be a researcher my whole life. […] I never got the job I wanted, so I started a Ph.D., which I was offered, but I wasn't that interested because a PhD leads to a position as a researcher.* (P88/FL)

> *When my PhD was almost finished, I could see that I probably wasn't meant to be a research scientist at university. It didn't really fit me. I'm probably not that innovative kind, more like the one who implements things instead. And that doesn't go very well with the university.* (P86/FL)

4.2 Role Models

When the physicists were asked to describe possible role models or admirable colleagues, certain characteristics reoccur as important. Some of the recurring characteristics which the physicists (male as well as female) point to are a broad knowledge of physics and scientific insight (P53/MS, P68/FS, P54/FS, P58/MS, P66/MS, P71/FS, P75/ML, P76/FL & P80/ML), being good at disseminating (difficult) topics (P58/MS, P60/FL, P67/FL, P70/FS, P72/FL, P74/FL, P79/FL, P81/FL & P83/FL), being able to keep focus on and interest in a specific subject for a very long time (the latter is stated more often by the males than the females) (P56/MS, P75/ML & P91/ML), and being able to balance professional interests with other interests in life (P65/FS, P63/FS, P56/MS, P69/MS, P79/FL & P90/FL).

A number of the interviewed physicists find it difficult to point to a definite role model within the realm of physics. Instead, it is easier for them to mention Danish and/or international colleagues who they find inspirational because they are intelligent, proficient physicists (P77/FL, P53/MS, P55/FS, P56/MS, P60/FL & P87/ML). Moreover, the interviewees tend to stress interest and involvement as very positive characteristics of their colleagues. On the negative side, however, we find a 'one-track mind' that impedes casual conversation. In fact, the personal

qualities of the inspirational physicists are not always the object of admiration, wherefore a number of the interviewees differentiate between personal and professional physics qualities. If a physicist is perceived to be particularly proficient and possesses great personal qualities, he or she is typically pointed out as a possible role model. In the opposite case, i.e. if the otherwise admired physicist possesses less fortunate personal qualities, he or she is not referred to as a role model but simply as a highly skilled physicist.

With respect to role models we have encountered noteworthy gender diversity; hardly any of the interviewees are able to think of a female role model. This is not to say there are no great female physicists but simply that only few female physicists have achieved a position (typically professorship) that enables them to become a role model for others.

Finally, a shared admiration seems to prevail among the interviewed physicists who are (fully or partly) educated at the Niels Bohr Institute, University of Copenhagen. All, except one, mention a particular person who has contributed to their positive experience of their studies and involvement in the physics environment during their educational course. Jens Martin Knudsen[10], a Danish astro-physicist, is admired for his inspiring teaching and excellent dissemination skills, his interest and involvement in the life and well-being of the students, and for his broad and philosophical perspective on physics.

4.3 The Stereotypical Physicist

This section will first deal with the interviewees' description of the societal stereotypical image of physicists and physics. Secondly, we will focus on the physicists' identification with this stereotype and their own (stereotypical) description of each other.

[10] Jens Martin Knudsen (1930-2005) was employed at University of Copenhagen. The interviewers did not ask about him during the interviews. His name was mentioned in connection with a question concerning role models.

Societal stereotypes

Overall, the interviewed physicists give very uniform descriptions of what they believe is the societal stereotype of a physicist in Denmark. Most acknowledge that the stereotypical image largely resembles that of Albert Einstein in terms of looks. Regarding other attributes, they (P58/MS, P81/FL, P83/FL, P86/FL, P89/FL, P52/FS, P61/FS, P65/FS, P70/FS, P51/MS, P75/ML, P80/ML, P82/ML & P87/ML) mention extreme intelligence, absent-mindedness, varying degrees of social disability, and last but not least being male. Being a physicist can complicate social interaction outside physics, as a number of the female interviewees note:

> *[W]hen I was a student is was a common joke that if you wanted to leave a party early you just had to say you were a physicist – it's sort of the opposite of a nurse.* (P68/FS)

Moreover, some mention that people generally think of physics '*as interesting but a bit strange and incomprehensible*' (P66/MS) and the majority agree that this idea is closely connected to the notion of the mad scientist.

> *And if there is one thing that is not "in", in this society, and I know this from personal experience, then it's to introduce yourself as a scientist. It will close down any conversation.* (P69/MS)

The emphasis on maleness is reflected in many of the females' description of people's reactions to their choice of becoming a physicist; they have been met with astonishment that revealed tacit gender diversity.

> *I have often been told: 'Oh my god, you don't look like a physicist at all'. Many, many times.*
> *Interviewer: What did they expect?*
> *Firstly, they expected a man and then they expected someone who sits in front of the computer and finds it extremely interesting to work on binary codes.* (P88/FL)

> *I had never thought it should be strange to study physics as a woman until I started there. People were like: 'oh my God!' I mean, people do*

> *not ask men 'isn't that difficult?' […] I think that as a woman you get that question more often […] or 'oh God no!' or 'that is really weird'. I was surprised.* (P60/FL)

Naturally, all of the above mentioned attributes do not always cling to the stereotype. The more predominant quality that comes up in almost all of the physicists' accounts seems to be the idea of extreme intelligence. In some cases the interviewees find it scares non-physicists away whereas in other cases the physicists play on the idea.

> *[I]n business situations, we use the fact that I am physicist […] It provokes a relatively predictable reaction; people go: 'Uuuh, Ahhh' […] 'He must be smart.' […] Or if we had to account for having created something smart that others hadn't, we used the fact that I'm a physicist. […] We made it part of the myth of why we were so good […] They were filled with awe […] and we played it.*
> *Interviewer: And it made a difference?*
> *Absolutely. Works every time.* (P87/ML)

The association of physics with the mad scientist and natural science as such, has a long history in Denmark, and almost all of the interviewees agree that the portrayal of physics in the Danish media since the 1980s has had a very negative effect.

> *Well, there are some horrible images of physicists in the media, which kind of function as the model for people's perception of what a physicist is.* (P74/FL)

Many are particularly frustrated with the great exposure of a Danish male physicist in the national media during the 1990s, because they feel he has been exploited by the media as entertainment to represent the image of the mad scientist rather than a person striving to enlighten the population. Many of the physicists are very direct in their description and frustration of this situation:

> *He is a wonderful man and a good colleague […] I am interested in the very areas [he] specializes in […] I find it sad when we have [physics] mediators who go on television and make absolutely no sense. […] And*

> *that means the purpose of putting him on screen is not to shed light on physics, it's more like a […] show meant to confirm people's impression of physicists as slightly eccentric people who make no sense and who exude a lot of enthusiasm for their own little field of interest, but who are not really of any use in the real world.* (P69/MS)

Combined with a gradual decline in the esteem of science in Denmark (see the section on academic change) and the media depiction of physics as abstract and strange, many of the interviewed physicists sense that the (wo)man in the street find it hard to relate to the discipline:

> *I have often met the prejudice that physicists are nerdy, with no social competence, and that they are a bit eccentric.* (P85/ML)

> *I usually say that if I sat at a bar and someone asked what I did for a living and I said that I was a physicist people would run away screaming. But if I said I was a polar researcher […] then people would say it sounded exciting. So I'm absolutely sure that the general image of physicists is really bad.* (P71/FS)

On a positive note, however, some of the informants (P76/FL, P83/FL, P71/FS & P87/ML) point to a recent constructive trend in the Danish media, which challenges the established image of the strange scientist by offering a more appropriate insight into the diverse work of physicists and natural science in general. Moreover, the political focus on certain fields of physics is also beginning to show its effect in society:

> *Today, you just have to attach the prefix "nano-" to some word, and it will be much more appealing to people. It has suddenly become a bit more hip to be involved with. So I do think there has been an improvement. It probably also has to do with the fact that physics has become, or has come to be perceived as being […] more relevant to the society as a whole.* (P85/ML)

And according to the interviewees, a change like this in society is very much needed.

Stereotypes within physics

As mentioned above, the public stereotype of a physicist is associated with maleness. However, this association does not only apply to the surrounding society but also to some parts of the Danish physics environment itself. A number of the female interviewees (e.g. P52/FS & P54/FS) tell of male colleagues who think physics is a '*man's field just because it is difficult*' (P81/FL). That some perceive physics to be a man's field is also noted by a few of the male interviewees who describe the impact of this tacit knowledge on the female physicists as follows:

> *It might not be easier because there are fewer of them [i.e. women], in terms of student environment and so on, it is probably harder as a woman, because you are more isolated as a woman, and you are definitely more strange as a woman if you do it.* (P80/ ML)

> *I don't think you don't get the female physicists because they don't want to. I think it is because they are not welcome; either because they don't feel welcome or because they actually are not welcome.* (P76/FL)

As we shall see in *Best Practice*, the Danish physics culture contains different attitudes to the association of physics as masculine, and not all groups practise a code of conduct that question the presence and skills of female physicists.

Though the majority of the interviewed physicists do not personally identify with the image of a mad scientist (P74/FL, P72/FL, P60/FL, P81/FL, P86/FL, P89/FL, P55/FS, P57/FS, P70/FS, P51/MS, P80/ML, P82/ML & P85/ML), some of them do admit to being slightly nerdy, just as they think some of their colleagues are nerdy (P56/MS & P73/MS). Being a nerd carries admirable connotations of being extremely intelligent and devoted but also less admirable connotations such as being absent-minded and having limited social abilities.

> *I think I am a semi geek but not quite. I do not think that people think of me as a geek, but when they get to know me they probably will. But at that point they know me.*
> *Interviewer: Is it good or bad to be a geek?*
> *I think it is great. I am doing just fine.* (P70/FS)

> *I guess maybe you are a bit nerdy if you're a real physicist [laughs]. I think that at geophysics we see ourselves as being less nerdy [laughs].* (P72/FL)

4.4 Summary of Identity

All the physicists express a strong interest in and love for their field. However, we do find a more practical or pragmatic approach to physics among the females, whereas the males generally express a basic curiosity towards understanding the workings of the world. We do not find the same differences in terms of our a priori categories stayer/ leaver. They all see themselves as physicists – also after they have left physics research in academia. Yet with respect to maintaining a research career at university, some of the narratives suggest that a certain idealism of dedication to the field is required.

Concerning role models, we find that only one physicist refer to a female role model. Furthermore, more male than female interviewees reject having had a role model at all, and a few more of the females than the males stress personal qualities – or the lack of these – in the physicists they find inspirational.

The physicists describe the Danish societal stereotypical image of themselves as a highly intelligent but slightly eccentric and mad male scientist with an odd appearance. Expectedly, none of the interviewed physicists identify fully with this image. However, they do point to features of the description that may apply to some of their colleagues and in some cases also themselves. In that latter case, the intelligent and nerdy attributes are typically emphasized.

5. Workplace Environment

In this section we will take a look at the gradual exclusion of some, but not others, from physics research in academia – why do some become leavers while others remain stayers?

From the discussions in *Career Path* and *Identity*, part of the reason is to be found in the physicists' interests in and ambitions within physics

research. However, the UPGEM survey finds that part of the reason is to be found in the workplace environment, too.

As previously mentioned, the data material is too rich for us to be able to include all details here. Therefore, this section will examine two of the more relevant points that have come up in the physicists' narratives about issues we see as contributing to the differentiation between stayers and leavers as well as female and male. Competition is a central element to all of the interviewees, but sexual harassment and harassment in general have also come up as adding to the disparity between the genders.

5.1 Competition at Work

The notion of competition is a recurrent topic in the physicists' accounts of the academic research environment and everyday working life. When looking at the recollections put together as an intricate narrative, two types of competition emerge: open and hidden competition.

Open competition

Open competition mainly goes on between research groups, fields or disciplines or even across nations. It is typically constructive and characterised by work procedures and practices where colleagues show group orientation by e.g. planning strategies jointly and where all know who is competing for specific funding. Difference in the prestige attached to the specific fields within physics can create competition between these fields just as groups within the same field may be competing, too. A male stayer describes the competitive atmosphere as '*a universal phenomenon. It goes on all over the world. But there is a battle*' (P56/MS). An integral element in academic research is to question each other's findings wherefore one must possess a persistent will and ability to argue, prove and stand up for one's point.

> *They didn't accept the theory we brought which is a part of how research is done; you retain your point of view and continue to do so.*

> *You spend a lot of energy on fighting the others and move yourself forwards […]. In twenty years we can see who was right.* (P88/FL)

Open competition is also defined as the ongoing race of being the first to publish new results (P57/FS & P66/MS) in the most prestigious journals, and such competition between the groups seems, in many cases, to strengthen in-group collaboration. Since everybody is competing for more or less the same money, the physicists generally refer to the academic research environment as highly competitive:

> *In general there is definitely competition, because your career is defined by being able to write some good articles and be the first to say something relevant. So the discipline as such is very competitive.* (P87/ML)

The male stayers and leavers have a relatively neutral attitude towards open competition, and seem to acknowledge that "*of course there's competition*" (P66/MS) just as they appear to accept the conditions.

> *[I] think it is just a part of the way that things are done in science; people constantly question what you do and your conclusions and everything else. And you have to get used to that critique because it is part of what we do, and it is part of what you need to do in science.* (P84/MS)

Open competition is generally accepted by all of the interviewed physicists, but the males talk, more often than the females, of open competition as a positive element that drives you to perform better.

> *[I]f the competition doesn't get out of control then I guess it is positive, because like everything else it helps speed up the process a bit and make people more focused, if they know that someone else is interested in something similar, working with something similar.* (P66/MS)

However, the notion that competition has a stimulating effect does not apply to all of the males since some of the male leavers accept that part of the reason why they have left academia is that they did not feel competent enough to win the competition:

> *[T]he competition definitely affected me in the sense that I didn't think I have what it takes.* (P87/ML)

Among the female physicists we find some who see themselves as competitive, some who do not want to deal with it, and some who appear unaware of the competitive environment. In fact, a number of the female stayers seem completely unaware of the competition – open as well as hidden, which stand in strong contrast to the many accounts of the competitive milieu.

> *Interviewer: Is there any competition in other areas? Internationally?*
> *No, not really.*
> *Interviewer: It is not something that you think about?*
> *No I actually do not.* (P65/FS)

However, it would be incorrect to conclude that the female physicists are not competitive since some of the most competitive females are to be found among the stayers.

Certain research groups, our best practice-groups, seem able to approach in-group competition, which is typically hidden, in a more open and constructive manner. With respect to competition for funding and positions respectively, the leader of one of the groups explain that:

> *There is competition for getting the positions, because there are so many who would like a position. But there is not competition for money; it's more a feeling of congregating. We have often made a plan of what we would like to get, and then it's one person from the group who applies for one thing and another who applies for something else. We share that, so it's many people from the group who apply for money. There are never competitive applications.* (P71/FS)

As mentioned, competition for positions is typically an in-group matter which is more or less hidden. In this group it is perceived to constitute real competition whereas competition for funding is not seen as actual competition. The latter is clearly open while the former, i.e. competition for positions, is neither described as hidden nor open. However, the following quotation from a physicist in the same research group tells us

that this in-group competition for positions does not come across as hidden or destructive.

> *There is competition. Also between the countries […] So we do cooperate, and people are good, from the beginning when you plan these projects, at thinking of who is responsible for what. We all work together on things [like] who is the head, who is the main author of the articles that are written in what areas, so those things are clear from the beginning. But there is competition of course. There is also competition here. [The colleague] who popped by before will also be applying for the permanent position this summer [as P68 is]. It is the same people who are applying for the same money.*
> *Interviewer: Does that influence the work atmosphere? Are you all clear on that?*
> *For us it has worked out all right. We are clear on it.* (P68/FS)

Hidden competition

Hidden competition typically occurs on a more personal level, i.e. individual colleagues competing against each other within a research group for one of the few (permanent) positions. As pointed to in *Mentors and Professors*, hidden competition may also break out when two colleagues collaborate closely and specialize in the same matter. In such cases, the hidden competition typically concerns the reputation and prestige of the individual rather than a battle for a permanent position.

Generally speaking, one way of increasing one's chances in this race is to emphasize oneself. Consequently, competition at the personal level is described as a constant need to flaunt one's intelligence, to show that you are doing well and working on something innovative and interesting, and that you stay late at work.

> *There are places, where it turns into a sort of competition about who sat up the latest working on experiments or who worked most hours this week on this particular program.* (P57/FS)

The narratives strongly suggest that hidden competition is of a disreputable nature such as stealing research results from colleagues, stalling the research process of others.

> *Well ugly things may happen there, when people steal each other's ideas […] It's not very nice. You know who it is, but still they are allowed to run around out there.* (P79/FS)

In *Career Path* we saw the importance of "the right connections" for career mobility. In similar ways, the narratives confirm that knowing how to network and take advantage of one's contacts in the system is also part of the strategy in competition:

> *You could see who the really skilled ones were and maybe also who had the right connections.*
> *Interviewer: Is it important that you also have the right connections?*
> *Well, it's not a good idea to have a bad relationship with the most important person. You have to be friendly with the important people.* (P86/FL)

In fact, being able to act and think strategically is perceived of by many to be central in obtaining a successful physics career. Consequently, a great number of the interviewed physicists appear very aware of, on the one hand, knowing, working and being friendly with people who can increase their chances of getting a (permanent) position and, on the other hand, never to reveal interesting observations to possible competitors, nor show signs of weakness.

> *[I]t's everybody against everybody and therefore you have to think very strategically and notice what your colleagues do and what it means when they do this and that and what sort of hidden ulterior motive they have when they do so and so. And that's a bit hard but that's the way it is.* (P63/FS)

The female physicists in this data do generally not have a positive attitude towards hidden competition, and equate academic rivalry with high school intrigues among girls (P63/FS). Interestingly, most of the recollections of hidden competition come from the female leavers.

> *[I] get hurt by that because I do not mind the fact that people are using my ideas but they should be honest about it.*
> *Interviewer: So he saw you as a competitor?*
> *Yes, he did. And I discovered that later on. I did not see myself as a competitor but he definitely did.* (P67/FL)

As the quotation above shows, the seemingly unawareness of (potential) hidden competition among some of the female physicists (P55/FS & P57/FS) results in astonishment and disappointment when they suddenly face unfair acts or hear of bad relations. Most of the female physicists' narratives of this in-group rivalry reveal that they were surprised to discover the hidden competition.

> *Interviewer: Is there competition between employees?*
> *Not that I know of, but there probably is; there are only two funds that give money to our projects so there may be some sort of competition. And you hear that as well: 'Don't be surprised, but these two cannot sit in the same room after this fight they had fifteen years ago about something.' So the longer you get into your career, the more you find out about these things that happen but that you just don't notice on a daily basis.* (P57/FS)

A few of the female leavers refer to hidden competition as a contributory factor in their decision to leave academia. Yet, they tend to present it more as a reluctance to take part in the hidden competition (P90/FL & P77/FL) rather than not being able to live up to it.

> *[W]omen are often accused of not being competitive enough […] there are some who do not have enough willpower to beat their competitors; women who know how to look good professionally but who do not master the rough part of the game. I think that may be the problem. When I look at all the professional women I know, they are just as competitive as the men, but the question is whether they are willing to backstab their competitors. Do they hesitate just a little too long? Some of them might.* (P77/FL)

All of the male interviewees express awareness of competition within groups, and they generally describe the academic research environment

as extremely competitive. Yet, they rarely see it as having had a negative influence on their work or workplace collaborations. Neither do they express that the more or less hidden competition man-to-man has affected them. On the contrary, the majority of the male physicists appear slightly more aware of and willing to accept this condition.

> *It does not annoy us. Of course there's competition.* (P53/MS)

> *Interviewer: You talked about you and a group who did post docs at the same time and applied for the same lecturers' jobs. Was there competition between you?*
> *Yes, of course there was […] it didn't really affect me. We were good friends despite of that.* (P58/MS)

Generally speaking, the male interviewees seem to talk more about the open competition than the hidden.

Hidden competition gone bad

Sometimes hidden in-group competition runs out of control and self-promotion is at the deliberate cost of others. The narratives the physicists tell in this connection are very sensitive and personal, wherefore many of these narratives are not take up in this analysis. Moreover, in order to preserve the anonymity of the interviewees, the following two sections will not list the otherwise used P-numbers; instead we employ fictive names. We will, however, list the gender and status (stayer or leaver) of the interviewees. Some details have also been removed or changed.

> *The atmosphere when you are having lunch is like: 'yes, yes' Because it is very competitive. It is negative. It is not good. It is so very bad. It is one of the worst things about science. I hate it. But you get caught in it yourself, and put questions at conferences that are only posed in order to show that something is wrong, or to show that there is something you know – instead of learning something.* (Simon/MS)

In other cases, (hidden) competition becomes so fierce that it borders on harassment. Such a situation may arise when mentors encourage a particularly competitive atmosphere in a group:

> *[T]here are many supervisors who like to set up competitions between their students. That way they think they will do their best, if there is a constant competition about who gets to use the instruments. That could lead to bullying or at least have the consequence that people feel badly about themselves, having to compete with those that ought to be their friends. It increases your power as supervisor if your students don't have the possibility of joining forces against you.* (Sandra/FS)

The same female also tells of a situation where a male PhD student "*gave up his PhD. because of bullying from other members of his group*".

Another example of competition gone bad stems from the narrative of a female leaver. In this case, the professional teamwork with her former professor ends, for various reasons, in a severe case of harassment in which she, among other things, becomes isolated from the group:

> *He was a very central character in our fairly small department […] and we were all very dependant upon what happened around the professor and it is very hard to participate in a social and professional partnership when you are excluded from speaking to the professor, which I was in a number of ways.* (Sally/FL)

One reason this conflict is allowed to run on is that no one in the group steps in:

> *The others could see this but they couldn't really do anything and it was also subject to taboo.* (Sally/FL)

Though steps eventually were taken, the situation could not be solved, and P76/FL has a strong feeling that though her dismissal (from a permanent position) officially was due to economy, the actual reason was the long-lasting conflict. Here we have another example of a selection mechanism that does not follow a transparent system of competence.

By piecing together the narratives to an intricate story of harassment, we find that the majority of the first-hand recollections are told by the female physicists.

5.2 Sexual Harassment

As we have just seen, hidden competition and competitive interactions bordering on harassment appear to be affecting the female physicists more than the male. In the following we will look into the problems of sexual harassment at the physics institutes in the Danish data. This type of harassment causes a clear gender differentiation as it specifically affects the female members of staff, and thereby adds negatively to the unjust selection mechanisms (Husu 2001).

Surveys and debates on the social working climate for women in physics have found that sexual harassment is an acute problem for many women in physics in the developed countries (e.g. AIP Conference Proceedings). In Denmark, we tend to pride ourselves of a developed gender equality mindset. Nevertheless, a number of initiatives from e.g. the Danish Network for Women in Physics concerning gender inequality and chilly working climate in science point to sexual harassment as a barrier for women's career track in physical science (Hartline 2002).

All informants, men as women, were asked the following question: *Would you be surprised if any of your colleagues ever mentioned sexual harassment or other kinds of harassment as a problem at the work-place?*[12] The elicited narratives show that a clear majority of the Danish physicists would not be surprised to hear about sexual harassment either at their particular workplace or elsewhere in the academic research environment. Often the physicists explain the lack of surprise by the fact that sexual harassment is a common problem at many workplaces or, and this applies to the majority, they (both sexes) have second hand knowledge of such incidences. Moreover, a number of the females have first hand experiences, too. Some of the interviewees reject knowing about cases involving sexual harassment when they first hear the question, but shortly after they contradict that statement by telling of cases they have heard of and sometimes even situations that have involved themselves, too. Only nine (both stayers and leavers) of the 41 interviewed physicists have never heard about any cases of sexual harassment at work. Most of these would also be surprised to hear about

[12] The interview guide followed by all the UPGEM countries is formulated in English but translated into the local languages for the interviews.

it since "*that is something you keep quiet about unless it is serious*" (William/MS).

The statements from both male and female physicists indicate that the actual cases of sexual harassment are of the following nature:

Verbal (14 accounts): e.g. comments and gossip about the physical attributes of some of the female colleagues, unwanted invitations to sex (by male supervisors) and suggested exchange of sex for study assistance (suggested by male supervisor).

Physical (7 accounts): e.g. being groped, attempted kissed and inappropriate conduct at social gatherings.

Psychological (11 accounts): e.g. a continuous subconscious notion that the women must be able to draw the line and ensure appropriate interaction.

The majority of the females and the males indicate that a preferred working environment is characterized by laid-back collegial relations where "*a pat on the back is not a violation of the personal boundaries*" (James/MS). Nevertheless, problems of sexual harassment do exist in the academic research environment of physical science. Before going further into this issue, it must be underlined that the cases of sexual harassment referred to in our material do not imply that sexual harassment is a consistent problem throughout all of academia in Denmark, but rather seem to lead back to certain places and persons. However, this section will not focus on the nature of these cases nor the individuals involved. Instead, we will turn to the cultural context within the physics milieu that seems to permit the occurrence of sexual harassment.

Acknowledging sexual harassment as a problem

One may wonder how sexual harassment can come up in the narrative of a relatively large number of people (in a relatively small sample seen from a quantitative perspective) if only a few individuals instigate these cases.

The answer may be found in many of the physicists' belief that the problem does not only reside in a few individuals but in the lack of will or courage at the level of management and administration to acknowledge sexual harassment as a present problem against which action must

be taken. Earlier international surveys on sexual harassment (e.g. Elix & Martin 1984) have found that in many cases the management eschews acting on complaints because the offenders often hold high positions at the workplace. Similar circumstances are perceived to correspond to the problems of sexual harassment at the implicated institutes in this data:

> *I've told some about it, but the problem is that he has repeated the same things quite a few times and in that connection – I am aware of that he's done sort of the same things in other situations. […] At a time people complained to an official in the Research Council about him and I've talked with the leader of the institute and others about it […] but nothing happens. It doesn't have any consequences for him. […] It's because there's a weak management in general. Still. At the university. […] The management is not fitted out to be a regular management in the HR areas. They have a fear of contact.* (Carol/FS)

Carol explains further that the lacking involvement of the management may be due to the fact that the management is "*not a professional management group and they don't have the wish or the courage or capabilities to confront unpleasant private matters*". A noteworthy common trait in almost all of the narratives from the women who have been exposed to sexual harassment is that the offences have no formal consequences.

> *After many months of arm-twisting I managed to succeed in him getting an official warning. He has a history of transgression, the female students find him unsavoury in his conduct towards them, he has repetitively sexually harassed his secretaries […]. [T]he head of department eventually said: "what do you want me to do about it, [he] is not going to change". So the attitude was that some men are like that and there is nothing we can do about it. And when I started digging, I found a number of files on him but there were others too. He was not alone in doing things that should not be happening at a working place. […] The rector of the university did not want to react on it. The union representative […] said the rector did not consider this a general problem at the university and in my case [the rector] did not wish to act.* (Ellen/FL)

According to some of the narratives, the involved institutes have within the recent years set up impartial procedures for handling complaints about sexual harassment by appointing a male and a female physicist

(both of high status) as contact persons and mediators between two parties if necessary. However, the descriptions of the role of these contact persons vary somewhat from narrative to narrative and it appears that many believe they are primarily supposed to function in relation to students. Despite the fact that the institutions have found it necessary to appoint contact persons, many of the interviewed physicists (male and female) tend to trivialize the matter.

> *Say that a leader of one of the institutes wants to sleep with one of the young researchers, then it might happen that he would take advantage of the situation. I don't hope so but he might. On the other hand a young woman might think that "if I pull up in my skirt a bit, I could get the job position instead of this and that man". It can be both an advantage and a disadvantage.* (Eddy/ML)

The expressed indifference to this problem may be influenced by the unresponsiveness of the management and other prominent persons.

> *It had to do with particular individuals, and it had to do with the fact that when people heard of it they didn't take it seriously. And I think that was the problem they had at [physics institute]*. (Sue/FL)

Only in one instance does a female interviewee tell of an immediate reaction from her supervisor after having reported an incident where a male colleague tries to kiss her on the mouth.

Women on guard

In Denmark, the culture of physics carries connotations of masculinity (Hasse 2002). This being so, the problem of sexual harassment might be more difficult to handle for Danish female physicists compared to female colleagues abroad. Denmark is widely recognised for its advanced gender equality, yet our data strongly suggests a general acceptance that women hold the responsibility for avoiding sexual harassment as they are supposed to be able to draw the line.

According to some of the interviewees, including one of the appointed contact persons, incidents defined as sexual harassment typically come

down *'to smaller misunderstandings about where the boundaries are'* (Darlene/FS).

> *Of course it depends on how serious it is; what you can do and what you cannot do – where some people take it too far, not because they have bad intentions, but because they have a different understanding of where the thin line is.* (ibid.)

The idea that the male has no bad intentions seems to translate into a general notion that women must set the boundaries, as can be seen in this male leaver's recollection of a case involving his wife:

> *[I]t has only actually happened once, I think, when she was [abroad] some […] guy acted foolishly and said stupid things. So it was only verbally. And then it's difficult to say what his intentions really were. Whether he was intentionally harassing her or whether he was just being stupid like men sometimes are when they get drunk. It wasn't during working-hours so to speak. It was under more social circumstances. But other than that, I don't think it has been very prominent. But then again, she has had this female boss who was very good at drawing the line and making clear how much you should put up with.* (Andrew/ML)

The narratives rarely dispute whether the offenders behave wrongly or are guilty. Darlene, for instance, confirms that '*It's very uncomfortable, for all parts, if we have to start litigation. But you have to do it, nobody should feel harassed*'.

However, in groups where it is known that the '*drunken computer scientists have always had the reputation of behaving stupidly at the Friday parties*' (Carrie/FL), or if it is accepted that a man may have '*this flaw that he cannot control himself*' you, as a woman '*must not put yourself in a situation where incidents […] are likely to happen*' (Alice/FS). The data contains several examples of women who believe it is their responsibility to draw the line and/or foresee potentially problematic situations:

> *You have to be able to see it coming, for example, there are certain kinds of people who I would decline even to dance with. Whereas some people might be prone to thinking nothing of it if their supervisor asks them to*

> *dance at a staff party, if I felt that he was looking at me in slightly funny way or something then I would make up an excuse not to do it. I would draw the line there to be on the safe side.* (Sue/FL)

Overall, the data does not suggest a strong pattern of female scientists leaving physics as a direct consequence of sexual harassment; only in one case is this clearly the case. Nonetheless, we argue that sexual harassment does contribute to the informal selection mechanisms by limiting the women's professional and social conduct at the workplace. Some of the female informants who talk of personal considerations following an incident of sexual harassment describe these as trivial or minor. Yet, looking into their narratives, we see a number of serious consequences. Some have to consider whether to find a new mentor/ PhD supervisor or change course and consequently field of specialization and interest:

> *The first year it was my first supervisor […] he asked me to come down to his office and we sat there for a while and had a discussion about why he wanted me to sleep with him and I told him why I didn't want to sleep with him until I left the office […]. It was very annoying at that time, because then I had to consider if I should find another research group. And I had chosen that group because they made something very exiting.* (Carol/FS)

In other cases, one declines an invitation for a visiting research stay abroad (see *Career Path* on the beneficial effect of research stays abroad), others avoid social activities at the workplace whereby they are cut off from potential social networking (see *Career Path* for a discussion of the value of networking in career advancement), and finally one explains how she must remember to dress in a particularly 'non-provocative' way, which indicates that the consequences also reach into the private sphere.

Preventing sexual harassment

Though the numbers of first or second hand accounts of cases involving sexual harassment may seem very high, it is important to stress once again that not all of the universities or all of the research groups in this

survey are marked by these events. In fact, we found a pattern that physicists working in particular research groups have heard of sexual harassment at the institute but have never experienced or heard any of the kind in their own group (our best practice groups). The size of this qualitative data is naturally too small to be representative; however, it is interesting that when we look at the composition of these groups we find a more even representation of both male and female physicists compared to other areas.

> *[T]he best way of preventing sexual harassment is to make sure that there is an even balance of the sexes in a group.* (James/MS)

As we saw in the opening of this section, great differences in power is a common feature in cases of sexual harassment. Likewise, the physicists from these groups agree that a highly uneven division of power, allowing a few "kings" to rule is unhealthy for the collegial milieu. Moreover, qualities such as free communication and interaction within the group, i.e. when people '*like each other and people interact very openly*' (Bruce/MS), are brought forth as an essential element in preventing sexual harassment.

5.3 Summary of Workplace Environment

One of the reasons for examining the issue of competition in academia springs from a hypothesis[13] that we would find more female physicists in less competitive universities. It has, however, proven very difficult to determine which Danish universities are more competitive, and we have therefore not been able to confirm or reject this hypothesis. Instead, we find that though some of the female stayers have a very positive attitude towards open competition and describe themselves as very competitive, the females generally appear to be less willing to compete and acknowledge the relevance of competition as opposed to the male informants.

[13] Based on a pilot project of one interview from each partner country, the researchers in the project formulated collectively 36 hypotheses which constitute points of departure for the analysis.

Moreover, the project also finds that harassment generated by destructive (hidden) competition seems to hurt the female interviewees more than the male, and thereby create a relatively clear gender difference.

Our best practice-groups stand out as having developed open procedures that tackle in-group competition. Situations that are often subject to hidden competition in other groups are here dealt with in a collaborative way. Since we find more women in these research groups than in any other groups or fields participating in the UPGEM survey, one may question whether the constructive handling of competition in these research groups attract and sustain women.

Though incidents of sexual harassment are very often elaborated on in the narratives, the problem is reportedly difficult to address formally. The risk of sexual harassment in certain areas of academia drives some female stayers to be very aware of not putting themselves at risk when engaging in e.g. social activities with colleagues. Moreover, we have found a common notion of women having to draw the line, and thereby prevent such incidents from happening. Clear differences in the attitude towards sexual harassment between stayers and leavers do not emerge.

6. Work and Family Life Reconciliation

As it appears from the introduction, we did not have or tried to obtain any knowledge of the physicists´ family circumstances prior to arranging for interviews. The physicists were only chosen from the parameters of gender and stayer/leaver status. Moreover, we did not have any assumptions that leavers rather than stayers would be parent. Thus, it was somewhat surprising to find the majority of parents among our leavers. In fact, many more of the leavers than the stayers have children (see Table 4 in the Appendix). Moreover, when looking at the distribution of children in our sample, another pattern occurs; female physicists with children tend to be leavers whereas the share of male physicists with children is more equally distributed among the stayers and leavers. The women generally talk more about children than the men, but among the leavers male and female physicists spend an equal

amount of time talking about children and family. Consequently, the question of children has come to play a marked role in the physicists' narratives.

6.1 Are Children and Research Incompatible?

In the narratives (Bruner 1986) of the leavers, we often find the perception that doing research is incompatible with starting a family, since working as a researcher in physics takes up the greater part of one's waking hours. The leavers tend to put forth only two solutions to this problem; either they must quit research in academia or their spouses must take on the main responsibility of home and children. The latter is expressed by the majority of the female leavers and those of the male leavers who are presently employed as college teachers.

Family or research – which is first priority?

When asked whether the physicists would sacrifice important work for their family, many interviewees said "yes" or that they hoped they would. This suggests that they consider family life to be as or more important than their work. However, the perception of *when* work starts to interfere with family life varies a lot. The female physicists express, more often than the male, an unwillingness to spend most of their waking hours doing research, regardless of their family responsibilities.
To take on the family responsibility is generally perceived to influence negatively on one's commitment to work and consequently on the kind of results one gets:

> *It would have been impossible to participate in doing those experiments with only three weeks to spare and look after kids at the same time. It is not an eternally ongoing process, we are dealing with shorter periods of time, but the way you work is not like going home for dinner at six and then go back to work afterwards. Within the world of physics and other sciences, the weeks you have got at your disposal you use in full – you are on. No eight-hour working days.* (P78/ML)

The career of this male leaver (a father of three) has been facilitated by his wife's willingness and, as she works part-time, possibility to take on the main responsibility of their children. Based on observations during

their time as physicists in academia, a number of the female leavers describe the successful physicist as a man who works very long hours and who has a partner who takes on the main family responsibility. In fact, descriptions of the male successful physicist form a very uniform pattern among the leavers and some of the stayers – male as well as female. The following quotation of a female stayer, for instance, represents the attitude that top researchers are often male physicists who have a (non-physicist) wife to take care of the family and thereby allows the man to devote himself to his job:

> *It happens a lot that men have wives who work less. […] Often wives come along, take leave and take care of the family, for instance in many cases the wife works 30 hour a week or less, and the husband has a job that needs more.* (P68/FS)

As a result, these females believe successful physicists must be willing to sacrifice family in favour of work. Nonetheless, the majority of the female leavers and some of the male leavers stress a wish and need to spend time with their children – a wish they often found impossible to fulfil while working in academia:

> *I want to go home and pick up my children and be with them while they are little, that is why I had them, not so they can be in kindergarten until five.* (P64/FL)

Some of the stayers (male as well as female) notice that devoting all of ones' time to work applies less to the younger generation of physicists (e.g. P69/MS & P71/FS). This observation is supported by the fact that several of the male physicists, aged 40 and up, have a part-time or non-working wife. In the Danish sample**,** we find no female physicists (irrespective of age) who have a non-working or part-time working husband. Possibly for that reason, we have no narratives of female physicists devoting all of their waking hours to their work.

The narratives do, however, reveal that few of the interviewees and some of their colleagues have deliberately chosen not to have children or a spouse. These narratives clearly uncover a strong belief that having children is incompatible with a career as physics researcher.

> *[B]eing a scientist and having a child, I think that would be tough, very tough. […] So I choose not to have children. But I think that if I really wanted to have a child I would deselect my career as a scientist. If I really wanted to have a child and I could see that it would be a problem I wouldn't mind giving up my career.* (P54/FS)

The envisaged problems of combining work life ambitions and children typically revolve around the issue of time. For instance, the young female stayer (P54) finds it difficult to imagine time for children when looking at her present everyday schedule. Yet, some of the (younger) stayers, who see children as an obstacle, still express a wish for trying to solve this incompatibility problem even though they believe it entails paying the prize of not being a great physicist.

> *If you want to be a great physicist then you cannot – It will cost something. […] If I want to be a good father to my children then of course it will damage my research. But I am willing to pay that price. Well it is easy to say that when you do not have any children, but I want to do that. When I get some.* (P56/MS)

Of this group of stayers, the females primarily express the above attitude. In fact, the younger male stayer (P56) stands out from the other male stayers in this sample, as they do not express a conflict between starting a family and being a physics researcher in academia.

Moreover, within certain research areas, some of the physicists (a few of the male stayers and one female top researcher) refer to parenthood as a quality in itself, as they believe it may increase the level of concentration and efficiency at work and thus be a benefit. Moreover, it is noted by an experienced associate professor (P52/MS) that there seems to be no difference in the results achieved by those who can work late hours (as they have no children) and those who leave the workplace in the afternoon to pick up children.

Children limit the working day

Picking up children from day care is mentioned as the core of the problem of balancing work and family life by especially the female

leavers. The fact that children must be picked up by 4 or 5 pm puts a limit to the hours they can spend at the workplace, and adds to the problem of balancing work and family life.

University research is both a flexible and inflexible work. On the one hand, many physicists stress the fact that you can work from home as well as at the workplace. On the other hand, the work can be inflexible if the work tasks demands that you devote yourself night and day – even for longer periods of time. To some it also appears problematic in relation to "getting things done" since this entails staying at work until after day care has closed.

Leavers see it as a gain in relation to children and family life when they find a job which typically makes it possible for them to leave work around 4–5 pm:

> *We have to be here between 8–16. We can't just start the day at nine or ten if we please. That's another difference. A cultural difference almost. […]It fits nicely when you have kids.* (P86/FL)

Working long or inflexible hours is not problematic in itself, but it makes a great difference to the majority of the physicists, both stayers and leavers, who have children, as can be seen in the following quote from a female leaver and mother who feels the possibility of devoting herself to her work is delimited by the obligations that come with children:

> *[I]t did not matter if I had long days, as long as you do not have children, then you can manage it.* (P89/FL)

Very often, the female leavers with children express frustration of the daily working hours when comparing themselves to (former) colleagues in academia who, unlike themselves, were able to spend 60 hours a week on work. One female leaver describes her former colleagues with no children as '*inhumanly focused on research*' (P65/FL).

Division of household tasks

The majority of the male physicists believe to have an equal division of household chores (i.e. cleaning, grocery shopping etc.) between them

and their spouse. The female physicists, however, often claim they hold the main responsibility and thus spend more time on children and household compared to their partner. The latter division also comes up in the interviewees' recollections of colleagues' situation. One of the female stayers states that '*men definitely have more time for work*' (P57/FS). However, a tendency towards a more equal distribution of household tasks does seem to be present among the young physicists compared to the elder physicists. Moreover, some find that spending time taking care of children and household carries little prestige in academia.

In order to balance research within academia and family responsibilities, a handful of the interviewed physicists have an au-pair, and both stayers and leavers regard such an arrangement as necessary in order to keep things together. In terms of "keeping things together" the interviewees refer to issues such as someone being at home when the children come home from school or the necessity of having someone to pick up the children:

> *So we hired an au pair girl, because my husband sometimes travels. And then –. I left at 8 in the morning and came back at 5.30, and I did not know when to make up for the lost time. It was impossible.* (P88/FL)

As noted previously, most of the female interviewees feel the main household responsibility seem to lie with them. If this is the case, having an au-pair may be seen as a relief to the women rather than to the men. This notion rests, among other things, on statements such as the above in which the woman stresses her own responsibility: '*I did not know when to make up for the lost time*'.

Physicist couples

One of the reasons for looking into the occurrence of physicists married to another physicist was a hypothesis of "double star" relationships: It was our assumption that women in double star relationships in physics remain in a lower position compared to their spouse. Yet, when correlating position to gender in the double star relationships in the Danish data, we cannot confirm this hypothesis. All of the interviewed

physicists except three[14] are in a stable relationship and ten are married to, or live together with, another physicist. This applies to approximately 1/3 of the stayers (five women and one man) and a little fewer of the leavers (three women and one man). Regarding the female stayers who are married to a physicist they are, except for one, *not* in a lower position than their spouses. Rather, one female stayer holds a position equivalent to her spouse, one female professor is married to an associate professor and two female stayers have spouses who have left academia. Additionally, the three female leavers in a double star relationship have spouses who have also left academic research. In fact, all the physicist couples among the leavers are "double leavers", and in some cases the couples have left academia simultaneously. Our data shows that the female physicists tend, to a higher degree than the male, to have a spouse or partner who is also a physicist,[15] and many of the narratives do in fact reflect this circumstance. That is in line with the previously mentioned image of the successful physicist being a male with a wife to take care of family and children. In our sample, only two of the male interviewees have a physicist wife. One is a leaver whose wife has left academia, too.

In the light of the outlined difficulties with balancing work and family life when working as a physicist researcher, it is interesting to have a look at how the physicist couples handle this problem. Do they benefit from having a physicist spouse? Among the benefits, the interviewees mention a better understanding of the requirements of the research career, i.e. the need to do research abroad, to attend conferences and the long hours at work. One female also mentions career promotion initiated by her boyfriend. The typical drawback is usually that family life becomes very pressed if both wish to make a career in research simultaneously; even without children career planning can be difficult. One female leaver puts it this way:

[14] Two male informants with no children; one leaver and one stayer, and one divorced female leaver with children.

[15] Though our sample is not representative of all physicists in Denmark, it is striking that we find so many female informants (also when we adjust for the discrepancy between the numbers of male and female interviewees) who are married to a physicist.

> *Both of us are physicists, so we would have to have positions at the same time, and that could be difficult. Doing a post doc would just postpone the problem; the considerations concerning where to go and which subjects we would have to find.* (P86/FL)

Moreover, the issue of dropping off and picking up children comes up again:

> *We pick up our children, and we are much at home with them comparatively, but it is always a question of planning so that one takes off early at times six or seven in the morning so that that person can pick them up and the other stays longer. Is it worth it? It is one big organisational hell to make this work. It demands a lot from both of us because we have to plan everything.* (P68/FS)

This view point does, however, not relate to all "stayer double stars" as we do find some who express much less frustration in terms of balancing work and family life. We will take a closer look at these stayers in the section *Best Practice*. The three stayer double stars interviewees do in fact express more diverse attitudes towards work and family life reconciliation than do the leaver couples.

In our sample, we see a tendency among the physicist couples to either stay or leave academia together. Only two of the ten couples consist of both a leaver (male) and a stayer (female). As mentioned, the double leaver couples have typically left research simultaneously, some even to the same company and similar positions.

6.2 Job Mobility and Family Life

In this section, we will take a closer look at job security and going abroad which are two salient topics in all the interviews. When speaking of job mobility, we distinguish between horizontal and vertical job mobility. We understand horizontal job mobility as the ability to be physically mobile, i.e. being able to go abroad or to go on conferences etc., whereas vertical mobility refers to career track advancements. We discuss the issues of horizontal job mobility in relation to problems of reconciling work and family life.

Short-term contracts

The majority of the stayers and leavers who have children find the academic structure with short-term contracts problematic in relation to family life. The problems typically concern uncertainty whether it will be necessary to move to another part of the country or move abroad in order to have a job or to advance to a more prestigious job. Moreover, uncertainty whether the spouse and children can come along seems to force some of our interviewees to question how long they are willing to live without stability in employment and place of work. As the leavers generally stress the disadvantages of short-term contracts in academia and the benefit of the permanent positions outside academia, we find that knowing the future whereabouts of one's family is perceived to be crucial to all the leavers with children (17 interviewees).

> *Gain – well, that's that I got a permanent position, so I didn't have to worry about prolonging it, or whether there was money. […] So even getting a position, having to apply for funding and spending my time on that, I did not have the resources for that. It was more important to – I wanted children, and there should also be room for them, I wanted a work day so I could take care of them.* (P89/FL)

Moreover, short-term contracts are perceived to complicate planning of family life in terms of sabbatical and parental leave etc. whereas permanent or long-term contracts would allow the physicists to plan their career and family. The physicists find it easier to plan their career with regard to family life (leave, children's school etc.) when they have e.g. a five-year horizon (P87/ML). Particularly the wish for buying a house seems realisable only if the physicist has obtained a permanent position. The aspect of insecurity due to short-term contracts is often mentioned as *the* reason for leaving academia:

> *Because I didn´t want to move around any longer. [...] I didn´t want to do short-term contracts anymore. And I had seen so many of my colleagues, friends and the like, who had applied for post-docs again and again and travelled the country – yes, travelled the world, right, to get a job for 1 or 2 years. And while having this job you are constantly*

> *looking for something else. And when you have an apartment […], then you don´t want to move again […].* (P212/ML)

The majority of the male and female leavers have children, but the male leavers in particular seem to express a great awareness of the need to create a stable home for their children.

Short-term contracts are also an important issue to the physicists who want children but haven't had any yet. In this group we find much awareness of the potential problems of starting a family when not being permanently employed. As in the case of the leavers with children, this group of physicists, hoping to start a family, also worry about the potential difficulties of reconciling work and family life if they have to move regularly to other parts of the country or abroad to ensure employment:

> *[I]t is a question about when I am going to get those children. I do not get any younger. I cannot see that I can get them during my post doc stay, and if I get home to a scholarship where I have to work hard to prove my worth, is it then that you start a family? I think that is very unappealing.* (P65/FS)

Though these considerations are widespread among the younger females, the problem is also recognised by some of the males, as for instance this male stayer with children:

> *[G]irls must have children when they are about 30, and it is also at that time they have to do their post doc and be on maternity leave and that is not an easy situation.* (P51/MS)

The question of the right time to take maternity leave will be touched upon in the section *Maternity and Paternity Leave*.

Parenthood complicates going abroad

As much research in physics is international, the interviewees must consider the question of raising their children in a foreign country or culture. As in the case of short-term contracts, this issue is perceived to be problematic by many of the leavers. Yet, the group of male stayers seems to be less concerned with leaving the family once in a while to go

on short stays abroad. As mentioned previously, some of these males may take stays abroad more easily if they have a stay-at-home wife or wife who works part time.

Though international universities may offer better job opportunities, the fear of "rootless" children has led some of the leavers, male as well as female, to settle down for good in Denmark.

> *[W]e thought a lot about going abroad again but our major problem has been the idea that if we leave again we will probably never return. We would emigrate, and we have been really close to doing that. We were actually convinced both of us that our career prospects would be better abroad. […] We actually wanted to give Denmark a shot for the sake of our children. We did not want them to have no roots. They were the reason we never wanted to live in the US [...].* (P77/FL)

> *[I] had been away from home for five years and I started to get homesick and I missed the Scandinavian climate and I wanted my children to grow up in a Nordic culture. […] I know several researchers who have travelled around the world with a child but of course it's very difficult. And if you're doing this for your own sake [you must ask:] if the child can take it and will it be [living] in different places, where they speak different language? So I guess you think a bit more about that when you have a child.* (P59/ML)

Another female leaver who is in a so-called "leaver double star" relationship describes how neither of them desired to continue a family lifestyle which implicated stays abroad. In spite of better job opportunities abroad, they both preferred to settle down in Denmark and take up non-research jobs:

> *So we have both left research. He has always supported me, and never questioned what I wanted or did not want while he was a researcher – he has not – that did not matter to him. He has left research himself, because this life with – to travel around the world as a researcher that is – some people can live with it and some people, I do not know, I didn't want to, and then when we had kids and we wanted to go back to Denmark then he said stop, he didn't want to travel anymore. [...] So that way it suited us well to settle down here with normal jobs.* (P64/FL)

Even though stays abroad can improve one's career prospects, co-ordinating family life with going abroad can be so difficult that the physicists chose not to go. Consequently, the unwillingness to move one's family may preclude physicists from gaining overseas work experience, which hinders their career progression. A male leaver, now working as a college teacher, sees a connection between his unwillingness to uproot his family and go abroad and his decreased opportunities for climbing up the career ladder:

> *I would never go [abroad] by my self. [My wife] was supposed to come with […]. For the six years I was supposed to work there, the intent was of course that they should come along. […] you could say that the reason why I was not able get out into the world was probably my own fault to a certain degree, as I had family and what not at that time.* (P82/ML)

This also applies to other leavers who, in spite of the explicit requirement to go abroad chose to stay at home with their husband/wife and children:

> *If you apply for a post doc at the Danish Research Council then you have to go abroad. Or at least, you're not allowed to work in the same place as you wrote your PhD. They prefer if you go abroad*
> *Interviewer: And you weren't interested in going abroad?*
> *No. I had both husband and child here at home.* (P72/FL)

In fact, the quotations above represent the typical viewpoint of a leaver with children in terms of going abroad. That career progression is largely dependent on this type of mobility is often viewed as an obstacle for the career progression for physicists with family responsibilities.

A young female stayer (P54) has taken her family responsibilities into account when considering her future career plans including going abroad as a post doc: She is aware of the fact that going abroad for a couple of years would most likely improve her chances of getting a position as assistant professor. Nevertheless, because she has husband and child going abroad is no longer an attractive option to her. As we have seen previously, the Danish sample of physicists seems to cover to some degree diverging attitudes towards the balancing of family responsibility and work among the physicists. With respect to stays abroad, we find that a number of the physicists, typically from the so-called best

practice groups, do not find it problematic to bring their children along on longer stays abroad either (see the section *Best Practice*).

In some cases, it is not only for the sake of the children that the physicists decide not to go abroad, the spouses may, for instance, have a career which delimits the possibilities of going abroad. The topic of sustaining a relationship comes up in the narratives when the physicists consider stays abroad. A couple of the stayers, male as well as female, relate to former relationships which have ended due to their stays abroad, and the bad experiences have led them to stay in Denmark and prioritize their present relationship instead. In some of these cases (in the Danish data these are often second-hand descriptions), the physicist succeeds in finding other ways through the demand of going abroad. However, it is difficult as it typically entails an extraordinary effort on the part of the physicist to compensate for a post doc position abroad.
Although the length and frequency of stays abroad tend to decrease for some of the stayers after they have had children, they generally find it difficult to balance the requirements of horizontal mobility with a harmonious family life. Longer stays abroad are perceived to be particularly difficult, wherefore nearly all of the leavers and some of the stayers have chosen to not go at all or only go for shorter stays after they have started a family. The following quotation exemplifies the wide-spread perception of going abroad before and after having children:

> *Had I not married then I would probably have stayed in California, if I had had the opportunity to get in […]. It was wonderful and one must be careful about what is important and for me family was more important than a life in California.* (P88/FL)

6.3 Maternity and Paternity Leave

As we have already seen from some of the statements, the time is somehow never right to get a child when employed on a short-term contract. The fulfilment of a short term contract can be impossible if one is away

from a specific project for a longer period of time such as e.g. a maternity leave[16] typically is.

Going on leave and set-backs

Being employed on short-term contracts seems to be more problematic for women than men as the issue of maternity can place the young female physicists in a bad position when applying for prolongation of a contract:

> *But the fact that you want children, then having these short-term employments was not very appealing. Because when you have children you should also have time to take care of them. […] And with these yearly employments, I could see a problem in not being selected next time; "sorry, we will not prolong your employment".*
> *Interviewer: And that was a risk if you had children?*
> *Well, if you would want to take maternity leave with your child, then you would not fulfil that one year employment. So I definitely looked for a permanent job.* (P89/FL)

Additional economic aspects also play a role for the temporarily employed physicists as they are rarely offered all of the benefits that are available to employees on a permanent contract. We find that the males are less concerned than the females – probably because most of the male physicists only expect to take paternity leave for a shorter period, if at all. The following quotation of a male stayer indirectly confirms the difficulty of the situation for the female physicists:

> *[I]f for example I had had children during my career, now I am married but have no children, and that is of course a big difference compared to the people who have children, especially if they have them as women, I can see that in my surroundings it is something that can prolong the course of the career a lot in any case* (P66/MS)

However, one male stayer (P56) sees future paternity leave as an obstacle for his career, and he even uses the term "*damage*" in relation

[16] See the UPGEM information box on maternity and paternity leave at http://www.dpu.dk/site.aspx?p=11524

to career prospects. Some of the interviewees touch upon possible solutions to this specific problem:

> *I definitely think that contracts of longer duration would be a solution. And perhaps making it more prestigious to look after ones family and private life. […] There is not much prestige in looking after your children or doing other things that does not have to do with your research. So more focus on people's right to do so and not be considered less of if you do, I think that could turn things around.* (P57/FS)

This female physicist also takes up the aspect of prestige, and she seems to have observed that prioritising children and family life is perceived as low prestige in physics.

One of the female leavers explicitly refers to maternity leave in academia as setting one back in terms of career:

> *[M]aternity leave sets you back. […] that has been the case for some of my colleagues, where they had to take leave at the time they should have been producing a number of articles in order to become acknowledged in their field. If you don't do that you are at risk of not becoming a 'member', of not getting enough done and thereby getting denied because you would normally be part of a scientific project […] and if you are absent for half a year and don't do anything you have to start all over with something new in order to come back on track. In that sense it could be quite a catastrophe having two children within a short span of time; it's like having to start from home base in ludo twice.* (P77/FL)

This perception is shared by most of the female leavers (P89/FL, P60/FL, P67/FL & P79/FL) and it also applies to some of the stayers, as for instance the following female stayer with no children:

> *On the one hand you do not want to treat people unfairly, and on the other hand, women who do not have children, they are more or less equal with their male counterparts. There is no problem there. But for those who have children they will continue to get out fewer publications because they are on maternity leave and so on and so forth. In that way they have a weaker position compared to men when they apply for jobs.* (P70/FS)

The time away from research while being on maternity leave can also weaken one's professional network and thereby reduce one's career possibilities:

> *[M]y ex-husband had been offered a job in Austria, and those four months when I was writing my PhD, we were in Austria. So I was gone from the university for a while, and I did not have my workplace. I was actually out finishing my writing, and then I gave birth and then I was on maternity leave. Then in April I had to make my defence, and make the final corrections. At that time I have been away from the university for an entire year, and I had lost some of the contacts. They didn't just give me some money and a job at that point.* (P67/FL)

One female leaver describes the difference between academia and her current work place as a matter of expectations; she finds that in academia you are not expected to take maternity leave whereas at her current work place the picture is quite the opposite:

> *Employees are expected to have children and you are expected to go on full maternity leave as opposed to the expectations within the scientific research milieu. There you do research even though you are on leave. You do not put your work aside for a year of breast feeding; you work and publish papers while you are on maternity leave. I have given talks at international conferences when I was on my first maternity leave [...].* (P77/FL)

However, the view on academia as unsympathetic to maternity leave is not entirely uniform. All the female and male interviewees from our best practice groups (regardless of their stayer/leaver position) tend to speak more positively about leave and do not see it as damaging to their careers:

> *We have four children […]. Then there is [a female]. […] She is a lecturer as well. She is expecting her fourth child at the moment.*
> *[A male] next door has three children, [a female], who was recently employed here and might return, she has three as well. We have a lot of students around who have been pregnant. But then there is [a male] […] he has five children. And our post doc, he has one child and he is going to have more, he has proclaimed.* (P66/MS)

For a further discussion please see the section *Best Practice*.

Shared leave

Although Danish males in academia are entitled to both (paid) paternity leave and (paid) parental leave, the narratives do not indicate that it is common for males to go on a longer parental leave. A male stayer puts it this way:

> *I remember when we had our son, and there was this female PhD student and [the supervisor] came up to me and said that she might go on maternity leave at some point so maybe we should think of that when applying for money for her PhD. And then she commented that I might also take a paternity leave and none of us had thought about that. So, men on paternity leave are still not quite common.* (P73/MS)

In Denmark, women constitute 95% of the parents on parental leave (Gupta et al. 2007). Due to uneven numbers of males and females on leave, the issue of maternity leave can be a potential burden for any women of childbearing age. A survey has found that when young Danish women apply for a job position they are typically expected to go on maternity leave for approximately two years and that makes them less attractive compared to their male counterparts (ibid.).

One of our interviewees, a female stayer, took a six months maternity leave at the birth of her only child. Afterwards, her non-physicist husband took a four months paternity leave. According to her, the time for maternity leave always comes inconvenient when having a career (in academia) but fitting in a m/paternity leave with work becomes easier if the parents share the leave (P55/FS).

6.4 Summary of Work and Family Life Reconciliation

The Danish data shows that the majority of the female physicists, as well as many of the males, perceive children as a hindrance especially to women's career advancement in physics. Noticeably more leavers than stayers have children and the majority of the leavers with children are female. The distribution of male physicists with children is more even between the stayers and leavers.

Physicist couples occur frequently in the Danish sample, and they have not confirmed our double star hypothesis that female physicists tend to be in a professionally lower position. Furthermore, our data does not indicate that a double star relationship facilitates work and family reconciliation in academia since the majority of our physicist couples have decided to leave physics research in academia.

Many of the interviewed physicists talk of the difficulties of balancing work and family life.

A great challenge occurs for nearly all the physicists when children arrive. For the women it is a question of finding the right time to go on maternity leave at the stage of their career where they need to be very productive if they wish to climb the career ladder.

Moreover, short-term contracts can be problematic for new parents as a long leave may prevent one from completing a specific project satisfactorily or building the necessary network whereby the chances of prolongation or a new position are diminished. Since Danish women take 95% of the parental leave, this leave becomes a problem for the career of the female rather than the male physicists. However, there seems to be a clear consensus among all the physicists that leave is likely to set one's career back.

Requirements of going abroad are also described as problematic by many of the physicists, because it can make it more difficult to sustain a relationship and settle down with a family.

Although going abroad often leads to better job opportunities, some of the physicists (in all the a priori categories) with children have deselected longer stays abroad. Some of the leavers, male and female, have also chosen to leave academia to lead a lifestyle that involves less travelling. The majority of the leavers express relief that travelling is no longer a compulsory part of the job.

The short-term contracts in academia are talked about as very problematic by stayers and leavers irrespective of gender. The insecurity in employment in academia and the better possibilities of getting a permanent position outside academia are by the interviewed physicists with children very often expressed as *the* reason for leaving academia.

The requirements of late working hours are in general viewed as manageable as long as you do not have children. The problem of picking up children from day care in due time seems to be a pronounced

problem especially for the female leavers. But interestingly, the three female stayers with children (two from our best practice groups) seem to manage picking up children and the daily working hours without great problems. Contrary to the leavers, stayers express more diverse attitudes towards balancing work and family life. And the stayers who do not think of this reconciliation as problematic tend to cluster in certain research groups.[17] We may ask why some physicists see parenthood as a benefit while others see it as obstructing their career.

The majority of female and male leavers (who are employed as college teachers) have found the experienced incompatibility between work and family life so problematic that they have decided to leave research in academia (or research in general). The leavers generally describe the workplaces outside academia as much more family-friendly than university.

The image of the successful physicist is described as a male who has his (part-time or non-working) wife to take care of the children. This image is shared by the majority of the physicists regardless of gender and current position in or outside academia. In practice, this description applies to the elder generation of male physicists rather than the young generation of physicists. In spite of the general wish to prioritize the family, they seem more willing to go on short stays abroad or leave the family to go on conferences etc. compared to the remaining interviewees. The tendency in the younger generation that both partners work full time indicates signs of a new masculinity where also males consider leaving physics because they have problems of reconciliation of family and work life. Regardless of family status, the female physicists and the male leavers generally express more unwillingness to spend most of their waking hours at work.

7. Best Practice

As we have pointed to a number of times so far, certain groups in interdisciplinary fields in the Danish sample stand out as more family

[17] We will elaborate on this finding in the section “Best Practice”.

friendly and group oriented than any of other fields we have looked at. Moreover, these fields seem to have been able to attract a high number of women (Svinth 2008).

7.1 Balancing Family and Work

Interestingly, within these research groups we find both a high demand for horizontal mobility and as well as men and women with many children.

> *We are a group which is very influenced by the fact that many – all of us have children and many of us have many children. It is influenced a lot by children.* (P68/FS)

This finding is striking since the majority of the interviewees mention children as the core problem of work and family life reconciliation especially in terms of going abroad. We have previously seen an unwillingness to uproot the children which has resulted in deselecting stays abroad. Yet, in these best practice groups we have encountered a somewhat different attitude:

> *For example, we have been on research journeys to Australia three times […] when we only had one child, we were in [a big city] for eight months, and then we have been to [a smaller city] twice. The last time was three years ago, and the first time was ten years ago. And back then, we uprooted the kids, put them in an Australian school, and set up a whole new network. We made friends among the other parents in the neighbourhood and so forth. And that's the sort of privilege that you have to appreciate. So we have just brought the kids along […]. We have brought them to all the places we have gone to if we were to stay there for an extensive period of time.*
> *Interviewer: Do many people in your group have children and do they do the same thing?*
> *This place is filled with children. I think it has something do to with role models.* (P69/MS)

In these interdisciplinary fields, the high demand for horizontal job mobility often involves longer stays abroad. These stays are not unproble-

matic for the group members, especially for those with small children, who might even feel an indirect pressure to go abroad:

> *You don't leave your family for a month and a half without it affecting the family. I hope we have a great deal of respect for it. If somebody comes to you and say that they can't go [abroad] this year, then it's okay. But that doesn't mean that people can't feel the pressure and necessity of it, because everyone plays an important part, and they know that if they don't go it will be harder for the rest. We have never told anyone that they had to go. But there is pressure, especially for those with small children who go away for a month and a half. There is pressure. We have never made anyone go if they've said that they couldn't go or that they could only go for three weeks.* (P71/FS)

Nevertheless, the interviewed physicists in these fields characterise their workplace as family friendly. Here a central member of one of the research groups notes:

> *Many in the group have many children and they prioritize the care of their family very high. I have always picked my children up at four o'clock. Always. For that reason we never schedule meetings late in the day.* (P71/FS)

This family friendly mindset seems to have been introduced and practised by the former male head of department and over time it has become common practice – a practice which is different from many of the other groups at the institute:

> *[I]f there is a child sick that is never a problem and we help each other take care of classes and so. I think we have a very child friendly politics here. But it is something we disapprove of at the rest of the Institute, because they schedule their meetings late and things like that. Personally I think that to be a woman at this workplace is great because there's basically full flexibility of your work hours. If the children are sick you can work from home and then you have classes now and then, but that's not such a big part of your schedule and often you can arrange to switch with a colleague. I think it's a good workplace for women, but I know that the stereotypical image of a physicist is one who has to work till 11 pm at the institute […] but it doesn't have to be like that. I often sit and work at night*

> *but that's almost always after the children have been tucked in. So it's not because I don't work a lot, I just work at home.* (P71/FS)

As we have seen previously, many of the younger males also express a wish to spend time with their children, and in these groups they also make use of and benefit from the family friendly politics of the group. Some of the physicists in these groups also describe the problem of taking leave when children are born as difficult but manageable contrary to statements from other research groups:

> *But as my job is – I mean – if I were to be away from here for six months, those six months would be lost for me that would be really bad. It's not the kind of job where you just hire a substitute. If I was away for six months it would be six months of lost research. But when I was on leave with [my son] we were allowed to postpone the project until I was back.* (P73/MS)

The many problems our interviewees from other groups find with reconciling work and family life are present but not salient in the narratives from these best practice groups. We have found a clear difference between the perception of children as a hindrance for doing research in some groups and the daily practice where children and family responsibilities do not become reasons for leaving academia in other groups. In some cases, family and children are even seen as a beneficial element in the work life. From this perspective, the perception of children as incompatible with doing research does not mirror "a fact of life" but can be seen as a certain normative construction of physicist activity. Therefore, we argue that it is not the children as such that cause problems but rather the perception of children in an activity system, which puts up sharp boundaries between family and work life.

In the best practice groups, we see a softening of the boundaries between family and work, as the researchers tend to describe their collegial relations as very group oriented and family-like in the sense that they respect and take care of each other:

> *[T]he girls I know in the field […], every time they went [abroad] during their studies the husband was given something to do. An effort was made in that regard. It is a small enough environment that people know each*

> *other, knows each others' wives and husbands and children. It is a little like family in that sense.* (P88/FL)

The perception of how to combine research and family in these 'best practice' groups is very different from the widespread stereotype of the ideal physicist as can be seen in the quotation below:

> *[W]ell, there are some who match the academic structure better than others – and those are ehm, single males. […] They match because they are so flexible. And they can go anywhere in the world and stay there for a year and afterwards they can go to another place and stay there and the like. Someone who do not have any obligations in terms of finances and family*. (P212/ML)

This description corresponds to the previously mentioned image of a successful male physicist who can devote all his time to physics research (see section 6.1), and which in the male and female physicists' own perception excludes women because the stereotype expects the women to devote their time to the family. But in the best practice groups we see that they do not give preference to the stereotypical male, and may even prefer women.

> *It is a part of the attitude that we want more girls here. […] And it gives a better environment and a better context.* (P51/MS)

7.2 Female Visibility in a Male Dominated Field

From a research point of view, natural science is often described as an objective science in which gender and culture are unimportant (Bergvall 1996, Merton 1942). Yet, from a social perspective, it is clear that physics in Denmark is a male dominated field in which female visibility becomes prominent. Several of the female physicists describe how they stand out from the crowd and receive much attention because of their sex. In some situations, they feel their sex seems to overshadow their abilities as physicists. Consequently, we see a clash between physicists who expect natural science in academia to be fully asexual (e.g.

P54/FS), on the one hand, and narratives of being noticed because of feminine bodily features (as described in *Sexual Harassment*), on the other. In the best practice groups, which have a more even gender-balance than most groups, we have not come across narratives of a particular female visibility, but rather that masculine and feminine qualities complement each other:

> *I'm a woman and they're men and we are allowed to be that. But I never connect that with work.*
> *Interviewer: So there was room for you to be a woman? It's not that people are almost neuter?*
> *No, not at all. I think it's lovely that we're so many women in the group; that we're so many women here.* (P71/FS)

The underlying notion of this comment may give us part of the answer to why all of the interviewees from these groups answered *no* when asked if they had ever experienced or heard of any incidences of sexual harassment *within* their group. Part of the answer may also lie in the fact that these groups are characterised by a more flat structure. Moreover, qualities such as free communication and interaction within the groups are brought forth as essential in preventing sexual harassment.

As previously mentioned (in the section on competition), the best practice groups seem to have tackled hidden in-group competition constructively by handling potential competitive situations openly and thereby creating a more respectful working climate, according to the physicists.

8. Pay

With respect to pay, we find clear stayer/leaver differences but not a gender difference. Though pay is not the decisive reason for leaving academia, the different attitudes towards pay between the stayers and leavers are the focal point of this section.

8.1 Stayers and Pay

The Danish stayers cluster in two groups according to attitude to pay: The content and the discontent stayers. The discontent stayers are very concerned with their salary and spend a lot of time discussing it in the interview, but none of them are presently considering leaving academia solely because of the pay.

Approximately half of the stayers are more or less content with their pay. They form a rather diverse group of physicists ranging from highly satisfied with their pay (represented by all the PhD students) to less satisfied (physicists from the level of post doc and up to the level of professor). Most of the latter do not consider their pay to match their qualifications and, in fact, only a few of the more or less content stayers consider the pay in academia to be reasonable. Nonetheless, these physicists define themselves as content partly because they view the research work in academia as a chance to pursue their interest. The aspect of having fun with research in academia because it is not routinized (see also *Identity*) seems to be one of the reasons why these stayers accept that pay in academia is low compared to the wages of their peers employed in the private sector. The narratives disclose a notion of idealism connected to doing research in academia. A male stayer expresses it this way:

> *There are lots of great jobs in the business world which are nice places to be. […] And in that way it is a good thing that the salary is not that big [in academia] because you need to have the need to do it and the idealism. You should not stay in academia because of the pay. It ought to be because of the fun in it. It should not be because of the power. It has to be something else.* (P51/MS)

Among the discontent stayers, the dissatisfaction with their salary often springs from a comparison between their salary and the much higher earnings of their peers in private research co-operations or physics researchers abroad (e.g. the US). Moreover, they feel underpaid in comparison with their workload and educational level. They often voice their dissatisfaction in the narratives, and to some of them it is a constantly annoying aspect of their working conditions. The discontent stayers with children also point to the increasing living costs in

Denmark, which make it difficult to provide for a family on the salary of a publicly employed academic.

Finally, poor possibilities of salary negotiation in academia in general, especially for those in temporary positions, annoy these discontent physicists much and are referred to as a reason for considering leaving academia:

> *My friends and my neighbours, most of them have a much higher salary than I do because they have different pay and career possibilities. I can be an associate professor here, yes all right then I am an associate professor, there is not much possibility in that. There are a lot of reasons for me to apply for something else. […] And now I also begin to think that my salary – I do not have much possibility to negotiate my salary. And it is typical that people do it when they get permanently employed. And I am thinking that I have been here for a lot of years, and I have some competences and qualifications.* (P68/FS)

In general, the discontent stayers believe that the poor pay in academia is part of the reason researchers choose to leave university.

8.2 Leavers and Pay

Pay appears to be important for the leavers with children (just as for many of the stayers with children), and since only five of the 22 leavers in the sample do not have children, the topic of pay is salient in most of the leaver interviews where pay is touched upon in connection with family life and the high living costs in Denmark. Many of the leavers find it unrealistic to provide for a family on the salary of one publicly employed academic. Some leavers consider returning to university research as unthinkable solely because of the differences in pay. Due to family obligations they are not willing to take a cutback on their pay.

Though the pay has seldom been the sole reason for leaving academia, a couple of the leavers claim they would never have left academia had the pay been better:

> *Yes. I would [have stayed in academia]. I'm 100% sure. I was extremely frustrated that with my long education besides the student loan I was paid so little.* (P59/ML)

The feeling of disappointment and frustration with the salary at university comes up in several interviews with the leavers. The above-mentioned male leaver represents a widespread attitude among the leavers when he adds:

> *I'm disappointed in the society which pays their best researchers in the whole of Denmark so little. I worked close to the National Hospital and I think the pay the nurses get there are ok, but with the addition for night shifts they earned more money than people with a much longer education. To get a PhD you have to study at least eight years. And somehow I think that is wrong. I have gotten this confirmed now that I'm working at the high school and there you get paid for extra hours. You don't get that at the institute.* (P59/ML)

Apart from poor possibilities for negotiating salary, the quotation also touches upon the aspect of unsatisfactory financial reward for holding a high university degree. With few exceptions, leaving academia has generally resulted in an increase in pay from *'a little more compared to university'* (P83/FL) to 80% more. Those (P79/FL, P77/FL, P76/FL, P82/ML & P59/ML) who are not enjoying a better pay are still more content with their present salary, because they tend to work less hours in their current job. The group of college teachers often expresses satisfaction with being paid extra for any overtime work as opposed to the condition at the universities where they could not be paid extra.

> *The reason why I chose the college position as opposed to a job in the private sector was that I knew that I had to be able to support my family. Cool cash. You are paid the same teaching in college and working as a scientist so there is no economic prestige in working at the university. My hourly pay has risen quite dramatically since I started my current job.*
> *Interviewer: Because you work less hours?*
> *Yes. [laughing] So in that sense there is no difference. So it is solely a question of being insured a family income.* (P77/FL)

8.3 Summary of Pay

The topic of pay is salient in most of the interviews and is touched upon in connection with family life and high living costs in Denmark. Moreover, many of the leavers and stayers express frustration with the poor and non-negotiable pay in academia. They feel underpaid considering their workload and educational level; however, a few stayers, primarily the PhD-students, are happy with their pay. Though pay is seldom the sole reason for leaving academia, it does seem to contribute to the decision. Furthermore, the better pay outside academia makes it financially unattractive to return to university. In spite of much frustration, the stayers seem to communicate a sense of acceptance that research in academia is not a matter of personal profit but devotion and being able to pursue and satisfy their intellectual curiosity. In this respect, we find a clear difference between the stayers and leavers but not between males and female.

9. Reasons for Leaving Academia

The interviewees in our data are generally very happy with their choice to become a physicist and many enjoy working with physics research. Nevertheless, they have pointed to a number of issues that have either made them leave or consider leaving academia. In this section we will first outline the reasons for leaving which the 22 leavers point to directly. We will also look at reasons which the potential leavers (mainly the female stayers) bring up in their narrative description of their work life. Secondly, we will discuss issues which the physicists do not mention directly as reasons for leaving, but which the analysis of the overall intricate narrative about the context of physics finds play a role in leaving or considering leaving academia. Some factors seem to push physicists out of academia, while other factors (outside of academia) seem to have pulled the leavers out of the university as a workplace.

9.1 The Interplay of Positions, Relations, Children and Work Hours

The lack of positions, the short-term contracts and better possibilities of getting a permanent position outside academia are some of the most frequent reasons given for leaving academia in the Danish sample.

> *[I]t was the combination of there not being anything, and then the fact that I could see that the life I had led thus far could not be combined with a regular family life.* (P89/FL)

> *What was crucial for me, was the fact that I could get a permanent position.* (P67/FL)

A permanent position provides financial and geographical security whereas employment insecurity leads to insecurity in family life. Consequently, the lack of positions in academia becomes a pushing factor:

> *The attraction of the position was that I had a post-doc, a six month post-doc, and I had been unemployed for six months. And maybe I would be unemployed for another six months, so it was a crucial attraction that I could get a permanent position.* (P67/FL)

Often the interviewees' narratives tell of colleagues who have left academia for these particular reasons:

> *[T]hings such as the lack of career opportunities, this is specifically in relation to Denmark, has been the main cause for people to leave physics. People find it too difficult to get permanent employment. Job security is one of the main problems.* (P85/ML)

For the leavers, the possibility of getting a permanent position is more important than staying in academia. This goes for both males and females:

> *Interviewer: So when you applied for the position […] it was a bit make-or-break: 'if I get it I will stay and if I don't I will look for something else.' You had made that decision?*

> *Yes, I think so. I was ready. I was not determined to remain in public scientific research at all costs.* (P78/ML)

Moreover, the combination of age and short-term contracts makes some of the stayers contemplate leaving. It is often mentioned that one must either obtain a permanent position or leave academia around the age of 40–45, as it will be very difficult to get a job outside academia when one is past 45 and has no experience outside academia.

Though leaving university, which for many of our leavers is equivalent to leaving research, can be a difficult decision, the prospect of a more harmonious work and family life reconciliation has pulled some of the leavers out of academia. One leaver recalls the impact of family responsibilities when he decided to give up his dream of working as a researcher:

> *Yes I had many sleepless nights. It was very hard. If you have to give up what you have wished with all of your soul. So you have to let the rational things in your life decide, because where will you live with your family and can you create a safe and nice home for your children? And maybe not be that much away from your family. We [him and his wife] both commuted and it took an hour and a quarter each way; an hour and a quarter times two that's two and a half hours. That is what you take from your children. Now I've got ten minutes to work and two more hours with my children every day. And that is also something you consider.* (P59/ML)

For the majority of the Danish leavers with children, different aspects connected to family responsibilities form the main reason for leaving academia. Again, we must stress that the children themselves are *not* the reason for leaving. Based on the narratives about work and family life, the reasons for leaving are identified by the physicists as the interplay of children, job position, work hours and pay. The majority of the leavers, male as well as female, express relief that travelling is no longer a compulsory part of their job. Though pay is rarely the sole reason, it does contribute to leaving academia. Moreover, the poor pay in academia makes it unattractive for the leavers to return to research in academia. We find no clear gender differences as both males and females stress these reasons equally. In the following quote, one of the

male leavers captures some of the crucial points and hereby represents the typical leaver with children:

> *I thought it was important to own a house and to be with my family. So yes they [his children] have been a great deal of the reason to why I left research. […] there's a great expense to be hired as an assistant professor and not knowing if you're bought or sold in a year or two. You can't plan into the future and it might be difficult to buy a house and it might be difficult to make the bigger decisions because you don't know if you're in job the next year or half a year and that's a huge source of irritation to have all the time.* (P59/ML)

In some cases, going on maternity leave(s) is seen as a pushing factor for those on temporary contracts because they may loose contacts in academia during the leave(s) or are not able to keep up to date with recent findings or able to write articles. Furthermore, the fulfilment of a short-term contract can be difficult when going on leave. Thus put together, leave(s) may impede the chances of getting a new position or receiving funding for a project which makes young female physicists less attractive than their male peers when applying for the next position.

Moreover, even some of the few leavers who do not have children (yet) state the difficult interplay of children and job positions as the decisive reason for leaving:

> *I was 30 when I changed jobs. I have been living with my boyfriend for many years; I would like to have children some day. If I keep getting a one year research position where I have to prove my worth during that year, I cannot see when I should have a child during that time at all. […] That was also one of the things that made me change; I could only see myself applying for my own job over and over and over again.* (P83/FL)

Some leavers state that laborious work processes resulted in insufficient satisfaction which made them decide to leave research. Furthermore, though all the physicists belong to some kind of group, the female leavers in particular (P72/FL, P83/FL, P81/FL, P76/FL & P77/FL), but also one male leaver (P82/ML), mention the sense of feeling lonely or unappreciated as either a contributory factor in leaving academia or as a reason for not wanting to return to academia.

9.2 Indirect Reasons for Leaving

Connected to the sense of feeling lonely, some mention a feeling of inadequacy. Though this is not described as a direct reason for leaving, it seems to be a contributory pushing factor:

> *I always felt, usually always not completely updated about things, never really good enough. It was the feeling of not being adequate, or not knowing enough, or not being fast enough, or not being able to remember enough. […] I always felt, not necessarily less worthy, just on the academic level I just felt inadequate.* (P64/FL)

> *[A]t one point a lecturer position was posted, a permanent employment that is, which I didn't get […] I had to take a look at my competition; simply put, they were just better than me.* (P82/ML)

The narratives about inadequacy tend to have some connection to competition, particularly hidden competition. The analysis of hidden competition shows that in order to make it in academia one must be ready to '*fight the others and move yourself forward*' (P88/FL). In fact, the term *fight* comes up in 16 of the 41 interviews when the physicists describe personal or colleagues' career moves:

> *It can be hostile […] It is a competition. You have to fight for the right to exist.* (P51/MS)

If women tend to appreciate a friendly working environment and support from colleagues/mentors more so than the men, a very hostile environment, as the one describe above, may be another reason why some do not feel comfortable at work and thus are more prone to leave.
Though some of the female physicists tend to downplay the issue of experienced sexual harassment, we see this as a contributory reason for leaving. Partly because the data holds evidence that at least one female has been forced out of academia due to sexual harassment. Moreover, in *Women on Guard* we also saw that cases of sexual harassment often restrain some of the female informants' possibilities of interacting with their colleagues. This impedes their chances of forming strong social networks which we have identified as important for career tracks. Moreover, the social restrain may result in some women not feeling

comfortable at the university as a workplace. Finally, it seems problematic for the interviewees to talk about these episodes. Some informants have refused to talk about it, though they admit to having knowledge of it and others asked us to be very discrete as they have never taken up these cases in the context of physics. Therefore, we suspect sexual harassment and harassment in general to be a more pronounced reason for leaving than it appears in the interviews.

9.3 A Portrayal of the Danish Leavers

Rather surprisingly, we found that leaving academia is very often equivalent to leaving research altogether (see Table 2 in the Appendix). Only five of the leavers (two males and three females) are still doing research; three of them are doing research in different governmental research institutions. The 17 leavers who no longer do research work in very different areas: Among the female leavers, three hold positions within applied physics, two are hospital physicists and one is a well site engineer. Another three are doing administrative work; two are at a university and one is in a private enterprise. Two were unemployed when giving the interview. Among the male leavers, two have established their own companies and are thereby self-employed, two are employed in different private enterprises; one as a patent consultant and the other works as a project manager. The remaining two male and three female leavers are working as college teachers.

From this listing of the leavers' current workplaces it is clear that at least five of them (the college teachers) are employed in a position that does not require a PhD degree.

In the section *Embarking on a PhD*, we saw that to a number of the leavers the thought of being a researcher simply does not match their personality or aims in life. With respect to the problem of academic 'brain drain', 12 (P64/FL, P67/FL, P75/ML, P76/FL, P77/FL, P79/FL, P81/FL, P83/FL, P85/ML, P86/FL, P87/ML & P88/FL) of the leavers believe they have left research for good:

> *Interviewer: But you consider returning to scientific research?*
> *No. That is no longer an option.* (P77/FL)

> *Research is over for me. I have acknowledged that. I will never get back there.* (P67/FL)

These physicists are a lost case for university research as well as research outside academia. The loss of interest in doing research, despite an education which specifically qualifies them to do research, makes them true brain drainers.

We also find that though some may come to regret their decision to leave it is very difficult, if not impossible, to return to an academic research position:

> *[W]hen you step out of the academic world, the doors get slam shut behind you.* (P59/ML)

> *As soon as you leave the academic environment – today that is a one-way ticket.* (P78/ML)

Indeed, time is of essence in this situation. None of our interviewees say exactly how long one can work outside academia before the door shuts definitively, yet it appears that a period of approx. two years is the maximum.

When taking a closer look at the lives of the leavers, we find that only very few of them wish to return to the university as workplace. Furthermore, the majority of the leavers seem very content with their current jobs outside academia. Regardless of the reasons for leaving academia, the majority of the leavers are now "happy leavers".

> *Interviewer: Does that mean you would actually have wanted to stay in academia?*
> *Not anymore. […] No. And that is because I can see with my colleagues I am still in touch with my supervisor and so on. It is because now I have tried something else. I think that when I was in academia I would have liked to have stayed in academia, and I think that is partly because you do not know what is on the other side.* (P83/FL)

In fact, we find comparatively more "happy leavers" than "happy stayers" in our sample.

9.4 Potential Leavers

When looking into the stayers´ perceptions of their future career, another interesting finding emerges; six of the nineteen stayers do not see themselves in academia ten years from now. Moreover, five of these six potential leavers are women (P54/FS, P57/FS, P62/FS, P65/FS & P68/FS), i.e. approx. half of all the female stayers consider leaving their research career in academia. Regarding the male stayers, only one (P56) is a potential leaver. Accordingly, the female stayers can be considered to be at risk of leaving academia. Put differently, they might be the brain drainers of tomorrow:

> *Interviewer: Right, where will you be in ten years' time?*
> *Well, there are two possible answers: I will either have found a more permanent research position within the university sphere or I will have started working hopefully in a research based company.* (P57/FS)

As in the case of the leavers, the topic of getting a permanent position comes up as a decisive reason for staying in academia. Moreover, the female stayers also express awareness of the advantages of the private sector *besides* a permanent position. In terms of her future, this young female post doc reasons this way:

> *The advantage of the private sector is the option of long-term employment, permanent working conditions and better chances of working 8–16, 37 hours a week, whereas a career within the university entails short-term employment and a lot of shifts, at least the first four or five years. So I decided to give it a shot for a couple of years, at least as long as I don't have any children. But if I can't see the end of it in three years time I may quit.* (P57/FS)

10. Conclusion

In the course of this report, we have unfolded numerous smaller pieces of 'collective' narratives about the physicists' everyday work-life. In this last part of the report we shall try to sum up these stories and

discuss how they are interrelated. We see many inherent self-evident boundaries in the narratives, which we can only sporadically touch upon in this conclusion. We are well aware of the risk of simplifying the many contradictions and complexities described in the analysis since everyday life cannot be captured as such in all its complexity. Therefore, the intricate patterns we have presented here do not serve as a definitive description of physics institutes as workplaces. What we try to capture is the context of everyday learning in the activity of physics institutes in Denmark.

We find it fruitful to expand the activity theory to include boundary-making processes in order to identify the selection mechanisms that include some in the activity system but push others out. The boundary-making processes are found in everyday life in all the components of the activity system, the community, the division of labour and the normative rules. The boundaries are dynamic and driven by inner contradictions. As the system continues its expansive learning, the boundaries are either stabilized momentarily or changed – but they are never static. When the boundary for who is accepted into physics is changed (e.g. more women enter research) inner contradictions can create gender differences. Women can for example be pushed out of the community when the normative rules do not include a proper conduct of how to deal with and acknowledge female individuals as colleagues on equal terms with their male counterparts – as is exemplified when a system accepts actions such as sexual harassment. The system defines and demarcates the good physicist (the stereotypical, successful physicist) as a male who practises a clear distinction between work and family life – and devotes himself fully to the work. This sets up a boundary between male and female in general, but also between the males who fit this stereotype and the new masculinities which have different values. These new masculinities do not belong to the traditional activity of physics, but bring in new conceptions of e.g. ‘manhood’ and ‘fatherhood’, which in turn transform the normative boundary for ’doing physics’ in an acceptable manner.

Other subtle boundaries seem to explain in more general terms why some physicists leave and others stay in academia. When changes appear in society in general (e.g. politicians decide to emphasise the usefulness of physics) these changes generate new internal boundaries,

which affect the object, and in this process the external changes transform (rarely without problems) into new internal boundaries. But before the new boundaries are stabilised they may lead to contradictions and tensions (e.g. between 'old' physicists practicing formerly prestigious physics like nuclear physics and 'new' physicists in the field of nano-physics), which might make or force some to leave the physics activity in transition.

Our analysis shows that motivational factors of the past will not ensure a future in physics research in academia. The female newcomers have, often to a larger degree than their male peers, a father or another family member who is a physicist. This might have spurred a love for physics. More often they have also had encouragement from school-teachers. With respect to the Danish school system, we have found that the relation between the teachers and the interviewed physicists is generally defined as very poor. As the women seem to be more dependent on 'mentors' and role models, this fact might prevent more women than men from pursuing physics careers. Men might express a more intrinsic love for physics, but there is no guarantee that the love for physics in itself is enough to make either male or female physicists stay on a career track in physics.

A great number of the interviewed physicists have not had to fight for a PhD position. Here physics seem special in relation to most other areas in academia, where PhD scholarships are something you fight to obtain. In physics, the PhD students have been "persuaded" by supervisors and professors. Even so, many of the physicists chose to leave academia and that is often equivalent to leaving research all together. Male physicists and especially female physicists who all the way have been encouraged to enter academia and climb the ladder waste the opportunity to stay in research provided by the PhD degree. Why? We must probe deeper than the physicists own explanations to find out what creates boundaries between those who remain inside and those who end up outside of the activity system.

In the narratives, we see examples of contradictions that arise because the universities are in a transition from having been workplaces, which typically attract devoted male physicists who can work around the clock and travel when it is needed because they are either unmarried or have a wife who takes care of the family, to becoming workplaces

which seem to attract more female employees and men with new masculinities. Today, family issues have entered physics for both male and female physicists. Here we see that the younger generation of male physicists are also interested in being able to be with their children – and many prioritise family life highly. These new employees often work in the emerging interdisciplinary fields that break down boundaries between disciplines, and they change the tacit knowledge and implicit rules of the former physics activity. Put differently, the context of learning in the everyday workplace environment is changing and the physicists change with it.

This context of learning in scientific activity in Denmark is and has been ruled by politics since the 1930s, but there seems to have been a recent major change of the object of the activity which has changed not only what kind of physics to study (from nuclear to interdisciplinary physics like nanophysics) but also the self-understanding of the role physics play in society. Physics has gone from being lofty, abstract and with no need for public interference to a discipline with emphasis on usefulness and, as pointed to in our material, an emphasis on nano-technology and similar interdisciplinary research. To some extent, this change seems to mirror the development at universities in general from a more isolated 'disciplinary' knowledge production (mode 1) to a co-production of interdisciplinary applicable knowledge (mode 2) (Gibbons et al. 1994, Nowotny et al. 2001). The mode 2 approach entails recognition of societal demands for useful research, but in our case, these new external demands initiate new contradictions within the system.

The "new" mode 2 physicists do not relate to the earlier times stereotype of an asocial person with no other interests in life but physics, as it was described in the section on stereotypes. They are social people who like to work together in groups. Maybe therefore many physicists also react to the new fierce competition following in the wake of new mode 2 universities. The physicists have to compete for jobs and funding in manners which can be harmful to the pleasure of doing physics and many experience this competition as detrimental for their joy of physics.

The mode 2 academic workplace appears problematic because the new type of useful knowledge production also entails more administration and political accountability (Shore & Wright 1999), which the physicists complain leads to much time wasted on e.g. writing appli-

cations for funding in the increasing internal competition. This competition is not always seen as fair by the physicists because other factors than professional merits play into the external and internal selection of which projects win the funding. Competition within the workplace is thus connected to the internal division of labour – who gets to do what? Here, many physicists refer to unclear rules of selection mechanisms, unfair competition and even outright nepotism. In this respect, our picture of science today is very far from the idealistic CUDOS norms identified by Merton (see note 5).

The way physicists are employed is changing from an emphasis on permanent positions within fixed disciplinary boundaries to a demand for flexible physicists, who can change fields and work in new interdisciplinary constellations when public demands for useful research change and who accept working on short term contracts and go on long stays abroad. The transformed boundaries are challenged by other changes in society – and the new boundaries for doing gender and family seem most salient but also more troublesome for the new physicists (irrespective of gender) compared to the traditional and stereotypical physics researcher. New masculinities characterise men who want to spend more time on their family, just as many women do. These external changes lead to internal contradictions in the system, as they seem to clash with the demands for a very flexible workforce on short-term contracts and long stays abroad. Only certain fields – like the groups we have described as best practice – have already seemingly worked out a solution to this contradiction by transforming the entire workplace to a family-friendly place. Boundaries between family and work life – which were so salient in the mode 1 way of doing science – are dissolved. In other places, apparently especially in the "old" mode 1 disciplines, there has been less reconciliation of work and family life and this might, in our analysis, be one of the deeply subtle and not explicitly mentioned reasons why male physicists with families, new masculinities and women with family responsibilities choose to leave the workplace.

Some stayers who are on a career track as either PhDs, post docs or even assistant and associate professors think of leaving – and we found it quite noteworthy that so many female informants were found in this group (half of our female stayers, and only one male). They still claim to

love the object (the scientific disciplines of physics), but consider – like many leavers have already done – leaving academia as researchers.[18] In the meeting with the academic workplace, the women seem more prone to become leavers. But we must also ask ourselves whether it is the academic environment that is especially hostile towards women?

Many of the women explain how they feel very visible in physics but not due to their competences as physicists rather as women. Especially sexual harassment and harassment in general, which in our research only seem to be affecting women, tell us that some male physicists in general do not seem to have adjusted to the new type of workplace with female colleagues. The female visibility comes to create a gender boundary, which is mainly experienced negatively by the women. We believe that this is one of the unspoken reasons for leaving which might affect the female physicists more than the male. Though no women or men explicitly mention this boundary, it can implicitly lead to subtle exclusion selection mechanisms because it refrains one from participating in building/enforcing ones implicit competences such as forming strong networks, showing devotion etc. in everyday situations at the workplace.

Analytically we see that the need to spend time on non-workplace related activities also create a boundary between those with less "external time-demands" and those who are responsible for picking up children from day care, leaving work "early", doing house chores etc. These persons happen most often to be women, who are on the 'wrong' side of the borderline.

Longer periods of time away from the workplace, e.g. maternity/ paternity leaves, may analytically be seen in the same light. In this period of time one cannot take part in networking (formally and informally), publishing articles and showing full devotion to the object of doing physics and this is problematic because all three aspects are part of the implicit and explicit competences that influence selection mechanisms.

One may think that the problems arising from being away from the workplace would also include stays abroad. However, we find that staying abroad reinforces the physicists' explicit and implicit compe-

[18] Researchers may be defined as: "Professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned." (Commission of the European Communities 2003: 6).

tences, with regard to international publications and research work (explicit competence) and developing/extending ones network by building relations to powerful (and known) mentors (implicit competence). We find going abroad may be more problematic for the young women who plan to start a family because they, to a higher degree than the male physicists, foresee that a long stay abroad might prevent them from starting up families.

In the physicists' "folk-narrative" it is explained that women have problems *because* of children. This is not confirmed by this study, though. Instead we find that the *context* defines children as the problem. What is particularly interesting is that we find "pockets" in physics where the physicists seem able to reconcile work and family life, avoid sexual harassment and in many ways seem to reconcile also the object of the activity with the community, the rules (implicit and explicit) and the division of labour without too much hidden competition.

In the *Best Practice* examples we do not only see that the physicists can retain their love for physics, they also refer to a larger degree to the usefulness of their work, a strong feeling of group solidarity and being able to combine work and family life. Naturally the best practice groups are not all idyll because some people might not fit in within the boundaries of the group – and in this case they leave. But when we compare the "complaining" quotes with our best practice examples we find another mind-set where both men and women feel comfortable – and in these groups we do not hear explicit examples of harassment in general, sexual harassment, nepotism or lack of understanding for family life responsibilities. The particular problem of an unsatisfactory social environment seems, in our analysis, to have been more or less solved in the pockets of best practice groups. Though many problems remain for male as well as female physicists (such as the short term contracts), these best practice examples show clearly that it is the workplace *context* for doing physics research which create leavers, especially female leavers, rather than children as such, demands for travels abroad, and work hours.

The female physicists seem in general to be more sensitive to the social environment through their different stages in their careers as physicists: Firstly, they rely on personal inspiration from a family member, typically fathers. Secondly, they are more dependent on good and friendly school teachers and, thirdly, when they enter university,

they appreciate personal support and encouragement from mentor(s) or supervisor(s) more than the male physicists. Therefore, it is especially problematic when their expectations of a supportive and social collegial network breaks down as in cases where they are exposed to outright discrimination in the educational system, disputable hidden competitions at work, harassment and, last but not least, sexual harassment. We argue that these factors can make the female physicists more vulnerable and more prone to leave the activity system. We may speculate why the male physicists appear to be less vulnerable. The possibility that the men (from the outset of getting into physics) are perceived as belonging to the activity, as we have seen in relation to teachers at schools and universities and in the stereotype of the ideal physicists, may make the men less susceptible to the negative subtle selection mechanisms.

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Appendix

Table 1. Distribution of the Danish stayers according to gender and position

Position	**Males**	**Females**
PhD-student	0	3
Post doc	0	4
Assistant professor	0	2
Associate professor	6	1
Professor	2	1

Table 2. Distribution of the Danish leavers according to gender and position

Position	**Males**	**Females**
Scientist	0	2
College teacher	2	3
Hospital physicist	0	2
Senior researcher	1	1
Project head	1	0
Industrial researcher	1	0
Consultant	1	0
Self-employed	2	0
Academic admin. and communication	0	3
Well site engineer	0	1
Unemployed	0	2

Table 3. Distribution of age among the Danish interviewees

Age	**26–29**	**30–39**	**40–49**	**50–59**	**60–69**
Males	0	9	5	1	1
Females	4	14	7	0	0

Table 4. Interviewees' parental status

Has children		**Has no children**	
Male leavers	5	Male leavers	3
Female leavers	12	Female leavers	2
Male stayers	6	Male stayers	2
Female stayers	3	Female stayers	8

UPGEM National Report
Estonia

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Table of Contents

1. Introduction

1.1 Summary

The current situation of Estonian physics (both institutionally and also in the sense of mentality and internal culture of the discipline) bears the mark of all the past historical periods and changes, whereas the strongest influence comes from the transformation of society in the 1990s, affecting science in general and, also physics – emergence of new social sectors, decrease in employment due to economic problems and the low salaries in scientific areas. Images of admirable physicists in Estonia bear a masculine undertone. It is possible to generally distinguish between three main types of physicists: the first two are based on Margaret Wertheim and Cathrine Hasse's typology, namely 1) the physicist as a priest of truth and 2) the physicist as a playful boy. In addition to this, in Estonia there is also an image of 3) the physicist as a blacksmith. Regardless of all these styles of being masculine by nature, it can be said that for women it is much easier to identify themselves with the image of the priest of truth, rather than the playful boy or the blacksmith, the latter even seems impossible. Estonian physicists by and large value the freedom to choose their working time and place, but they miss social communication and intellectual atmosphere. It seems that a female physicist's career depends more on the personality of their supervisor. Both male and female respondents value family highly but contribute to it differently: women are more responsible for taking care of household chores; men have a bigger role in providing financial security for the family. The general opinion of interviewees is that it is beneficial for physics as a science if people rotate and travel a lot; however male physicists spend longer periods of time abroad and therefore perceive absence from Estonia in a more negative manner than women. In their opinion travelling affects family life.

1.2 Research questions

The present report is a part of UPGEM (Understanding Puzzles in the Gendered European Map – Brain drain in Physics through the Cultural Looking Glass) project, which has been brought about because of two problems:

1) Vertical segregation in natural sciences – the representation of women on the highest levels of the career ladder is low.
2) Horizontal segregation – the number of women in natural sciences and especially in physics is low altogether.

Since the number of female physicists is different in different countries, it is inevitable for the question to emerge – what are those national-cultural factors that shape the career of men and women inside the community of scientists? (UPGEM proposal)

One of the aims of the present report, therefore, is to describe Estonian physics and produce a particular depiction that could be compared with the research results of the four other countries participating in the project (Denmark, Finland, Italy and Poland), by contributing to one of the three main axes of the UPGEM project – **1) the cultural axis**. Therefore, the discipline under research is seen from the socio-cultural viewpoint – what are the values that Estonian physicists share, how they describe their discipline, estimate their work environment, human relationships and their own career. The research is based on the pre-requisite "that by studying and interpreting self-narratives, the researcher can access not only the individual identity and its systems of meaning but also their teller's culture and social world." (Lieblich, Tuval-Mashiach, and Zilber 1998)

In addition to providing a general description, the original objective of the current research was to analyze the materials on the basis of two more axes, one of which – **2) the axis of gender**: (women – men)[1] – proceeds from the hypothesis that there are certain differences evident in

[1] The term *gender* in this context refers to the biological differences between men and women, although the authors of this report do not believe in biological determinism and consider it essential to make a distinction between biological and social gender.

the career paths of men and women and, speaking about the possibilities this project offers for analyzing the materials, the way men and women see the differences in their professional lives.

The report discusses a situation that is extreme from the point of view of a career in science[2]– leaving physics. For this objective, the interviewees include former physicists and the issue is also added to the interview guide. The main idea was that giving reasons for and explanations of the radical choice may shed some more light on gender-related differences. Therefore it is procedurally important in the current research to ask – **why do people leave physics?** This involves the last axis of the project – **3) the axis of leavers – stayers**.

In the context of Estonia, the "social experiment" is also added, helping to bring out the gender-related values in the sub-layers of the local culture, namely the social transition period caused by the shift from the (declared gender-equal) Soviet regime to a free-market society.

1.3 Research data

The Estonian database consists of 36[3] interviews which were conducted with former and current physicists of Estonia. The interviews were carried out during the period of March 2006 – April 2007. Most of the conversations were in Estonian, one in Russian. All the interviews were transcribed and translated into English. In order to guarantee the anonymity of the respondents, all the necessary personal names, the names of institutions and cities were either coded or deleted. The respondents had the possibility of checking out the transcriptions or translations of their interviews and also of making changes and corrections, if they wished to do so.

As far as the notions of male-female and leavers-stayers were concerned, the choice of interviewees was based on the principle of sym-

[2] Career path is to be understood in the widest sense not only as a career ladder, but also involving an understanding of why people choose physics in the first place.

[3] One out of 36 interviews contains the answers of two people – in addition to the main interviewee (a female leaver) a male leaver was also present.

metry by David Bloor, a sociologist of scientific knowledge. According to Bloor, in explaining scientific knowledge, the causal context of the views of the opposing representatives must be discussed equably, that is, symmetrically (Bloor 1991). A similar approach is the Cultural-Historical Activity Theory where the method of culture contrast is applied. There was an equal number of male and female respondents and also an equal number of leavers and stayers. In choosing the respondents, the lists of employees published on the web sites of institutions of physics were used. In order to find leavers, the interviewees were asked to remember people they knew were not in the field of physics anymore.

In the current report:
— A physicist is defined as a person who has obtained a scientific degree in the field of physics.

— Stayers were defined as people who at the time of the interview were working full-time or part-time in one of the following structural units of physics of the following institutions: Tallinn University of Technology, National Institute of Chemical Physics and Biophysics, Tartu Observatory and the University of Tartu, and were engaged in physics-related research work.

— Leavers were defined as people who at the time of the interview did not work in these institutions anymore or had changed their discipline (either for humanitarian[4] or social sciences).

— Interviews of complicated categorization: the leaders of the aforementioned institutions and structural units were also considered among the stayers, even when their connection with the research work was minimal or even non-existent at the time of the interview. The leavers also involved people working in the area of physics, but whose current job is not financed by the public sector or is situated outside the borders of the European Union.

[4] The term 'humanitarian' in this report refers to the disciplines in Humanities and Social Sciences or the academics in these disciplines. (Authors' note)

The time of the interview emphasized in the definitions is significant because of the fact that on the axis of leavers-stayers, the status of a person cannot be permanently fixed. Hereby we do not only consider the conceptual possibility of the changes in the position or the differences according to the gender-axis – the notions of male-female that are much more stable by their nature – but also the actual changes in the positions: at least one of the people interviewed as a stayer left physics shortly after the interview and two interviewed as leavers are back in the category of stayers again.

The age of the respondents ranged from 25 to 80 (see Table 1), the average being 48.9 years. People from different disciplines of physics, astrophysics, theoretical physics, high energy physics, geophysics, solid state physics and chemical physics were represented.

Of all the interviewees, 29 have children and 7 do not. Of the respondents with children, 17 were men and 12 were women. There were more people with children in the group of leavers than in the group of stayers: 17 and 12, respectively. The lowest number of the respondents with children was among the female stayers – 4. It should be noted here that among the female stayers, there were 4 people under the age of 30. In other groups, none of the respondents were younger than 30. For the interviewees' parental status, see Table 2.

Most of the respondents who had left physics did so during, or due to, the social-political changes of the 1990s. Out of 18 leavers, 13 respondents (6 women and 7 men) changed their jobs after 1991[5], whereas the lives of 5 interviewees (3 women and 2 men) took a turn before this date, but these included 3 who had based their decisions on the ongoing changes. For the current jobs of the leavers, see Tables 4 and 5.

Table 1. Age of the interviewees

Age	25–34	35–44	45–54	55–64	65–80

[5] 1991 was applied as the reference year because on August 20, 1991 Estonia regained its independence.

Female	4	4	3	4	3
Male	1	6	3	6	2

Table 2. Interviewees' parental status

	Children		Childless
Male Leavers	9	Male Leavers	–
Female Leavers	8	Female Leavers	1
Male Stayers	8	Male Stayers	1
Female Stayers	4	Female Stayers	5

Table 3. Stayers' present working status

Position	Doctoral candidate	Post-doctorate	Senior researcher and Senior Lecturer	Professor	Technical and Administrative staff
Female	3	1	3	1	1
Male	1	–	5	2	1

Table 4. Leavers' present working status

Present Work	Research and Development	Management	Other
Female	1	5	3 (2 of them unskilled workers)
Male	3	5	1

Table 5. Leavers' present work distribution in the public sector and the private business sector

Sector	Female	Male
Public	7	3
Private (business)	2	6

1.4 About data analysis

The objective of the present research was to find answers to the following questions:

1) In what ways do the former and the current Estonian physicists discuss the following issues: changes in the field of science, identity, work environment, family and mobility?
2) Are there any differences in these aspects in the answers of men and women?
3) Are there any differences in these aspects in the answers of leavers and stayers?

During the research it appeared that there were no significant contrasts on the axis of leavers-stayers, which does not mean, however, that involving this particular axis in the research would bear no importance at all. The following analysis is constructed on the principle that the motives given by the leavers as the reasons for giving up physics are the focal point. The rest of the material provides the context, helps to explain these reasons and adds motives for staying in physics.

Bringing out the gender-related differences did not prove very easy, but was still possible. It is important to say that the blocks of issues discussed reveal these differences to dissimilar extents, which is also the reason for a certain unevenness in the report. For instance, family issues provide a better ground for looking for gender-related contrasts, whereas in other issues the situation description plays a more important role.

The most difficult problem in collecting the data was finding the balance between the necessary thoroughness of an in-depth interview and managing to cover all issue groups. Compromises were inevitable, since if both conditions were met, the duration of an interview would have been 3 – 4 hours. The first interviews included nearly 4-hour long sessions, which were good for the analysis, but in continuing with such a strategy the number of the interviews should have been decreased. Therefore, not all the interviews that the analysis is based on, are of the same degree of thoroughness and not all of them cover the questions in the interview guide (see Appendix B).

Another problem was that the layoff period of the 1990s left such unpleasant memories to some who personally experienced it, that they would rather not talk about it. Two people refused to give an interview and in the case of one, this was the exact reason.

We provide a qualitative analysis of the Estonian data, applying the computer programme Atlas.ti as the tool for collecting and grouping similar text passages. The method of analysis is based on empirical material, treating it with care and respect, but also proceeding from the prerequisite that with a qualitative method the importance of interpretation on different levels of research must be recognized. "Reflective research has two basic characteristics: careful interpretation and reflection. The first implies that all references – trivial or non-trivial – to empirical data are the result of interpretation. Thus the idea that measurements, observations, the statements of interview subjects, and the study of secondary data such as statistics or archival data have an unequivocal or unproblematic relationship to anything outside the empirical material is rejected on principle" (Alvesson and Sköldberg 2000). This means that quotations are not perceived as mechanical building blocks in this report, but they have obtained their final meaning in comparison with the rest of the materials and inside the whole picture.

2. Changes in the field of science

This chapter concentrates upon how Estonian physicist perceive the changes that have appeared in the field of science, both in physics in general and also in the research institutions these people are connected with. The average age of the respondents as mentioned above was 48.9 years, whereas the oldest interviewee was 80. Thus the most important developments of the last half a century were mainly described on the basis of personal experiences. The focus of this chapter provides an essential framework for understanding the presentation as a whole, because the current situation of Estonian physics (both in the sense of institutional as well as the mentality and internal culture of the discipline) bears the mark of all past periods and changes, whereas the

strongest influence comes from the transformation of society in the 1990s, which affected science in general and also physics.

2.1 Changes in the widest sense

The most general development as mentioned by the interviewees concerns the changes from the beginning of the last century – the decrease in the importance of a scientist's individual contribution and the increase in collective production. The first decades of the 20th century are considered the era of individual geniuses. The post-World War II tendencies and the industrialization of physics brought about the "collectivization" of both the science and knowledge, the main indicators of which are 1) the increased size of research groups and 2) the changes in publications.

The physics of the pre-occupational Republic of Estonia[6] was very small-scale in comparison to the science in the Soviet era. After the World War II, the size of the research groups constantly increased until the beginning of the 1990s. For example, in the case of Tartu Observatory:

> *It started after the war, it started from the state that it had been in before the war – let's say, there were about four-five astronomers here altogether and then, let's say, in the beginning of the 90s, when the Soviet system crashed, then there were, well, the number was at its highest, _ let's say, when we're speaking of, we here have in addition to astronomers also atmosphere physicists, geophysicists, altogether there was, like, over 60 of us who dealt with research […]*[7] (P319/MS)[8]

As was mentioned already, another important difference when compared with the beginning of the century concerned publications. The

[6] 1918–1940.

[7] In extracts from Estonian interviews following marks are used: – stands for unfinished thought, _ stands for pause, between % marks are putative word(s) as the recording was not very clear or good quality.

[8] Interview citations are marked as follows: M – male; F – female; S – stayer; L – leaver.

number of publications has increased, but that's not the only change. When earlier single author publications were the most common, the current standard tends to be 5–7 authors. Depending on the research discipline, publications with even 200 authors need not be surprising.

> *This is, let's say, about a hundred years ago things got done – an article had one or two authors, but now there are very often five, six, seven authors, I'm not talking about the ones from any CERN laboratories or such, but also theoretical works. Where all the work could be done by one single person, but there are five or six names listed. There are several reasons for that, perhaps there used to be different criteria in the older days, instead of writing down your name it was registered in the acknowledgements that I have spoken to this and that person and thank them for good suggestions, but today people are listed as authors instead.* (P310/FS)

The reason for the increase in the number of authors exists not only in evaluating scientists according to the number of publications, but it also indicates the increase in the importance of research groups and cooperation.

Of the general changes, mainly male leavers mention the convergence of academic, theoretical physics and applied physics and the increasingly „intimate" relationship of the two. Science is expected to yield more profit and practical output. About such conceptual changes in science, (see e.g. Woolgar, 1988.)

> *And another thing is this applicability, that's become more important, in a sense the border between academic and non-academic is decreasing, because it's being imposed on, it's also imposed on in the European Union. There are very many grants, a lot of financing behind this if you do applied researches.* (P306/ML)

2.2 Physics of the occupational era

Generally the respondents agree that compared with the present situation, the prestige of physics was quite high in Soviet Society. The

scientists see the reason mainly in the Soviet Union's military ambitions and the Cold War. A story very popular among physicists tells about how Stalin, trying to ideologize science, succeeded in influencing biology (through the prevalence of "Lyssenkoism"), achieved some results in chemistry, but made an exception of physics because the Soviet Union needed a nuclear bomb.

> *[…] physics stayed as it was, the theory of relativity remained untouched and quantum mechanics remained untouched and the argument was the following –, now this may be just a rumor, that Kurtchatov, the father of the Soviet nuclear bomb, is reputed to have said, Joseph Vissarionovich, alright, let's say, we give up _ the theory of relativity, we give up quantum mechanics, but then there's going to be no atomic bomb, either.* (P334/MS)

Therefore the interviewees considered physics to be a relatively objective area, free from Communist ideology both as a scientific discipline and also as a work environment. The institutes of physics represented freedom of thought for them and as far as freedom of speech was concerned, the respondents were quite satisfied with their work environment of the time.

Institutionally the physicists were not only gathered around universities. Science in general, and physics as well was practised in the institutions of the Academy of Sciences, higher education institutions and the research institutes of Ministries (Tomusk 2003). The Academy of Sciences basically played the role of the 'Ministry of Science' and in comparing the financing of the institutes subject to it and the research sectors of the universities, the situation and the experimental basis were allegedly better in the former.

> (P0/ML): *The matter was, some instruments could have been bought only through Academy. They weren't sold to universities at all.*
> (P322/FL): *And the university didn't even have that much money.*
> (P0/ML): *Yes, they didn't have money, either.*

> (P322/FL): *Yes. But* ***Romance***[9] *was Academy [unclear], and therefore they were better financed.*

A similar selection was carried out in human resources and the best university graduates started their physicists' careers in the institutions of the Academy of Sciences.

> *But subject to that the Academy of Sciences was privileged and had the right to take the top graduates to itself immediately. It can be said that they took first and then the others could take, more or less [unclear]. And it could be said with this that it was more or less like the medieval town council that incorporated its members. Recruited new member by incorporation. I mean, chose a person who was thought suitable and took.* (P329/MS)

In order to become "real" scientists, young people tried to start their career paths in these kinds of institutes. Nevertheless, the beginning of a career was not merely a matter of will. It was up to the placement committee to decide how to divide the freshly graduated students according to the places commissioned by the Academy of Sciences and the Ministries. The committee considered the graduate's study results, their other services and wishes and on the basis of all this, the fates of the fresh graduates and their jobs for the next three years were decided. When the three-year service was completed, the young people were free to apply to other places.

> *In the Soviet era, there was such a thing as appointment, that is, compulsory appointment. You had to go and work somewhere, because the state – the state paid for your education, right.* (P314/FL)

Placement into a prestigious institution of the Academy of Sciences would, in terms of a stable social order, have meant a linear career. Even more so, because unlike the current academic practices, in which most of the scientific staff at the universities are employed for five-year cycles, a job or a career level represented a secure position.

[9] Research institution under the Academy of Sciences.

> *But we were that Soviet society – they wouldn't let you go up, but they also didn't let you drop down – so, all in all, in between _ the contract, if you had it _ if you had been elected a senior research fellow, you couldn't go lower anymore, it was that safe [smirking].* (P303/FS)

Nevertheless, it seems that it was easier for male graduates to get an advantageous placement. Among the interviewees, only women were placed as secondary school teachers (which, in terms of prestige, was the lowest area in physics[10]). They all tried to return to doing research and only one was unsuccessful, the other three continued their careers in the institutes of physics.

> *So, I don't know whether the two years as a secondary school teacher after graduating count as career or not? That was 1955–57.*
> *Interviewer: And where was that?*
> *In Secondary School, a teacher of physics and mathematics.*
> *Interviewer: Was it an issue of placement or how did you go there?*
> *Yes.*
> *Interviewer: But during your university years, did you specialize in teaching?*
> *No, I didn't. […]* (P327/FS)

Soviet Estonian scientific research was a small element of the huge Soviet research arena and there was a lot of cooperation with the institutions in the Eastern part of the Union. The universities of Leningrad[11] and Moscow also played an important role in personal careers. In a society where the processes work in a centralized manner, not only material but also the mental resources tend to accumulate at the centre, so the scientific institutes in Moscow and Leningrad fascinated the brighter students and studying and working there meant being at the centre of Soviet science. The system drew in students from high school; there was, for example, a special preparatory school for real sciences, which some Estonian school students attended. Students who had finished a regular secondary school had the opportunity to apply for the

[10] Although a large number of physics teachers in schools were men. The majority of them were trained in the Tallinn Pedagogical Institute.
[11] Saint Petersburg.

state-provided vacancies (reserved for the Soviet Republics) in the University of Moscow or Leningrad.

Among the respondents of the current research, many had used these opportunities or had gone to the centres as post-graduates after graduation. Interestingly, the interviewees who at the time were more geographically mobile, were also "more socially mobile " – by now, all of them have given up physics, to greater or lesser extent, but it did not happen at the same time as returning to Estonia (the last ones returned during the confusing times of the beginning of the transition years), but much later.

In addition to the aforementioned issues, information also tended to gather at the centres and many physicists spoke about the availability or unavailability of information. As to the most outstanding changes within the last 20 years, many physicists, especially the female leavers, mentioned the improvement in the possibilities for finding information, especially due to the Internet and free communication with the institutions of physics in the Western world. During the Soviet era, people often travelled to Moscow to get the articles necessary for their research work.

> *Well, at that time, when we're speaking about literature and, and things like that, then it cannot be compared to the present situation. We went, we went to Moscow libraries to copy some articles from some international journals in English or ordered these on the micro-discs or –. Well, the access to all those things you really needed, that was extremely complicated. But that's only because of the time. […] but the foreign articles, especially on that topic, these weren't subscribed to Estonia and that's why it was like that – very difficult to obtain. There was no Internet at the time, right, where you can see and read things, […]* (P323/FL)

While the contacts with the East were very common, contacts with the West were a lot more complicated, but there was some cooperation nevertheless. The allowing of cooperation and scientific relationships between the natural scientists of the Soviet Union and the West may ideologically be the result of the doctrinal reformulations of the post-Stalin era, according to which scientific truth was no longer dependent

on the class position of the scientist. Thus, regardless of the social sciences being different in the Soviet Union and the Western countries, the real sciences were the same since nature is one and the same throughout the world (Allyn 1990).

> *Well, that [participating in conferences abroad] was _ the Soviet time was very restricted because the KGB stood in between _ and I don't even know myself _ how should I know? Was it about the local, our own Estonian department, […] department of foreign affairs or was it from Moscow somewhere, but once you had got out, it was easy, that person was safe. But now all the borders are open, now you can, I'm telling you, you can find anything you like on the Internet. There are conferences, tens of invitations, all you need is money. So access _ if here's anything to hinder you, it's the money.* (P303/FS)

2.3 The 1990s

The process of Estonia gaining independence, the social and economic changes and higher education reforms affected the local scientific research to a great extent. "As a group Estonia, Latvia and Lithuania inherited quite a developed R&D [research and development] sector from former USSR. However, this sector was tailored to serve the needs of the large Soviet Union. As a consequence, their former advantages turned into disadvantages, because in the transitional period to market economy, this R&D sector could not sustain its capacity and had to be reduced to match the opportunities and needs of a small independent country: it had not, however, been designed for that purpose" (Blagojevic et al. 2003). Depending on the institutions, the number of employees was decreased even by two-thirds[12]. Three sets of factors can be discerned in the reasons that shaped the community of physicists: 1) factors drawing people out – the emergence of new social sectors, 2) factors driving people away from physics – a decrease in the number of

[12] The number of scientists and engineers in science generally decreased in 1992–95 by about 15%. In 1996-99 it was mainly the number of scientists and engineers without a degree and technicians and assistants that was decreased (Laasberg 2002).

jobs due to economic problems and the low salaries in scientific areas, and 3) the natural defense mechanism of the community, which preferred to concentrate its resources on 'survival' issues, rather than creating new posts for young physicists and thus ensuring new generations of physicists. The latter factor affected both young men and women similarly, but in the other two, men were influenced more by the factors drawing people out, whereas in the case of women the factors driving people away also played an important part.

2.3.1 Factors drawing people out of physics – the diffusion of the elite into the new social areas

Physics "lost" some of the members of its community at the start of the process of gaining independence in Estonia. The reason was that physicists considered themselves a mental elite and the mental atmosphere in the institutes of physics nursed political discussions and the forming of opinions.

> *But_ so when it was political, we were all friends, we had a common enemy, the Russian state, the Russian government, we never really thought it would come to an end, it was like _ well, the rules of the game, you curse among yourselves and that's it.* (P303/FS)

When the times changed and social activity already bore a meaning, it was only logical that the intellectual elite moved on to the social level of those who made political decisions. This happened primarily because of their interests, but also because of the skills in solving non-standard problems and perceiving that as their mission. One interviewee emphasized the importance of the scientist Endel Lippmaa's activities in relation to the central government of the Soviet Union being forced to admit the existence of the Molotov-Ribbentrop Pact.

> *We must have competence. And precisely – and physicists are important in this sense, that they are accustomed to solve unexpected situations, non-standard tasks. That's why we need physicists. […] That is really the most important thing.* (P319/MS)

There were men and women among the physicists who contributed to the legislation of the new Estonia, but of interest are the reasons men and women bring for their leaving science. The following examples come from the people who left physics at approximately the same time and are approximately of the same age, the only difference between them being gender (the first response is provided by a man, the second interviewee is a woman).

> *Interviewer: And what, what was the reason for this gap here or leaving at that moment?*
> *In 1990. Well _ I wanted to break free from the prison. That was the time when all people _ were interested in politics and that spark of hope that came in out 1985 –. Or was it 1986 or 1987, or something, when – when people sensed or thought of that, depending on their optimism. I really wanted to contribute. To break free.* (P331/ML)

The male physicist clearly indicates his own will to contribute to the social life and also points out the possibilities the political sector offered to reach these objectives. The woman, however, describes the process of decision-making as complying with the wishes of her colleagues and perceives it even as an unpleasant or uncomfortable step. So even here the factors drawing away from the scientific community can be noticed, although there is a positive nuance – she was chosen to represent the opinion of her own social group:

> *I had no plans about leaving science even as I was involved in those Popular Front issues, I never even thought about going into politics. It was more that my colleagues decided that I should apply and to the very last moment I had this feeling that OK, fine, I'll apply because I can't and shouldn't refuse from applying, but I was hoping nevertheless that this choice _. That it would be someone else going into politics. […] I was pretty much worried about the situation and the night the results were finally announced _. I realized I had been elected and it was such a shock for me. I remember I cuddled up against my husband and cried a lot, as it was such a shocking situation that _. I had pictured my life in science and one moment it's something totally different. […] It was such an unexpected turn in my life where I can say the outer aspects were*

> *more important than my own will to go into politics as I didn't have any actually.* (P304/FL)

In addition to the attraction of politics, in the 1990s there also emerged a totally new area in Estonian society – the business sector, which might have drawn the biggest number of employees from science.

> *Well, it could be said these kinds of inborn makings of a businessman were suppressed in the soviet system. If the system collapsed – when, that is the possibility to start one's own business opened, then these people started this business.* (P329, MS)

A great many physicists started their own businesses or became employed by the IT-companies. One characteristic trait is that among the interviewees it was mainly men who went into the business sector. The majority of female leavers opted for the public sector.

2.3.2 Factors drawing people away from physics

1) Loss of funding from Moscow.

The regained independence inevitably caused the funding of science from Moscow to cease and all of a sudden physicists found themselves in a situation where there were many people, but limited funds for salary. In order to solve the problem, different strategies were applied. First of all, people were encouraged to find themselves new jobs, whenever possible. One female interviewee left because she was insecure about her position and future in the scientific institution and she happily accepted a decent salary and a post with a stable work contract in information technology in the public sector.

> *Well, when the republic was restored, then the funding just got so small and there were massive layoffs and practically only one fourth of the institute survived _ and since I was made a very good offer, then I found that it was wiser for me to leave.* (P317/FL)

Another plan was to decrease the number of employees. On the one hand, it happened in the natural way – when people retired, their posts were not filled with new people. However, that did not suffice – now there was a need for criteria on the basis of which scientists could be compared and the number of publications became the main basis for comparison. The scientists were ranked and the ones towards the end of the list faced the probability of losing their jobs.

The third possibility was to enter into contracts where full-time work was substituted by 0.5 or 0.75, according to the financial possibilities.

> *There were both and I mean _ research fellows have fixed-term contracts. And when your fixed-term contract comes to an end, then you can apply for another five years or three years, well, like it's been over the times, as far as I know it's five now. And then you are either elected or not, there is a research council which then elects you or doesn't elect you back. And it can give you a one-year contract, it can give a three-year contract, it can give – offer you 0.75 workload, 0.5 workload, well, just as the money allows at the moment. That's the way life is there right now and these changes started with ninety – well from one on already.* (P317/FL)

The real amount of work expected from people on part-time contracts was, however, a full workload. Such an attitude, that a person working in the area of science must be fully dedicated, but in paying out the salaries the current projects and grants are taken into account, can be met even nowadays. On the basis of the interviews it seems that the tactic of "that should do" is more often used with female employees: mostly the young ones whose career paths are just beginning, but in one case it concerned an interviewee who had reached retirement age. The following example is a young woman's explanation from a later period. She describes a situation where her workload was increased from part-time to full-time, whereas there was no intention to increase her salary.

> *Then I – then I was working part-time. That was when my pay was 2500 kroons. Right, that was it, right. But then he thought that I would be working full-time from then on, but would still get paid 2500 kroons, like, that's not right.*

> *[…]*
> *Interviewer: So they simply maintained the same level –?*
> *Yes.* (P320/FS)

One should mention that a similar strategy was being suggested in her husband's case, except that the husband's salary was 4000 kroons already for a part-time workload.

> *Interviewer: And they increased your workload, but didn't increase your pay.*
> *Yes. But that is – that is normal, it has happened before I think, it seems that yes, that they might favor men more there [laughing].* (P320/FS)

2) Hyperinflation.
Parallel to the decreased financial possibilities and also pushing the process onwards, the transition years of the 1990s were influenced by increasing prices. The value of money gradually decreased on a daily basis and in 1992 inflation surpassed 1000% (Estonica), thus calling for exceptional economic abilities in order to manage with a scientist's salary.

> *I started in the computer business because the income, the salary was hopeless at the time. Inflation started, very rapid inflation, my wife was paid approximately the same amount and then she stayed at home with the third child and the question was, what to do and there was no other option than start earning somehow, my wife was already considering selling cotton candy or something, in order to – well, there wasn't enough to buy food anymore. It was absolutely impossible to support a family like that and so I went into business, I didn't have that plan right away, but I was pretty successful in the beginning.* (P318/ML)

3) Re-structuring the whole area of science.
The changes were deeper than just the loss of funding. The Academy of Sciences that performed as the 'Ministry of Science', now became an assembly of academicians, retaining remarkable prestige and authority, but that was about the limit. A decision needed to be made on what was to become of the institutions that used to exist under the Academy of

Sciences. Here different tactics were applied. Most of the institutes were joined with higher education institutions, where they became more or less integrated structural units. A couple of institutions retained a more or less independent status.

Re-structuring also took place in the higher education institutions. Different structural units were joined and, during this process, the number of employees was decreased. Two female interviewees-physicists whose contracts were not prolonged, were the victims of this process. In both cases the research topic was closed as lacking perspective.

> *One third was fired, all the laboratories were closed and the topics were closed and I was a little longer there than (P0, ML), because I was in Doctoral studies at the time. And that being in a Doctoral programme simply extended my time there. But then the rooms were gone and all that. And they simply wrote OK, leave and nobody cared, where or what*. (P322/FL)

These three processes driving people away had the greatest influence on leaving in the 1990s and also on the opinions on why people gave up scientific work. Active physicists, when asked about the reasons for people to leave, almost always named money as the main reason.

> *Well, one reason that everyone mentions is money. It's obvious that elsewhere you start making better money faster than you do in physics. That's a fact, you can't argue with that. I think that all physicists, as thinking people agree with that.* (P333/FS)

Looking at the explanations of the physicists who have left, this aspect usually holds true for male respondents. Interestingly enough, women do not emphasize the lack of money. Therefore it seems that the ones who have stayed have a certain overview of the reasons for men to give up; women, however, seem to be "invisible" and so are their problems. It is quite meaningful that locating female leavers presented the most

difficult part of the project[13]. In our searches for leavers we usually asked active physicists whether they knew anyone who had given up the profession of a scientist. There were always numerous examples about men, but it was a lot more difficult with women, because sometimes the respondents could not even remember what had happened to the women they used to study together with in university: whether they had stayed or left or what they were doing at that time. It seemed that the female stayers had a slightly better overview of the motives of the female leavers or at least they could remember particular female physicists who had left or given their own opinion on their reasons for leaving.

2.3.3 The lost generation

One of the results of the social changes in the 1990s was the lack of jobs for the graduates in the local research disciplines, which forced them to choose whether to leave physics right away or continue in foreign universities. A large number went abroad and some decided to stay there. However, if they had had a family before leaving, it was quite common that after their Doctoral studies they returned to Estonia.

However, the situation here had not normalized as yet, so a lot of those who returned had to find a job in another area. Thus, in a way, there is a lost generation of physicists in Estonia.

> *[…] Another problem has emerged, that just that, as one generation is missing among physicists in science, the generation that left Estonia in the beginning of the 90s, then in some sense –. […] That generation is about now, I'm of course generalizing because the number of these people is not so big, it is this kind of a personal view of mine but it, it's this kind of a 40-year-old physicist who somewhere at the end of the 80s was about 25 to 30. […]* (P312/MS)

The generation gap in the society of physicists also plays a decisive role. One male leaver who had come back from abroad was considering

[13] This tendency is not characteristic of Estonia only. The "invisibility" of the women was first noticed by an UPGEM research assistant Jenny Vainio when conducting research in Finland.

continuing in the science but then found that he did not have much in common with the people he would have been working with. There was no young company to inspire him.

The influence of the lost generation manifests itself in two ways:

1) Young physicists who have just started in research have no role models that would represent the values and skills that are necessary to cope with the changed field of science.
2) There are no social interpreters for the old physicists and newcomers. With women, the problem of identification doubles, because it's not only the gender that matters in becoming familiar with the discipline, but also age. The following example comes from a younger woman.

> *There are many people alone. Actually, they're all such individualistic people. Maybe something like, we do not feel we have anything to talk about. They're all old people, 50 or 60. I have no idea what to talk about with them, just work.* (P300/FS)

2.4 The Estonian physicists' evaluation of the present-day field of science

2.4.1 The current system: financing of science in Estonia

Financing is project-based and is divided roughly into two: state-targeted funding of research disciplines and financing of smaller projects by the Estonian Science Foundation (ETF). In addition, it is possible to apply for grants for applied fields from the Estonian Development Fund and the ministries. There is practically no private or business-based financing in the field of Estonian science.

1. Targeted funding by the Ministry of Education and Research
The targeted funding of research and development (R&D) institutions is based on the research topics. Targeted funding can be applied for by R&D institutions that have been evaluated and are listed in the relevant database. The continuation of targeted funding is based on the evaluation of the results by the Council of Scientific Competence. In evaluating the expediency of the targeted funding of a new subject matter

the Council of Scientific Competence will take into account the pre-requisites for fulfilling the particular topic in the R&D institution applying for the funding and also the actuality of the topic. The research topics of the R&D institutions are subject to evaluation every year – the continuation of financing is based on the annual reports. The duration of one R&D topic used to be four years and from 2008 it will be six years. After the expiration of this period, funding for a new topic must be applied for (*Homepage of Estonian Ministry of Education and Research*).

In 2007, there were 214 topics with at least 5 grant holders, in the total amount of 299 700 000 kroons.

From 2001, the financing of centres of excellence is considered one type of targeted funding. In 2007, there were 10 centres of excellence that were financed to a total of 26,800,000 kroons. Among them are the Institute of Physics of the University of Tartu and also the National Institute of Chemical Physics and Biophysics.

In order to develop new topics and courses, a so-called baseline funding was established in 2005. Subsequently, in 2007, 17 institutions received a total of 97,310,000 kroons.

2. In addition, through the Estonian Science Foundation, the state also finances individual and small-group research projects that can be applied for by Ph.D.s or scientists with an equal degree form any public research institution and higher education institutions. The group may also include graduate students and other scientists, but the remuneration of their work is allowed only when they receive no other remuneration from elsewhere or by part-time workload so that the workload remunerated will be 1.0 altogether.

In 2007, 630 projects were financed to a total of 101,600,000 kroons *(Homepage of the Estonian Science Foundation (ETF))* and *(Estonian Research Portal (ETIS))*.

2.4.2 Attitude towards the current financing system

The attitude towards the current financing system is different, but generally it can be said that the most critical ones in their evaluations are the middle-aged and older male physicists who would prefer the funds to be concentrated on a few more vital topics rather than distributing the funds evenly.

> *Money is divided equally to all considering the personalities, not according to what they do or what they're capable of. Science is an elite area, some can handle it and some can't. The ones that can, should get the money.* (P302/MS)

When interviewees suggest that funds should not be allocated equally, but only to the best, they are probably referring to the fact that the number of topics and projects is already too big for the meager financial resources in Estonia and that they would prefer only a few of the best. On the other hand, the Estonian Ministry of Education and Research is not in the position to make such a decision, because all the disciplines are evaluated internationally and there is no sign that any of these topics might be declining in importance or necessity. The applications and annual reports are examined by an international commission of experts.

Women tend to be a little happier with the financing system and do not criticize this particular aspect. It is very characteristic that at the time when women describe the changes that have taken place, men keep evaluating the Estonian science policies. A typical trait is the negative attitude of male leavers towards project-based work.

> *[…] I think that creative science as such in a good sense, it's under pressure, more than it used to be. And for young people, it shouldn't be about one-year projects only like it is now. Young people, when they are in their creative prime, I already spoke about that today, they should have a chance to solve some tasks that take them three years, not that they have to be able to come up with the results in one year only.* (P318/MS)

The interviewees considered the conditions of experimental equipment as the biggest problem in the present field of science. Interestingly enough, however, the ones who most criticize the condition of the experimental basis are men and mainly those who have stayed.

> *Well yes, certainly. Well not –. Something has improved, but, but, but whereas back then it was, after all, really possible in several disciplines to, well, do research on a top level technologically, then now this base is out-dated. I mean, we have – we spend in relative figures twice as less of GDP per one physicist then back then. What is the best indicator of it. It is –. And that means that, that well, one needs to considerably limit the range of one's ambitions when working in Estonia.* (P309/MS)

3. Identity and career path

The aim of this chapter is to analyse the interviewees' descriptions of physics, physicists and themselves, and try to find any possible patterns, on the basis of which to provide explanations for the development of careers.

3.1 Different styles of doing physics

Our claim is that all the images of physicists in Estonia bear a masculine undertone. It is possible to bring out three main ways of doing physics: the two first types of physicists are based on Margaret Wertheim and Cathrine Hasse's typology, namely 1) the physicist as a priest of truth and 2) the physicist as a playful boy (Rolin 2006). In addition to this, in Estonia there is also an image of 3) the physicist as a blacksmith[14]. The first image seems to be the prevailing dominant one both in society in the wider sense and also in the community of physicists themselves; the second-ranking is the physicist as the blacksmith; there is less mention of the physicist as the playful boy, but the image exists nevertheless. Regardless of all these styles being masculine by nature, it can be said

[14] This image has been borrowed from an interview with a male physicist.

that for women it is much easier to identify themselves with the image of the priest of truth, rather than the playful boy or the blacksmith; the latter even seems impossible.

There is probably no need to emphasize that all the metaphors brought out previously are only useful tools for dividing the dominant shared values in Estonian physics, not the scientists themselves. This is proven by the fact that the utterances of all the interviewees can be found under the descriptions of different metaphors. There are probably no physicists in the Estonian physics arena who would solely express the values of a priest, the playful boy or the blacksmith, but there are certain patterns of attitude that can be used in explaining the development of careers of both the men and the women. We do not stick rigidly to Margaret Wertheim's or Cathrine Hasse's descriptions, but we hope to follow the idea of these images.

3.1.1 The physicist as a priest

The most important characteristic of this metaphor is the idea that physics is perceived as a semi-religious activity, the aim of which is to reach the truth. Here, one can see some similarities to an aspect of the culture of physics, as described by Sharon Traweek: "They [high energy physicists] have a passionate dedication to this vision of unchanging order: they are convinced that the deepest truths must be static, independent of human frailty and hubris. Simultaneously, they believe that this grand structure of physical truth can be progressively uncovered, and this is the highest and most urgent human pursusit" (Traweek 1992). It is important to add that the image of the physicist as a priest in the Estonian context does not contain the notion of power, or if it does, then the notion is quite the contrary – distancing oneself from the desire of power. That means, a formal career is considered unimportant and valueless.[15]

[15] This addition is necessary because, as with any widespread metaphors, there is a danger of forgetting the ambiguity resulting from cultural differences. From the discussions with the Italian UPGEM researchers it appeared that differentially from the

> *I am in science strongly convinced that what is called the faith in truth or serving the truth, or in other words, in order to achieve results in science one has to _ well, the objective truth, as such _ as such an ultimate goal is placed in the most important position. And other values would largely have to be subjected to that, to what extent, is of course always a question of extent, but basically I believe more in the serving of truth than, well, let's say, then, being orientated in a technical sense to achievements or position or _ status, there are quite a lot of these people in science, as well.* (P309/MS)

Such a clear conviction and the expression of it are not very typical in the interviews; usually the interviewees admit the limitations of physics or sometimes there is a touch of self-irony very typical to Estonians. Nevertheless it can be said that many interviewees share the reductionist views on the perception of the world and the role of physics in it – that physics is concerned with the simplest, basic, fundamental issues. All the other sciences are engaged in grasping the phenomena of the higher levels and are therefore more complicated and less certain. Physics is universal and sees the whole world as its object.

The interviewees find it difficult to differentiate physics from science in the wider sense, because only physics is seen as real science. In describing the identity of physics as a scientific discipline, they brought out qualities characteristic of science in general. The definitions became clearer in contrast to humanitarian sciences. There were at least two differences between humanitarians and physicists.

First, considering the Soviet regime, there were the scientists honestly serving the truth. Many interviewees mentioned a relative freedom from Communist ideology as a specific characteristic of physics. Physics was objective and apolitical and thus different from the humanitarian sciences which were ideologically biased.

> *Yes, I was very much interested in works of popular science related to physics. I was interested in very many things, but the main reason why I*

Estonian context, the image of "priest" in their case was strongly connected with the notion of power and the interviews refer to the "priest" in a negative way.

> *and many others started with science subjects was that it was a relatively honest job. It was an discipline where there wasn't any ideological pressure, none whatsoever. Completely honest disciplines.*
> *Interviewer: What kind of ideological pressure? You mean compared with humanitarian disciplines _.*
> *Yes, compared to humanitarian disciplines where it was totally crazy.* (P301/MS)

This circumstance was brought out mostly by men as a reason for their choice of a career as a physicist. In the case of women, being apolitical was rarely mentioned in relation to the choice of career. Nevertheless, one female stayer, similar to one of the male leavers, brought up the issue of false beliefs, although not as a direct comparison with the humanitarian sciences. In her opinion, the mission of physicists should be the opposition of common sense to the pseudo-sciences so popular in the society.

> *Now the physicists should be a stronghold to that _ a stronghold opposing to easy life, that there's no need to study much or, all in all, we study only the "soft" disciplines like business management, public administration, all the things that are necessary too but not in such amounts – this boom, this boom of such soft disciplines is way too much. And also humanitarian disciplines, I understand these were like repressed during the Soviet times and have now started to flourish but physics, surrounded by other real and natural sciences, should be the centre of opposition to such humanitarianism and socialism. So that the realistic way of thinking _. These are no, alright, these are sciences, but all that astrology and numerology and all those bogus sciences, pseudo-sciences, these are the ones physics should be opposed to.* (P303/FS)

Second, compared to the humanitarians who hold different perspectives, methods and traditions, physicists share the same paradigm.

> *Well, first and foremost physics differs from humanities because it has a certain method. So whereas the humanities, let's say, psychology, sociology, could be compared to a bush where there are different schools, right, different schools follow from different assumptions and a very strong thing is quotation and authority.* (P333/FS)

Speaking about the personal characteristics the interviewees admired in physicists, dedication was mentioned quite often. And although this quality was idealized by all the respondents, men and women, leavers and stayers, it seemed that it was valued the most by the women who have left physics.

> *[…] but thinking about the people I know personally, then for me they were _. Authority was about wisdom and also dedication to science.* (P304/FL)

Thus, the main manifestation of dedication is the amount of time the person sacrifices to their work.

> *[…] I very quickly realized how difficult it was to reach that front line in science, not into the top, but the front line, when you're already in the area you don't know so well and you can work there, it demands great efforts and a lot of time, that science. And it is inevitable that all the other areas of your life fall into the background or you have to concentrate very much on what you're doing. You can't let your concentration spread onto very many areas of interest, for example.* (P304/FL)

The background areas of life definitely include personal and family life, the value of which was emphasized by almost all the interviewees. However, since the maximum dedication to physics is the widely accepted value in the community, it inevitably means minimizing the home duties in many cases. Men and women use different strategies here. In the case of men it often means being responsible for one or two certain tasks; the strategy of women, however, includes trying to do as much as possible in as little time as possible, calling it multitasking or net planning.

> *[…] and in addition to that I then learnt net planning, the net planning of all of my activities. So I did one thing, the third was on-going, the fourth was also somewhere there, again something was cooking or, well, burning in the oven at the same time and, and then, at the same time, I*

> *also managed to change the children's diapers and so on. A young person can do a lot of things.* (P315/FS)

An image of the physicist as a priest also contains the idea that being a physicist is not merely a job, but something bigger which influences the person's life much more than ordinary paid employment. The job of a scientist is perceived as heroic. This may be best illustrated by an opinion given by the interviewees, which in the simplified manner could be expressed as "once a physicist, always a physicist", meaning that the physicist's education provides a certain way of thinking that will last throughout their life. Therefore it is actually not possible to "leave physics for good".

> *[…] it's not like you can leave physics, well –. Wherever a person with a physicist's education goes, they'll continue with physics at least to some extent. Perhaps that one poet is. I haven't read his works, perhaps there's a lot of physics in his poems. But I'm certain there is some way of thinking, that analysis and analytics, that probably comes along with it. But you can't really leave physics, once you've been in it, you'll continue doing that in any job. But of course, that's no longer physics as science anymore then.* (P332/MS)

And on the other hand it means that official retirement is not perceived as being very natural. Since being a physicist is not paid employment but rather a dedicated vocation, it is only natural that people work until they die. For example, in the answer to the question, whether they knew anyone who had left physics, one of the interviewees named a woman who simply stopped working as a physicist after she had reached retirement age.

3.1.1.1 The positive influence of the physicist's image as a priest

The main positive influence manifests itself in the heroic perception of the scientist, thus motivating people to consider physics as their future area at a relatively young age.

> *And in the beginning I had a very low opinion about the humanitarian areas, I thought they didn't know anything even themselves, they were just being vague, but physics was real science, I wanted to become a physicist ever since the first grade, in the first grade I knew it was to be a scientist, but in the second I was already sure it was a physicist and I was absolutely, I have always wanted to become a physicist. So nobody encouraged me, on the contrary, I very much wanted that myself.* (P318/ML)

At the same time it is relatively easy for women to identify themselves with this image, considering the official ideologies claiming physics to be gender-neutral.

> *Yes, there was a queue, who can take exam as first [laugh] and then the boys suggested that women can go first.*
> *Interviewer: And then _.*
> *And he then said, there were no men and women there, just physicists.* (P300/FS)

Physics as an discipline is gender-neutral in itself because since truth has no gender, it is basically possible for anyone to apply for the understanding of it, with the person's abilities and the level of dedication being the key factors. In our opinion, the image of a priest of truth is more related to theoretical physics, since mathematics also does not seem to have any gender. The following quotation is from a male theoretician.

> *[…] you have paper and a pencil and a task, solve it and this has nothing to do with your being either a man or a woman.* (P302/MS)

Some female physicists considered their mathematic abilities the main motive that made them chose physics, although some also mentioned pure mathematics being too dry and that physics added something to it. The notion that receiving good results in mathematics (in addition to good results in physics and an overall general interest in the subject) is a deciding factor in choosing a future career, also came up in analysing

the Estonian materials of the BASNET project in 2007, although in that project the whole sector of natural sciences was studied (Laas 2007).

> *[…] And then I met – since that – it was, all those entrance exams were, like within two weeks or something – it was, it was just like that. Everyone was studying and then I met one guy who studied – he went into physics. And since I was teaching mathematics to all the girls in economy, he said, so, you're good at mathematics, come into physics. And since I so desperately wanted to go to university, I thought, well, I don't want to go into mathematics, that was too dry for me – no, so I thought, OK, I'll give it a try. And so it was, there were vacancies in physics and so I went, I took two more exams, oral mathematics and physics and I was accepted into physics.* (P326/FL)

Another reason why it is easier for women to identify themselves with the image of a priest of science is the fact that there is already one saint-like female scientist – Marie Curie. Reading her biographies has made some women (but only women!) consider the profession of a physicist.

> *Now, when you're referring to classical physicists, then definitely one among the physicists, I think, for me she was the reason why I chose physics in the first place, certainly this is Marie Curie, right, I have read about her and she's, yes, very admirable _ persistence is what I'd like to have –, like that quality that would surely have come in –. The way she, I don't know, melted tons and tons in order to get one gram of a substance, right, poisoning herself, well, actually radiating herself in the process. That persistence that takes you, right –. That can't have been easy. But she's exactly – moving on persistently, while making sacrifices.* (P323/FL)

3.1.1.2 Problems with the image of the physicist as a priest of truth

The problem with this particular metaphor is that the strongly heroic image of a scientist gives rise to certain expectations that the everyday life of a physicist may not live up to. Furthermore, it is possible that in

the work environment the physicist happens to be in, the values connected with this image are not shared and this may easily lead to frustration or loss of interest. For instance, one male leaver said that at one particular moment he felt he was bored and did not want to dedicate his life to something that was boring.

> *I felt it was boring, you remember I already feared that at a young age. Physics is boring, physics is not about, not about the truth, that's the problem. I was interested in the way things really were, I have been interested in that all the time and as long as I thought physics is about how things really are, then so long physics was undoubtedly the best thing, when I started to have doubts about that, the authority of physics reduced in my eyes and all those doubts were just a question of time.* (P318/ML)

And the same interviewee a little later:

> *Interviewer: And what do the physicists do?*
> *They do useful things that give results. That's very simple, when a shoemaker makes shoes, it's important that these are comfortable to wear, the essence of the shoe isn't important at all, whether there is any – I don't know, what kind of problems he's thinking about then, yes. I'm not that much interested in that, it's not exciting for me, I want it to be interesting, that my life had a sense, what I'm living for, what's the meaning of life, I think, yes, that life has to be interesting.* (P318/ML)

Another problem is the fact that this image does not contain any means of rewarding on different levels. There is the Nobel Prize, but generally being accepted as a scientist and being able to do scientific work is seen as a privilege in itself. The lack of the rewarding system was the concern mainly expressed by men. One of the male leavers also mentioned this as one of his reasons for leaving.

> *Another thing I don't like, is that science is not very motivating. I mean, science lacks the mechanism of motivation. I mean, when you're successful, you're successful mostly for yourself, the others are happy about it, but there's no material motivation or anything. I think it's wrong not to have any mechanisms of motivation of that kind.* (P305/ML)

As mentioned before, the image of the priest of truth places certain demands on family life and meeting these may prove problematic. For example, in order to have stability in the background system, men need the total support of their wives (the best situation is if the wife is also a "believer of truth").

> *Yes, we had that agreement from the very beginning on, because I said when I had to do science and, then I simply had to do it and it was my priority number one and there was no doubt about it and if there were any doubts then it was better if we didn't move in together. That was clear very early already. Because at the time I was certain I was going to be a very good physicist.*
> *[…]*
> *Interviewer: Do you know anybody who has left physics because of family duties?*
> *Yes, I do. I know many of them. I mean, such understanding families like mine, are very rare.* (P318/ML)

For women, the belief in the black-and-white choice between the family and scientific work seemed to be problematic and one could also note the opinion that if, in connection to having children, family life will become more important (and also time-consuming), there is no longer any sense in continuing with physics.

> *For me, family is a priority. The work, work is not so important. I'd say, this is also that kind of problem, why I feel I'll leave Doctoral studies.* (P300/FS)

The question of justifying the activities:
When science is financed by the public law structures in a democratic state, the questions of the relationship between physics and the society are inevitable, for instance, "Why is this research necessary?" or "How to improve the prestige of physics?" The most common solution seems to be to increase its popularity and to provide a simple explanation of what physicists do. But according to the image of the priest of truth, all such answers and reasons are insincere and frustrating, mainly because

it is simply not possible to ask these questions in this framework. If truth and knowledge are the ultimate goals, then any attempts to justify such activities reduce, in a sense, the ultimate goal and the nobility of these activities.

> *Interviewer: Do you have any good ideas on how to make physics a more attractive career choice in scientific institutions?*
> *No, I don't. I mean, it's a very dangerous thing. Scientists are no clowns, right? Our work is not show business. I understand, it's very important nowadays and PR and sales and all, but for science it's really damaging.* (P302, MS)

3.1.2 The physicist as a playful boy and the physicist as a blacksmith

3.1.2.1 The physicist as a playful boy

Again we must emphasize the fact that this concept is not used to look for one-to-one similarities in Cathrine Hasse's research work with the Estonian interviews. This image is used to connect certain values, personal qualities and skills into one. When reading the interviews, the image of the playful boy associated with the following: venturesomeness, an easy grasp of theoretical models, enjoying the physicist's work and considering it fun and also certain manipulative ways with physical reality and the public.

The reason why we do not compare our own data with Hasse's theoretical tool arises from the difference of our base materials: Hasse's playful boy expressed a certain way of being in physics that manifested itself as the result of participatory observation and therefore the concept embraces the dynamic aspect, the way in which people in their activities are sometimes accepted as the members of a group and sometimes are not (Hasse 2002). The interview materials, however, are much more static and do not enable any such analyses.

The physicist as a playful boy first and foremost values intellectual games with theoretical means of work, which are easily used one way or

another. Free thinking and the habit of organizing imaginative experiments are important parts in the work process.

> *What I have admired most is that people are competent in their discipline, they orientate freely in it, are able to think freely, smell of sweat disappears from this whole thinking process. It's like a game were you can think one way or another. Such intellectual aptitude has always fascinated or amazed me most.* (P306/ML)

This kind of preconception induces the skill of elegantly arranging different pieces of information together and the ability to solve the mysteries of the world of physics.

> *Well, erm, let's say _ regardless of who I look towards, but most surprising are the ideas that, whenever someone says them out loud, seem so clear in the essence, but what you would never have thought of yourself. That's probably the most – something like, whoa, he came up with this, I would never have come up with that myself. Although I might – might have had the background information as well. So this is the putting together of the picture or solving a puzzle in an elegant way, that's probably what generates most admiration.* (P307/ML)

A necessary premise for this ability to emerge is childish curiosity which, in the formal school system, is unfortunately too often extinguished. When this curiosity survives and does not disappear even when the world is seen through mathematical prisms, the choice of career as a physicist has proven to be the right one.

> *[…] I mean, serious scientists aren't characterized by wanting to, well, make a contribution, but they _ they just have a very great curiosity, which is like, well, in some ways a childlike curiosity or naïve, you could say, just to understand how nature is built. And, if this now – it's now accompanied by: the existence of the respective methods, then the theory and generally an education in mathematics or physics, then it is possible to make this interest real on a, let's say, academic level.* (P319/MS)

Playfulness certainly has its price and in order to keep working in physics in such a manner, people must have some sense of adventure,

because not all their ideas will be welcomed among scientists. Indeed, since most ideas that are thought of have not been considered fully, many of these might also become subjects to ridicule.

> *That means, with every new idea I risk with my being in this very same society, I risk getting expelled, risk getting ridiculed, risk getting fired. I mean, that I start telling silly things, I mean, a new idea can't emerge as a beautiful, clear, concrete, a fine thing that everyone just goes: "Oh, how great," every time I dare think something new, I become a target. It's a lot easier to say "well, I had an idea, but it was just an idea" and see that it is in coherence with the trends and in coherence with the financers. […]* (P318/ML)

An important part of the image of the playful boy consists of manipulating reality. Figuratively speaking, the use of power on reality and the conjuring up of the results are essential in experimenting in any case.

> *I learn it by theoretical concepts and that results in, like, illusion, that this is then the description of reality. But when you go deeper into it, you'll see that there are huge mathematical constructions behind it. How's that connected to reality? There's a big gap, reality is like a touching point. This is how we think, that it is in relation with reality, we affect it by our way of thinking, we create a structure with our thinking, we can manipulate reality, but they're not really identical.* (P306/ML)

The same logic is also applied to activities outside the laboratory. Working in science is often humorously called "satisfying one's curiosity at the expense of the tax payers", but more straightforward formulations also occur; the following passage is taken from a male leaver's description of an admirable physicist.

> *Lively mind and wits, in his case especially. Intelligence, in that good old Estonian sense. What else. Brilliant demagogy. By the way, which is, I'm not being ironic now, I mean, demagogy is also one, well, a part of life and research work. Otherwise it's not possible to write even a single report, it's not absent now either.* (P316/ML)

However, there is one more value that is considered essential in the case of this image of the physicist – enjoying one's work and considering it fun at every level. For a physicist as a playful boy, physics is not simply a job, but something that is certainly necessary for being happy.

> *On the Finnish radio broadcast there was usually on Mondays one, a lecture on something, a professor spoke and that was in the 1960s. Perhaps at the end of the 1960s, one man was speaking about what work is. They just explained to the dumb Finnish people, what work was. And I remembered that I haven't really done any work in my whole life. What I did there, was simply my own curiosity and fun. Well, both experimenting and writing, too. That wasn't only, that wasn't work, that was –.* (P0/ML)

3.1.2.2 The physicist as a blacksmith

We borrowed this metaphor from an interview with a male physicist who was describing the positive qualities of a physicist's job that helped a secondary school teacher show that the job was interesting.[16] This image characterizes a down-to earth, practical person who is able to solve problems that have proven too difficult for ordinary people. The most important characteristic of this metaphor is the fact, that it is connected with activities concerning iron. Under this image, we gathered all the skills and values that are connected with technical issues, engineering and experimenting in its direct sense. Our claim is that this image is the hardest for the women in Estonia to identify with and that directly affects their career choices. Here is the quotation in question:

> *Well, let's say this that this man exactly matched those ideas of a physicist I have used when alluring the young this way. This means that, yes, I – if I have had to explain why it's good to be a physicist then I have used the expression of one of my colleagues, who introduced*

[16] The emergence of this image largely resulted from a conversation with Imbi Tehver who, in explaining the different ways of understanding physics, that if in Northern Europe physics is mostly related to engineering, then in Southern Europe the emphasis in physics is the view of the world.

> *himself like this that do you know, I'm a blacksmith for the fourth generation, a physicist is also a blacksmith. [Laughs] Something like that. Well, well, actually the idea is that as in a village community, rural community, blacksmith was the one, who was able to do all the jobs, found the solution to every problem. Let's say to all the problems related to iron and smelting it, related to metal and smelting it, all that in general surpassed the skills of the average person. And in this way a physicist should also be a person, who finds solutions to problems that appear in inanimate nature and that surpass the skills of the average person. Well, you see, it should be like that in principal. So, yes, in my opinion this person matched exactly with this kind of an idea and also was able to present his subject very well and make it interesting and well, of course the ability to present oneself is important as a person. Well, for a teacher first of all and well, let's put it shortly that he made the boy want to be like him. [Laughs]* (P329/MS)

A physicist's job is most satisfying for people who in their everyday life might enjoy repairing cars or household appliances. The physicist as a smith truly enjoys operating the "palpable and visible" physical world. Theoretical physics, where the feedback from the real world is more distant, holds no such appeal for this type of physicist.

> *Well, in my opinion theoretical physics is very close to mathematics, and I'm not so keen on flapping around with a paper and pen, I'd like to work with my hands and, for example _. For example, we have a superconductor organic crystal here on the wall [points at a substance in a test tube]. Erm, that tiny speck there. […] But that's something, perhaps being very down-to-earth or you see these things and you know they're real and you see how they are made and you can operate with them and then you use certain instruments in order to get information out of them.* (P332/MS)

In the case of this particular image, the concept of a physicist is very closely connected with experimenting skills and the 'physicists-as-smiths' identify themselves with the other "manually thinking" jobs, engineers, for instance, or even dockyard mechanics.

Now speaking about _ I can't even say 'physics' because _ the scientists are often very interdisciplinary, sometimes you have no idea what scientists they are. They're simply scientists. Whether they're physicists or into – since our whole research discipline is materials science then we also have ship-building mechanics whose achievements have even reached the USA –, they have patents in the USA. Although by education they're dockyard mechanics. So it's like – I don't even know what to say. (P330/MS)

3.1.2.3 Problems with the images of the physicist as either a playful boy or a blacksmith

The problem with these two metaphors is that they are very difficult for women to identify themselves with. The problem occurs at its strongest with the image of the blacksmith. It is probably needless to emphasize that the priest's profession is not necessarily seen as a male domain in the cultural context of Estonia, whereas the blacksmith is a strongly masculine image. First of all, we will present the problems the women had with the image of a playful boy.

The image of a playful boy involves curiosity, a certain sense of humour and inevitable lightness and happiness, making women's attitude towards physics seem (with some exceptions) a little more serious. Women perceived the area to be more closely connected to the concept of "work" rather than "game". A good example was a married couple who have left physics. In their case, the gender-related differences were especially clear ((P0/ML) is the husband and (P322/FL) the wife), whereas it is quite interesting that the husband may not have understood that the wife's attitude towards physics was different from his own:

Interviewer: But did you consider physics fun?
(P0/ML)*: Yes.*
(P322/ FL)*: Well, you see, my husband certainly thinks it was fun.*
(P0/ML)*: Definitely fun. At least not like those religious people, interpreting those Jewish myths.*
(P322/FL)*: I don't know, I never considered it fun.*

(P0/ML)*: [Laughing] Well, perhaps it wasn't fun for you –*
(P322/FL)*: No, it wasn't.*
(P0/ML)*: – but at least you pretended to have a lot of fun.*
(P322/FL)*: About fun, then perhaps these very same –, when there was an interesting conference, then it was fun, yes. And interesting people and interesting places and –, in that sense, yes. [Unclear], but generally, %I took it very seriously%. Whether I liked it or not, but still –.*

It is even easier to see the differences in the influence of the metaphor of "the physicist as a blacksmith" on the careers of men and women. Three of the interviewed women were more or less connected with experimental physics. One of them had left, one was planning to leave (which she also did later on, although at the time of the interview she was still working in the research institution) and there was also one relatively young stayer who was working in a group of experimental physics, but had not been allowed to make any experiments yet. The interviewee who was employed at the time of the interview but left later on, described a situation she found frustrating and which was probably also one of the background reasons that made her seriously consider leaving. The problem was that the supervisor wanted her to go to a foreign laboratory to perform some measurements, but the interviewee felt too unsure about her skills to agree.

Interviewer: Have you been abroad in connection with your research?
Yes, I have, during my Master's studies I attended a conference in Italy and then I had to go to France the next week to perform some measurings but I said I couldn't. That I'd be there three months and I'm not such a specialist, well, I'm not such a specialist to perform such measurings somewhere abroad alone. I asked what was more important, the results or that I go. He said for the institute results were important. And I said I couldn't give them those results. (P300/FL)

Only among the men's interviews was there an example of interest in technology having motivated the person to study physics and that physics seemed an appropriate discipline for developing and expressing such interests.

> *Well, I don't know. I wasn't really a sci-fi fan to _. I liked physics in general, but I was a more technical person, in my childhood I liked messing with technical things very much. That's why I found technical disciplines so appealing, but I also liked physics and so I went to study that. I don't think I can explain it in any clearer way why I made such a decision.* (P305/ML)

In addition, when looking at the future careers of the interviewees it seems that in specializing further, some female physicists consciously avoided, to a large extent, the options that were involved with the technical side of physics.

> *Well, I still think it isn't, but it's actually the same at the university, I mean, physics is a really wide subject. And at the university they teach you, they try to teach everything to everyone and that might not be right for everyone and as for me personally, electronics was really not for me during the university, it was so –. And let's say, the part of physics that is concerned with very technical issues, that was not for me, I don't like that part, but the part that is connected to nature, I like that. Now as to the Master's studies, I also went back to environmental physics, as this is more connected to the real living environment.* (P308/FS)

To complete this topic, there is an example which clearly shows that in Estonia, everything that can be labelled under technical issues, is considered a male domain. The following passage is from an interview with a male stayer – our conversation was interrupted by two female students he supervised over a problem with the experimental device. The interviewee's help was not being actively sought for the reason that he probably was most competent in the vicinity, but because the male student he supervised and who was mainly working on that device had left the laboratory and the interviewee was the only male available.

> *Interviewer: But when you said before, you didn't like travelling, so how, – ?*
> *[A young female student enters.]*
> *(Female student 1): Sorry, are you in the middle of an exam?.*
> (P330/MS)*: No, this is not an exam [laughing]. What is it, then?*

(Female student 1): No, [Femalestudent 2] had an accident, some pipe burst, perhaps you can do something?
(P330, MS)*: Where?*
(Female student 1): [To Female student 2] Hey, (P330/MS) *is here.*
(P330/MS). *Has everyone left now?*
(Female student 1): Yes, everyone's gone, you're the only man here.
(Female student 2): No, he'll have his lunch and then he'll come.
(Female student 1): Oh, so the water is not running?
(Female student 2): No, you can turn the water off.
(Female student 1): Oh, in that case everything's fine.
(Female student 2): [laughing]
(P330/MS)*: That's not cooling water, is it? Hey, that's not cooling water, is it?*
(Female student 1): Yes, it is.
(Female student 2): No, no, that's further – I have no idea what water it is. It's, when you start to vaporize, then you need to turn on some other water.
(P330/MS)*: Oh, then it's still something else, it's not the cooling system. You didn't turn off anything there, did you?*
(Female student 2): No.
(P330/MS)*: Oh, very good, let it be then. [The conversation with the students ends, the door closes]*

4. Work environment

The purpose of this chapter is to give an overview of the attitudes of Estonian physicists towards their work environment and which aspects they expound in both the positive as well as negative sense; and to observe these from the point of view of how these might influence people to either leave or stay in physics. This issue is made rather complicated by the fact that the work environment may be very diverse in different institutions and also at different times – the equipment, the relations between the employees and the work atmosphere may be profoundly dissimilar when comparing the Soviet era to the present.

Regardless of the complexity of the topic, our claim is that Estonian physicists value their freedom to choose their working time and place,

but they miss social communication and intellectual atmosphere. They are isolated from one another. There is no discussion of personal or family matters at the workplace. The interviewees try to find the golden mean between participating in the information interchange in their work environment and the solitude necessary for concentration. In this background system it seems that isolation from the intra-community communication more severely affects women; or to be more exact, women's careers when compared to their male colleagues', depend more on the personality of their supervisor.

4.1 Freedom to plan one's working time and workplace

Many interviewees, both men and women, mentioned as a positive aspect the fact that the working time is not strictly regulated. People are neither forced to arrive to work at a given time every morning or to leave at a given time. When necessary, for instance, it is possible to go to the hairdresser or the doctor within the working day and then work at weekends. None of them thought they worked less than formally required – often enough, physicists tend to be workaholics. Yet it cannot be said that the working style has always been like that. Bearing in mind the Soviet working culture, they also mentioned strictly following the discipline of everyone arriving at work punctually every morning (again, not in every institution). The freedom to choose one's working time is partly the result of the changes in science policy. Ensuring financing and providing results have moved to the lower levels of the hierarchy and every principal investigator is responsible for their own work and results.

Together with free time planning, Estonian physicists also value the possibility to work at home, even when this possibility is used rather infrequently. Generally people prefer their offices, because not everyone has the necessary conditions at home and, in addition, it is believed that constant working at home may cause disturbances in dividing working and relaxation time and thus have a debilitating effect on performance.

Physicists active in their field sometimes worked at home because of the following reasons:

1) In the instance that the conditions at home were more comfortable; for example, at times when it was calmer and quieter there than at work, such as during strenuous writing periods when it was necessary to work more intensively and concentrate fully.

> *If I remember correctly my experience in working at home showed that whenever you needed to work very intensively, to do something really quickly, then home is an ideal place, you can concentrate fully and nobody's disturbing or annoying you. But you can't work like that for a long time first of all and then you need some change, you don't want to work alone and it becomes a real routine and I think in the long term the efficiency actually drops.* (P305/ML)

2) In the instance that the interviewee had to take care of their close relatives. One male physicist started to work at home after his wife became seriously ill. There was one male and one female physicist who thought that being a scientist enabled them to take care of their children, should the children fall ill. Yet it must be admitted that the latter possibility was emphasized as an advantage by a female stayer.

> *The main thing that you have to divide is time. And I divide my time between home and work. And to some extent it is working with your head and the work is anywhere, it enables me to do the impossible, to put these two things together. For example, when my child is home sick and, if I were a sales person, well, I would have the choice: either to have somebody look after the child and to go to work or to be away from my work and sit by the child. But since I'm a physicist, then I give the child the medicine, I feed the child and when the child is watching TV, I can take my laptop and %go and calculate%.* (P333/FS)

As far as the influence of the working environment on the career is concerned, comparing the Soviet era and independent Estonia it is obvious that it is very difficult to compare the interview materials. Nowadays the social system allows for people themselves to be fully responsible for their personal life and its challenges, in the Soviet time the workplace (and in this respect research institutions were no exceptions) took care of many problems. Very often the choice of a

workplace for fresh university graduates was based on whether and what kind of accommodation came with the job or what other advantages were provided at the specific workplace.

In such a context a situation was possible where the borders between work and home became very vague even in spatial terms, as in the case of the astro-physics village in Tõravere. This institution was designed to be a science village, where the aim of the whole infrastructure was to support the main goal – to make scientific production more efficient. Dwelling houses were built close to the observatory. There was a special kindergarten for the employees' children, established on the initiative of the physicists themselves.

> *But what Tõravere offered in addition, first of all we here had _ well, we kept putting up residential buildings, so that the young people could get an apartment, and second, we built the kindergarten, so there was no problem with children. And exactly this kind of dealing with problems _ the issues of everyday life by Tõravere, this was a very important contributory factor. And our, in our families the average number of children, well, I can't really say if it was twice as much as in Estonia on average, but it was definitely considerably higher. […]* (P319/MS)

Both, the leavers and stayers, men and women were happy with the Tõravere work environment. It must be emphasized that in addition to everything else, the communication and emotional atmosphere there were also seen as very positive. Yet the structure specially designed to be science-centered had one drawback – designed to satisfy a "certain type" of purpose and for a "certain type" of people, it loses its advantages as soon as the population changes and the interests and goals of the new generation of people living there are different.

> *Tõravere was an ideal society anyway, that was an established village, it was a very good time for doing science, for some time such villages are an ideal society for doing science. […] That's a way to solve all the family problems and everything, you can be at work and at home at the same time, right. You have all the ideal conditions and it lasts for about 30 years until the next generation grows up that is not from this area of speciality and then it becomes a real village, when the children grow up*

and there were lots of those astronomy-villages in Russia. They were very successful and good until the children grew up, that's when the degradation began. (P318/ML)

4.2 Desire for intellectual environment

Based on the interviews, the essence of a physicist's job seems to be finding balance between total calmness, that is, an ideal environment for concentration and the need to communicate. When all kinds of disturbing factors decrease work efficiency, the main drawback in the work environment is to be found in the lack of multi-leveled communication. Many interviewees considered the absence of an intellectual environment to be the main problem at their current workplace – everyone is engaged in their own business and there are very few common discussions. In the case of some institutions it is again necessary to point out the difference with the Soviet era, where there were a lot more seminar-like events. (Yet even then in some areas, working on your own was the only way to keep working in physics.) There was one female leaver and one male leaver among the interviewees who saw this lack of communication as a problem which made them consider giving up their job – they did not like that it was not possible to work with someone else and to discuss their specific discipline.

I liked working in physics, it's a purely mental job. And very interesting. And I liked to work in a team, team work. Like that. And that was, of course a problem, as when I came to Paramount[17]*, there was no team here. Very few physicists. Just me _ my supervisor was xxx. And there was a moment when I asked him "Who could I discuss this with? Who could I communicate with?" And he said: "Just me." That, of course, was a problem. [Laughing] Because when you have a team and everyone moves on together and there's, like, cooperation. I'd like that. When it appeared I was alone and there was no demand for that, it's not clear*

[17] Research institution.

> *whether anyone needs that and whenever you have to go somewhere, problems arise immediately.* (P322/FL)

Some physicists mention in their interviews regular social gatherings or coffee mornings at foreign universities, considering these very important in creating an intellectual atmosphere both for scientists and students.

Nevertheless, communication problems do not only concern work; even establishing personal contacts in the simplest meaning may not be successful all the time. Our impression was that some of the interviewees even experienced social isolation. The following example is taken from an interview with a female leaver

> *Interviewer: And who, were there other people in the room?*
> *Yes.*
> *Interviewer: Did you interact with these people?*
> *Yes. But there were still few people, we didn't interact much. Well, with other, other people whom I didn't have much to do with, well, I didn't, like, interact with them.* (P324/FL)

Naturally, it must be taken into consideration that in the case of younger physicists, the possibilities to communicate are also limited by the general aging of the physicists' society and the lack of any mediator generation between them.

4.3 Discussion of family issues in the work environment

As far as the issues outside work are concerned, Estonian physicists do not seem to discuss personal matters. The interviews gave an impression that the intimacy of family-related issues are not willingly talked about, at least this is the case with men. An interesting indicator here was the fact that two men refused to answer family-related questions. There was no similar response from the women. Yet, the respondents of both genders tended to give rather short answers in this area.

Why is there no discussion of family matters (how to bring together working and family life) at work? Representatives of either gender bring

out different reasons. Men do not think they should talk about their private life and the conversation topics are found elsewhere, at the same time assuming that women, perhaps, talk more about these issues.

> *Now we don't speak about such things, men don't speak about things like 'my child's ill'.* (P302/MS)

Women explained the lack of communication on family issues with the low number of women at their workplaces and they share the opinion that male physicists do not discuss family issues with their colleagues.

> *Interviewer: Do your female and male colleagues speak about different possibilities of bringing the work and home duties together?*
> *No. We never speak about such issues.*
> *Interviewer: Not even with your female colleagues?*
> *Well, I mean, I don't really have many female colleagues [laughing].* (P310/FS)

4.4 Mentorship

Even defining the word "mentor" presented problems for the interviewees. Most often, as was expected, the supervisors or co-supervisors were named as mentors, often equating these two notions. This means that whenever the supervisors did their job well, they were considered as mentors.

Other people who played their roles in the development of the interviewees' career and who could be described as mentors, were the director of the institute, boyfriend, father, mother, members of study and work groups. However, the materials do not indicate the role of mentors or the lack of them to be perceived as of great importance. A few interviewees made it very clear that there are not enough resources at the research institutions to enable a more personal approach or step-by-step guidance of the students; it was even seen as harmful to young people's development, since they will not learn to be independent. But there were also different opinions; in two interviews the positive role of

the mentor is emphasized, both by female stayers and the mentors were, in one case, a woman, and in the other case, a man.

In case of the positive example with the female mentor, her influence on the career was obvious, because the interviewee, who has made great progress in physics, gave up an academic career after graduation, becoming a secondary school teacher. After some time that job had exhausted itself and the interviewee came back to physics with the help of her mentor who really supported her in every way possible. She even compared her relationship with the supervisor to that of a mother and a daughter.

> *[…] In the sense that she's an older woman and she has actually been to me, as she has no children of her own, she's been to me –. We established a very good emotional contact and I was really like a daughter to her. She helped me in a real way and, let's say, during the essential work, but she's given me a lot of good advice on how to get along well in this man's world [laughing], because this discipline really is relatively, well, it's mostly men here engaged in this discipline and.* (P308/FS)

The other interviewee in question found herself a mentor by chance. Her former supervisor did not have enough time for her and since she was left "on her own", her current supervisor took charge of the situation. The interviewee admits that the help and support of that person have been most important in her career, which is still in the opening stages of its development.

> *Yes, my supervisor is very – he pushes and _ and pushes me all the time. I myself actually might not be as _ might not manage to do all the things. […] Well, he makes sure that I can go there – wherever I have travelled, events, he's taken care of everything. And supervising and everything. In my opinion, he goes to too much trouble and it isn't good for him, or his family, and everything. In my opinion, he shouldn't go to so much trouble.* (P320/FS)

The beginning of a career is the very stage where the main role of a mentor manifests itself. The ensuing career may depend on whether there is a research topic with good future potential to be found. It is

necessary to admit that many of the interviewees considered finding a good topic very important, although here, in addition to supervisors, schoolmates and colleagues may also prove useful.

However, what happens when the choice is not very successful, the topic does not seem interesting and getting on with the supervisor proves troublesome? Four younger interviewees (three women and one man) changed their supervisors in these situations – three of them were successful, but one woman did not do quite so well and by now has given up her career in research. In her opinion, one of the reasons (and also the main reason according to a colleague) for her to give up was the fact that she had problems with her supervisor who gave her tasks that proved too difficult for her and at the same time never supported, helped or encouraged her in any way.

> *Interviewer: What about now that you went to xxx, did you have a supervisor there? Or how did the studying process work out there or did you have to do everything on your own?*
> *Mostly on my own and there were people, well, my supervisor said that this needed to be done and that was it, he left. He's a xxx and he had all those meetings all the time. So I went and found someone, they'll help, lots of guys work there [laugh].* (P300/FS)

The colleague's view on the situation:

> *She also, that xxx was the one, was the one who employed her and, well. The thing that bothered (P300/FS) was that every day supervisor would come and give her a new task, he wouldn't explain how to complete it. And these tasks were such that (P300/FS) would have had to have worked there for 20 years in order to have been able to complete them. Like _ when you think about it, it's a totally absurd situation.* (P320/FS)

Another, and a little more drastic, story is not so much connected to the insufficient work of the supervisor or mentor, but is rather about how important the supervisor is at the start of one's career. It is again from the revolutionary period of the 1990s when the structural units were united. The female interviewee was forced to leave physics because her supervisor died and in the uniting process, it was her competitors who

kept their jobs during the redundancies. The demise of those without the support of their supervisors was almost a foregone conclusion.

This may be just a coincidence, but reading the interviews it seems that in Estonia, the fates of female physicists (at the start of their careers) is more dependent on their supervisors than those of their male colleagues, and that in both the positive and negative sense – a good supervisor gives the career a good boost, an unsuitable one may become a reason for leaving science.

However, it must be stated that the career of female physicists may also be influenced in a positive way by other support structures: members of the research group, husband, spouse, all of whom according to the interviewees played an important role in choosing the right research topic, and also in finding the right structures for scholarships and naturally also in the emotional sense.

5. Family

The following chapter focuses on the survey of family-related issues: the influence of the parent on choosing a career as a physicist, the support of the family, gender roles in the family and the issues related to parental leave and children. On the basis of the interviews it can be said that both men and women think that physicists value their families, but their contribution to family life is different. Among women, there are more of those who take the main responsibility for the issues related to children and also household chores. This also coincides with the general situation in Estonia (Derman et al. 2006). Men consider themselves to be more responsible for the financial security of the family. In order to guarantee financial security for their families, some of the male physicists felt compelled to leave their jobs during the transition years of the 1990s and move into the private sector. In the case of women, family-related duties have caused leaving less often, yet physicists commonly believe that family, mainly the birth of a child and taking care of the child tend to hinder a woman's career.

5.1 Influence of the family on choosing a career in physics

One of the hypotheses we wished to either confirm or confute, was the opinion that the decisive factor in choosing a physicist's career, especially in the case of women, was having a physicist for a mother or a father. This idea was supported by some interviews, where it was evident that parental influence played some role in the choice of the respondent's career. Yet, in analysing all the materials, the parents having had a deciding role in choosing a career in physics cannot be claimed to be the most evident tendency.

Also, it is erroneous to claim that a physicist as a parent would affect women more than men in the choice of careers, because among men and women there was one respondent in either group who considered their father's profession as a physicist to be an inspiration in their choice as well. The female physicist mentioned that her father suggested that she take up the same discipline. Because of her parents she had an idea what a scientist's life would be like. In the case of the male respondent, a similar association with the past can be noted.

> *Well, sure, my father was an example for me.*
> *Interviewer: Only that?*
> *Well, not only, but sure, the interest, the interest in this area, but, well, of course _ I see what my parents did, of course, I see what, what happens at the physics laboratory.* (P307/ML)

The professions of parents have been different and in some cases the parents have also been researchers. In addition, with some female interviewees one of the parents has been an engineer: with one it was the mother, with another, the father and with a third interviewee, both parents were engineers. One interviewee expressed the idea that due to her mother being an engineer, nobody in the family had any doubts about a woman succeeding in physics.

> *Well, my mother was an engineer, also a person with a technical education […] – and in this sense yes, that at home I wasn't given an ounce of the talk that girls couldn't understand math.* (P333/FS)

5.2 Advantages of having a physicist as a wife/husband

For a female physicist it is important to be together with or married to a physicist. There are several reasons for this: the husband supports and encourages the wife to advance her career or the husband has influenced the wife's specialization in physics. Women have also valued physicists as husbands because of the aspects of having someone to understand them, having someone whom to talk to, to exchange ideas with and to help maintain motivation.

> *I don't have that many colleagues. My husband, well _ at work he's my basic colleague, and in his case, I can say that his, well – motivation. That's like the best thing. And that's what you need for doing this at all. Motivation*. (P320/FS)

As to comprehension, women have also commented on the fact that non-physicist spouses might not understand why they spend so much time at work and not at home.

> *[…] That, well, if the people, who you usually see in science, it's a family. My brother and his wife, they work in the same laboratory and my course-mates are husband and wife, so they have the same job and so it's simpler, but if you do one thing at work and then meet a man and it's something different. He keeps yelling all the time: "It's five o'clock already, your working time is over!" [laugh]. Then it's very difficult.* (P300/FS)

One of the women was certain that even in the case when both the husband and wife are physicists, but do not share the same job or specialization, men tend to have a negative attitude towards their wives' longer working hours (she had heard such complaints from her female colleagues). Five women shared their area of specialization with their spouses.

As to the male respondents, there are not so many examples of the couples of physicists. A man whose wife had also been a physicist in the same discipline stressed the aspect of mutual understanding that is present between people who share or have shared a similar professional discipline.

> *Well, of course they have supported me in the sense, like I said, my wife also works in a very similar – or used to work in a very similar discipline, so in that sense _ let's say, the mutual understanding of each other's doings is relatively good, so in that sense there are no conflicts, like why are you engaged in such strange things that nobody understands or like that.* (P307/ML)

5.3 Variations in interpreting family support

Women perceived the support of the family in two different ways. The first type of support, which was less emphasized, comes from their parents and is connected either with taking care of the children, so that the woman can dedicate herself to her work, or providing financial support.

> *Well, my mother helped in looking after my child. When I was finishing my Master's studies.* (P324/FL)

The other type is moral support that comes primarily from the spouse, but also from the parents. Women considered it very contributive if their parents did not disapprove of their choice of occupation and were understanding and encouraging while they were pursuing their careers.

> *They always approve of what I do, that's very important, you know, that they don't disapprove, like, why are you pursuing nonsense like that.* (P320/FS)

Men mainly describe the help and support of their new families. They mostly speak of situations of there being stressful times at work and their wives then taking care of most of the household chores. Another

aspect highly valued by male interviewees is their families' understanding that their job sometimes requires them to work long hours.

> *Well, they [the family] simply have taken some duties as theirs, you could say that. At least during those earlier times when I took advantage of that.* (P330/MS)

5.4 The position of the family in the pyramid of values

The majority of the female interviewees, both stayers and leavers, thinks that other physicists (regardless of gender) consider their families to be a priority.

> *Interviewer: What do you think, do physicists – can you remember, did they see their families enough as a priority?*
> *I think they did, yes. _ At least the people I communicated with.* (P326/FL)

Nevertheless there are some female respondents who do not wholly agree and differentiated between the attitude of men and women towards their families. They claim that men do not always place the family at the top in their hierarchy of values (for them, career sometimes comes before the family), but women with children always consider their children more important than work.

> *[…] and in the morning he's there before nine o'clock, and in the evening he leaves maybe after nine o'clock, sometimes earlier. And at times he's abroad for months. At weekends he conducts experiments. For instance, yesterday he was still working at eleven in the evening. I don't know if he considers his life, his family important. I don't know, maybe he himself actually does consider his family important, but I, when I look at him, it seems to me that he doesn't consider his family important, […]* (P320/FS)

5.4.1 Women's scale of values

As far as the scale of values of the female interviewees is concerned, almost all the women would be ready to sacrifice their career for the good of the family. Children are very important to women and work usually ranks second.

> *Yes, I consider my family very important. Umm –. If I had to choose between my family and physics – between my children and physics more precisely – then I would cry but I would choose my children. Children for a woman are, like, if you have born children into this world then no matter what, it's your life mission to raise them, that's the life mission number one. No scientific achievement can justify leaving your children on their own or if I found the formula from which the world proceeds, the children are everything, that's why –.* (P333/FS)

In the cases of a couple of female leavers it can be said that the decision to leave physics was connected with this value. If it became too difficult to achieve a balance between work and family life (i.e. taking care of the children), women gave up the former. For one interviewee problems arose on the grounds of identity – after the birth of the child and the change in priorities it was difficult for her to concentrate on the discipline that suddenly seemed so far from real life. For another interviewee, it was simply insurmountably difficult to bring together family life and Doctoral studies.

> *In 1995 I got married and had a baby. And then everything became more complicated. And then I had another one, after a short time, two years. And then everything was really complicated. [Laughing] And that's it.* (P313/FL)

Nevertheless, both male and female physicists share the opinion that family life may prove "fatal" for women, either by disrupting their career or simply lessening their success. Some of the interviewees thought that the situation of women was more difficult because of

family duties and therefore the profession of a physicist was less suitable for them than for men.

> *Yes, it [physicist as a profession] is more suitable for men.*
> *Interviewer: And why?*
> *Because it just is. One reason is, it's quite a difficult discipline and secondly, there is family, so it is easier for a man to combine these two. He can afford sitting in a laboratory twenty four hours. A woman can't. Then you simply have to choose between family or work or career.* (P300/FS)

For the same reason, a lot of male respondents seem to be convinced that their careers would have been absolutely different, had they been women. Some male interviewees claim that being a woman would not change anything in itself; however, they often discuss the aspect of family in their responses and the most evident difference from their current situation is seen in the probability of having been more involved in the issues of raising children as well as doing more household chores.

> *Interviewer: But what do you think; would your career have been roughly the same if you were a woman?*
> *Well, probably not. […] I mean, there are women whose career is similar, but on the average, of course, I think, it probably would have been different, because in this career there are a whole sequence of decisions that I didn't have to make, but a woman would unavoidably have to make, and there is nothing that can be done about that. […] Well, it has primarily to do with children.* (P309/MS)

It is obvious that because of children, the career of female physicists in Estonia is not as linear or as rapid as in the case of male physicists. Nevertheless it should be noted that the interviewees did not find it very easy to give examples of women who had given up science for family reasons; rather, it seems to be a common conviction among the interviewed physicists.

> *But I imagine there have been cases where a woman stayed at home because of the children and later it just wasn't possible for her to return*

> *to her previous post. There certainly are such cases, but not among my acquaintances.* (P304/FL)

5.4.2 Men's scale of values

In comparison to the female interviewees, the male respondents held notions somewhat different from their female colleagues. Most of the men (both stayers and leavers) also believe that physicists value their families highly. Yet there are also those who are convinced that a career in science and family life do not go together very well. The main discord between family life and a scientist's life seems to lie in the necessity to travel a lot.

> *Well, that depends on a person, but usually a scientific career is a great obstacle to family life.* (P302/MS)

In the case of men, the reaction to the question whether they would be ready to sacrifice their career as a physicist for their family was more varied than in the case of women. Some men think they make sacrifices in their everyday work all the time.

> *Well, you have to make sacrifices in your work all the time, well, even in order to pick the daughter up from the kindergarten or do something else, yes, of course that affects working time. Working time is considerably shorter because of the family duties and before getting married, as a Doctoral candidate, you could engage yourself for much longer in whatever you found interesting.* (P307/ML)

Two others said that their readiness to make the sacrifice depended on the reason it was made. For example, one male leaver thought that if a child is ill, it is only natural to stay away from work for some time and take care of one's offspring. However, if it were necessary to drive the child to some sort of extra-curricular activities, then he would not cut his working time.

Generally, in the context of Estonia, the responsibility for children lies mostly on women or the women themselves have assumed this task

as their primary duty. On the other hand, the transition period of the 1990s clearly showed that taking care of the financial security of the family is mainly the men's task. When evaluating the reasons for leaving physics after Estonia had regained independence, and discussing specific people, the problem of a low salary was connected with men. (Women were mentioned twice and in both cases it was clear that they were the only breadwinners in the family.)

> *But now, the other variant, one of my other colleagues with whom we also worked together in the lab – left physics after having defended his doctor's thesis, by the way, when the changes came. Just for the reason that he needed support a big family. I can understand that, you couldn't support a big family for what the university paid.* (P329/MS)

Therefore, when the respondents speak about giving up research work because of financial reasons, they usually refer to family reasons, and most of the stayers as well as some leavers perceived that as a sacrifice. This is because of the fact that in many cases leaving physics meant exchanging a fascinating and interesting job for something less appealing.

> *Interviewer: Now, what was the reason that made you decide to leave that place?*
> *Well, I left because, the time was such that – well, I hadn't yet provided schooling for my children, and then I thought, 'that's nice', in the beginning, a docent received 800 kroons a month. Of course, the value of money was different back then compared to what it is now. But I found that it would have been enough for my own needs, and if I hadn't had to provide schooling for my children, then I wouldn't have left. But since I had to, I left and became involved in business, as a result of which I achieved my goal in that sense.* (P328/ML)

One male leaver was certain that if he did not have a family and children, he would quit his present job and return to the scientific world, because he could afford more risks – risks, that would concern him alone. Yet, on such conditions he would not have left the research institution in the first place. To answer the question whether his career would have been different had he been a woman, he said:

> *I don't know, in Estonia perhaps I would even have some possibilities. And then there are two options, whether I'd be a married woman or a not married woman. If I were a married woman, I think the Estonian stereotype would prescribe the husband to support her and in that case I'd opt for the purely academic career.* (P306/ML)

5.5 Parental leave

Interviews have touched upon maternal leave and not paternal leave, for the reason that the latter is a relatively new phenomenon in Estonia. The current law regulating staying at home with a small child was passed only four years ago in 2003. The children of the interviewees, however, were born either during the Soviet era or the first decade of the independent Estonia. Hereby, brief descriptions of the regulations characteristic to these two periods will be provided.

The Labour code of the Estonian SSR stipulated the duration of pregnancy and maternity leave as 112 calendar days (56 prior to and after the birth of the child). On pregnancy and maternity leave women were paid their average monthly salary. Women, whose length of service was at least one year, had the right for partly paid leave until the child turned one year old. Only mothers or women who had adopted children had the right to parental leave.

With the regaining of independence of the Republic of Estonia changes occurred in the area of pregnancy and maternity leave. The corresponding leave was extended to 126 calendar days (70 prior to and 56 days after the birth of the child). The payment of the benefits until the end of the pregnancy and maternity leave was based on the Health Insurance Act. Either of the parents was entitled to parental leave, at the same time suspending their work contract. Parental leave benefits were paid on the basis of the State Family Benefits Act.

5.5.1 The duration of the parental leave

For the majority of female physicists, maternity leave lasts from a couple of months to a year. Some women who were on maternity leave for a short time only, found a way during the first year to work mostly at home, writing dissertations and/or articles.

Besides working at home, other possibilities were also put into practice; for example, sometimes the young mothers received help from grandmothers and/or paid babysitters who took care of the babies. A few women talked about taking their children to daycare centres at a certain age (in such cases the child has usually been nine months old).

> *Interviewer: Did – for how long were you at home with children or how long were you able to be?*
> *Officially, little, I mean I came – the set maternity leave, after which I came to work right away. But of course I could – I went home as much as I could from work. Of course, my mother helped me and back then my home – my home and the workplace were close.* (P315/FS)

Rushing back into physics may also have been motivated by the widespread belief that a longer absence from research might make it difficult to keep up with scientific developments. A similar opinion can also be noted in men's responses.

> *Figuratively speaking, science is a long race and when a woman has to take time off for maternity leave, then that puts her at a disadvantage.* (P331/ML)

In one female stayer's drawing, where she depicted her career as a time-line, she marked the time periods after childbirth in a way to indicate a standstill in her career.

> *That has been done all the time [laughing]. And that's exactly the reason for such lameness [points to the graph] so all in all, during that period the children were more important than developing my career or anything* (P303/FS)

It must be emphasized that being at home with children for a longer period of time does not necessarily mean a catastrophe in the physicist's career. One female stayer was at home for 3 years with her second child and her career really took off only after she had returned to physics.

5.6 The division of household chores between men and women

On the basis of some interviews, one could note that there is a certain age-based difference in the women's attitude towards housework. Younger women think that their older colleagues take housework as their duty because in their opinion it is a part of being a woman and such traditions are not questioned. One of the women described an atmosphere at work where the career of men was seen as a priority and housework was perceived as the women's realm.

> *But I've had an impression that – there are really very few female colleagues here, they´re older ladies, of course, grandmothers already and – and I simply have an impression that they obviously prefer, well, they have the traditional way of things, that women do household chores and men do something else somewhere else.* (P308/FS)

This opinion is, to an extent, also supported by the interview materials. Although most men and women claim that they share housework with their spouses and although in some cases it is difficult to figure out the share of each of the partners, it is clear that the women who perceive their spouses/husbands to do an equal share of household chores belong to the youngest age group.

> *Interviewer: So housework is not a burden for you?*
> *No. But we have divided everything, my boyfriend cooks and I do the cleaning, I'm better at cleaning and he doesn't mind cooking.* (P310/FS)

In the older age groups there are women who are responsible for most of the housework. Some women find that this is their way of supporting their husband's career.

> *Interviewer: And _ but how did you within the family – did the husband do any kind of housework?*
> *No, relatively little, but I wouldn't say nothing at all, because he was just completely devoted to his work.* (P317/FL)

The women whose spouses or husbands help them with household chores, primarily mention cleaning and repair work as the men's tasks.

At the same time, in the older age group of female interviewees there were two respondents who claimed that they paid as little attention to household chores as possible, and both of them belong to the group of stayers.

> *Interviewer: But how did you divide household chores with your husband _ or how _ how was that?*
> *Mostly those got reduced down _ to the minimum, those household chores. But mainly still, the everyday routine, idiot's tasks like cleaning. Cooking was reduced to a minimum, for several days at a time and _ but all those cleanings and things.* (P303/FS)

Some of the men admit that their spouses have a greater workload at home than they do. There are also those who do housework together with their families (for example, having Saturdays as cleaning days with the whole family) or have, in their opinion, divided housework equally with their wives. Some male respondents see taking and bringing the children to or from kindergarten mostly as their responsibility.

> *Well [smirking], I can't deny I have far less duties than my wife, so, but yes, as the child goes to kindergarten right next building, I always take the child there and bring home afterwards.* (P302/MS)

The other activities named by men were cleaning, repairing different machines and cars, heating the house; in fewer cases men also mention cooking as their contribution to taking care of the household.

None of the male interviewees claimed to be doing more household chores than their partners and none of the women thought they did less than their spouse.

6. Diverse aspects concerning foreign trips

When discussing the attitude of Estonian physicists towards foreign trips, different time periods should be treated separately. In the Soviet system, foreign contacts were considered a privilge and not everyone had the possibility of attending the Western conferences necessary for professional development and, therefore, travelling was seen as a source of motivation to continue in the chosen discipline.

> *[…] but then onwards, and what encouraged me enormously was that when _ it was 1983 when I first attended a conference abroad, so then, then I didn't want to leave the discipline, things were too interesting by then, conferences every summer and that meant you had to start preparations in October already – all papers, documents, twelve copies of character references, spravka (certificate), what not, and also that you have a presentation for the conference in summer.* (P303/FS)

At the same time it is emphasized that going abroad was immensely complicated and when it was possible to go for a longer period of time, it was very difficult for the physicists to take their families with them.

> *I'm telling you, the first time I went abroad was in 1990, because it simply was not allowed before.* (P318/ML)

> *Interviewer: Next question: Have you been abroad in connection with your research? If so, did you take your family with you?*
> *No, it was the Soviet time.* (P301/MS)

Travelling has, by now, become an inevitability. Estonian physicists generally agree that mobility is necessary for scientists. Travelling to different countries, communicating with other people, getting to know new methods, and working in different laboratories will help develop research – it also prevents stagnation in the field of science.

In women's interviews there is more mention of shorter trips abroad than longer absences from Estonia. Foreign trips are connected to the area of research, the majority of respondents mentioned conferences as

their main reason for travelling. The duration of travels often ranges from a few days to a maximum of one to two weeks. Short absences from home may also be the reason why women do not perceive travelling to affect their family life. Interviewees may claim that trips abroad are frequent, but in their evaluations this is not brought out as a disturbing factor affecting family life.

> *I've been away for several times, but for short periods of time.* (P333/FS)

In comparison to the interviews given by women, men speak much more about longer absences from Estonia. These travels are usually connected to working or studying in a foreign university or laboratory. One of the interviewees even mentioned that staying in Estonia would have meant a different career choice. Men have mainly named Finland, Sweden, Germany and Switzerland as their destinations; USA, Japan or England have been rarer options.

> *[…] afterwards I went to study physics, then there were those times, I went to Finland, that gave me a chance, if I'd stayed in Estonia, I wouldn't have become a physicist, yes? etc.* (P302/MS)

6.1 Several motives for going abroad

There are two kinds of reasons for studying or having a career abroad. The main reason, again primarily connected with the period of the 1990s, is the fact that leaving Estonia presented a possibility for the young people to stay in physics, since there were no vacancies in Estonian research institutions at the time. In addition, there was a remarkable difference in salaries between foreign countries and Estonia.

> *Interviewer: Why wouldn't you have become [a physicist] if you had stayed in Estonia?*
> *Firstly, because at that time it was financially impossible to live in Estonia, and secondly, in Estonia the younger generation is almost non-existent. A large number of people of my age, the majority in Estonia*

> *now, have had their career somewhere abroad and then come back.* (P302/MS)

A less frequent reason that men point out, and which still holds true, is the lack of possibilities to do scientific research in Estonia (for example, the technical equipment in the laboratories restricts the carrying out of some particular research).

First of all, laboratories abroad are pointed out as more modern. This is also one of the main reasons that has been brought out in a recent research on the mobility of Estonian scientists (Murakas et al. 2007).

> *Back in 1992 there where no conditions here. So it was quite obvious that to continue here in a so to say new quality, one would have had to leave Estonia.* (P309/MS)

Secondly, it was pointed out that the literature on physics is much more varied and also more easily accessible in Western countries.

> *Well, I'll have to speak about that period in Sweden again. Here it was very, very liberal. Very good possibilities. Well, they had _ a very good library, all those journals, basically _ They had everything on the spot.* (P311/ML)

6.2 Problems with the requirement of mobility

A certain number of men who went to work abroad for a longer period of time, had the chance to take their wives with them. At the same time, some risks are seen in the wives leaving their jobs in their home country to go to live with their husbands in a foreign country. In these cases, husbands may became the only source of income for the family.

> *In order to live in a normal way and move to another country with your family, you should, it's not that simple that you move to a foreign country and your wife finds a job there too – it's not like that. So in principle one person has to support the whole family and the salaries in science are not very high.* (P305/ML)

> *Being together influenced my family life very positively. I think, now the fact that my wife gave up her job was a big risk and problem, but she was lucky to get her job back afterwards.* (P302/MS)

Female physicists have not described any situations where their husbands would have given up their jobs in order to follow their wives abroad.

It is remarkable that men evaluate absence from Estonia in a more negative manner than women. In their opinion, travelling affects family life. These evaluations may also be based on the fact that in the case of men, the travels and absences from home tend to be longer than for women and it is not always possible for the family to accompany them.

> *Such long separations are always bad. They destroy the certain balance. And my children were teenagers and all this is, such things are always certainly bad.* (P301/MS)

Several male interviewees claimed that the ideal of science, that requires constant travelling and rotating between different laboratories in order to maximize professionality, is incompatible with family life. A couple of interviews also clearly indicate this as the reason for leaving physics.

> ***Well, I didn't really want that. At the time I had, I already had a wife and if I had become a post-doc somewhere, it would have meant living out of the suitcase for quite a number of years. I mean _ when I was here, in Sweden, we got to know a few post-docs there _ and they were a lot older than me. But, it's like, he was like _ there was one from Italy _ he had been a year in one country and then a year in another country and then a year in a third country. That means more or less living out of the suitcase. Like, when you're twenty, it would be, like, OK. But when you're over thirty, that's not what you want from life.*** **(P311/ML)**

7. Conclusions

When discussing the issue of leaving physics in Estonia, studying the reasons for leaving in the cases of both men and women, and consequently hoping to figure out the values influencing the actions in the cultural context in physics the transition from the Soviet scientific system to the democratic environment of market economy cannot be underestimated. Most of the interviews, that were carried out within this project, to a varying extent touched upon the problems that needed to be solved during the socio-economic changes. This factor became, in a way, an advantage in carrying out the research, because such an extreme social "experiment" presented much clearer specific perceptions of being a physicist, a man or a woman.

The most significant example is how clearly the material subsistence of the family is seen as the man's responsibility. This aspect would not be so surprising in itselt, if there had not been the domination of gender equality declared on the ideological level for a half-a-century. In the years after Estonia regained its independence, the group of people who left physics included those physicists whose opportunities to work in the business sector had been limited during the Soviet period and who wanted leave the public sector. But there were also those for whom this step was involuntary, because had they continued in research, the men would not have been able to "fulfill their duties to the family".

Nevertheless when leaving for economic reasons, the attraction of new social sectors to the male physicists caused by the decrease in financing and the parallel hyper-inflation, people were also forced to leave by the internal issues in the institutes of physics. Financing issues not only decreased the salary funds, but also the numbers of employees.

Among the respondents interviewed during the research, more women than men had experienced redundancies. For two female respondents who lost their jobs, one of the contributing factors was the lack of a mentor. Therefore the position of both respondents had been weaker in the social network of their institutions.

Leaving or staying in physics, especially the beginning of the career, is – and especially in the case of women – influenced by finding a

suitable supervisor, but the intellectual atmosphere at the workplace is also important. A lack in the latter was experienced by both men and women: intellectual atmosphere is described as the general possibility of discussing the issues of personal research with colleagues, but also everyday social communication, the insufficiency of which was most severely felt by young female physicists, because in addition to gender differences, the high average age of the scientists and the lack of the mediator generation also play a certain role.

Regardless of their gender, in describing the nature of a physicist's work, the interviewees valued the relative freedom of the academic world, to set their own goals and choose their working time and place. Even though the opportunities in deciding on their time and place for work were actually rarely used by the physicists, the freedom of choice was seen as an advantage of this particular job. This helped to solve some of the problems concerning the balancing of work and family lives; e.g, to work and at the same time take care of a sick child.

Both male and female interviewees found that since home duties and taking care of children was seen mainly as the women's responsibility, it was more difficult for women to have an equal career in science. This particular conviction was also supported by some male physicists who expressed the opinion that their careers would have been different, had they been women.

Estonian physicists also perceive the demand of the scientific world to travel a lot as a certain disadvantage from the perspective of family life. The need to be mobile was described as negative mainly by male physicists. In two cases, this opposition of mobility versus family life also influenced the decision to leave physics. It is not quite clear why men specifically see this as a problem, but the reason probably lies in the fact that the male interviewees had spent more time abroad, whereas women mainly spoke about shorter trips – conferences etc. The female respondents who had spent more time in the research institutions abroad, belonged to the youngest age group and did not have any children yet.

On a general level, at the time of writing the current report, a question concerning horizontal segregation in a broader sense arose. Provided that many of the men left academia because of the low salaries and, regardless

of the fact that the Estonian economy is much more stable now than it was in the 1990s, the graduates of physics are better-paid in the private sector than in the academic world. Since women do not associate themselves very directly with the problem of low incomes in the public sector, why is the percentage of women among the people working in the discipline of physics still no higher than barely one fifth[18]?

Within this report, we cannot provide an answer to this question because the low number of women in Estonian physics is not the result of them leaving physics more often than men, but because they do not go to study physics in the first place. During the current research we only interviewed those who had already gone into physics. Therefore the present research may shed light upon certain tendencies that, to some extent, explain the situation of women in physics and clarify why the profession of a physicist might seem culturally less attractive for women. The study found the problems to be mainly related to the issue of identity.

The reflections on identity in the interviews have been grouped, employing three exaggerated metaphors: a priest of truth, a playful boy and a blacksmith. All these images bear a more or less positive meaning in the context of Estonia, when referring to male identity. However, it is difficult to combine women's identity with these metaphors – of these three images, the values associated with the model of the physicist as a priest of truth can be most frequently recognised in women's answers. That is, they value dedication and the activity of looking for the fundamental truth. Whether by chance or not, it is also an image which does not place high significance on a formal career. The situation is more complicated with the images of the physicist as a playful boy and the physicist as a blacksmith, because most of the women seem to perceive the job of a physicist to be more related with the concept of work than play, and the purely technical area is considered rather a male domain in the context of Estonia.

[18] The amount is based on the names of men and women listed as employees on the web pages of Estonian institutions of physics in December 2006.

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UPGEM National Report
Finland

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Table of contents

1. Introduction

The purpose of this report, which is part of the European research project known as UPGEM (Understanding Puzzles in the Gendered European Map), is to examine the gendered career paths of Finnish university physicists. The project design was inspired by statistical data that showed female scientists all around Europe moving upwards in the academic rank slower than their male counter partners, while some female scientists even leave academia prematurely. In Finland, this pattern is all the more intriguing because women outnumber men in most academic fields at the level of graduate studies; however, the higher the place in the academic hierarchy, the wider the gap between numbers of male and female scientists (Academy of Finland 2005, web page). Physics is one field where, historically, women have been substantially underrepresented. The first Finnish woman to complete a Ph.D. in theoretical physics received this degree only in 1992; only in the year 2000 was a woman nominated for the rank of physics Professor in Finland (University of Helsinki, webpage). Today, approximately 5% of the physics Professors in Finland are women despite the fact that since 1996, more than 20% of the Ph.D. degrees in physics have been completed by women (KOTA database). In this report, I intend to shed light on some of the features of academic working life that contribute to a situation in which Finnish female physicists, although as fully qualified as men, are not as likely to pursue a top academic career.

The research data consist of in-depth interviews with both male and female physicists who either work in university positions or have left academia. The data analysis focuses on the processes through which gender differences arise in terms of family, mobility, university changes, workplace environment and choices in individual career paths. The observations based on the interview data suggest that gendered processes happen through such social practices as division of work, workplace interaction and identity formation. However, it is evident that male and female physicists do not form two monolithic groups; rather,

differences within the groups of male and female interviewees emerge from the data.

1.0.1 Research data

The research material consists of 36 interviews with Finnish physicists who mainly work in the country's capital Helsinki and its environs. The group of interviewees was chosen so that an equal number of women and men were interviewed. Moreover half of the interviews was conducted with persons working in university institutions, while the other half was conducted with persons who had left an academic career. In this report, the interviewees currently working in academia are called *stayers*, while those who left academia are called *leavers*.

The interviewees represented different ages ranging from 29 to 59 years and all academic levels, from Doctoral students to Professors (see Tables 1, 2 and 3, Appendix). They came from four different research institutions, the University of Helsinki, the Finnish Meteorological Institute, the Helsinki Institute of Physics and the University of Turku. The fields represented were astrophysics, atmospheric physics, astronomy, geophysics, materials physics, meteorology, nuclear physics, particle physics, theoretical physics and X-ray physics. The interviewees who had left academia had most often moved to research or management oriented jobs in the corporate world or to public institutions. Some interviewees had left university for teaching positions in such institutions as poly-technical schools (see Table 4, Appendix).

I collected the Finnish interview material during the period of one year from March 2006 to February 2007. The stayers were chosen to represent diverse fields of physics, different academic positions and different age groups equally. In order to find physicists who had left university positions, I consulted university departments and their webpages. Most of the leavers had left academia after completing their Ph.D. degree and all but one had left fewer than ten years ago. In general, finding interviewees was rather unproblematic; most of the physicists contacted were willing to donate their time for an interview. However, six of those whom I contacted refused to give an interview and three could not be reached at all, either by e-mail or by telephone.

The interviews were mainly conducted in Finnish and then translated and transcribed into English. However, in two cases, English was used as the language of the interview. All the interviewees were offered the opportunity to read and comment on the translations of their interviews. To assure the interviewees anonymity, all personal names as well as names of cities, universities and organisations were omitted from the interview extracts used. However, the gender of the participant in question as well as their classification as a leaver or stayer was attached to these extracts

1.1 Analytical tools

1.1.1 Gender as a set of social processes

To make sense of physicists' work from the perspective of gender requires addressing the question of how gender is defined. In this report, gender is not viewed solely as a biological category or an inherent quality of a person but rather as a social dynamic or activity. Gender is something that is acquired and negotiated through social processes; it is seen as a constitutive element of social relationships that are based on the perceived differences between male and female (West & Zimmermann 1987, 125). Organisations, in this study, university departments are investigated as a set of social practices that can produce gender difference on the level of structures, individual consciousness and interaction. Thus, gender differences can be produced and reproduced, for instance, through division of labour, explicit and implicit norms and regulations as well as symbolic and social boundaries in an organisation (Acker 1992). Gendered processes can also include access to participation, motivation and identity formation, competency development and paths of inclusion and marginalisation in a working community (Salminen-Karlsson 2006). Studying gendered processes in an organisational context thus means that attention is paid to the processes through which segregating attitudes and practices are constructed, consolidated or challenged by the organisation members (Gherardi 2001, 247).

1.1.2 Research questions and data analysis

One of the main purposes of the UPGEM project is to determine whether female and male physicists' career paths differ, and if so, how. In this report, five main themes related to physicists' work, family, mobility, working environment, changes in the universities, career paths and professional future, are investigated in more depth. My hypothesis is that there are differences in how male and female physicists perceive these issues. Meanwhile, I assume that there are also differences between the narratives of physicists who have stayed in academia and those who left their university careers.

The research questions guiding the analysis were formulated as follows:

1) How do Finnish physicists discuss issues related to family, mobility, working environment, changes in the universities, their career paths and professional future?
2) Are there differences in how stayer and leaver physicists discuss these issues?
3) How is gender difference produced in the narratives of Finnish physicists?

My goal is to investigate these differences on a qualitative level and from the perspective of gendered social processes. When analysing the interview data, I hope to be able to point out structures, social practices and modes of interaction through which gender is produced in the context of Finnish physics institutions. Due to the limited number of interviews, quantitative information from the data is presented mainly for the purpose of supporting the qualitative analysis.

2. Thematic analysis

2.1 Family

In the Finnish context, the issues of children and reconciling work and family were most often associated with the theme of family. Childhood family, on the other hand, did not often arise as a topic in the interviews. In this section, I will examine the Finnish interviewees' narratives concerning reconciling work and family matters. [1]

The majority of the Finnish interviewees (15 women and 14 men) had been in a steady relationship, and most interviewees (11 women and 12 men) had children (see Table 5, Appendix). Even though quantitatively female interviewees talked more about issues related to family and children than did their male counterparts the Finnish interview data still confirmed that both women and men physicists value their families very highly. Most Finnish interviewees defined family or private life as their first priority and assumed that their colleagues, independent of gender, did the same. They stressed the importance of having life outside work as well as the need to find compromises between professional ambitions and private life responsibilities. Many cited male colleagues as examples of devoted young parents who take family responsibilities very seriously. Both female and male interviewees saw the economic instability, the short contracts and the low pay typical of academic work as being problematic in terms of supporting a family.

An interesting detail in connection with the family relations of the interviewees was that nine of the women were married to other physicists, with six being academically of higher rank than their spouses. Of the 18 male interviewees, only two had spouses who were physicists. This observation may be connected with the fact, that many female physicists mentioned their spouses as being important in supporting their career or even being their mentors. Male physicists, for their part,

[1] This section has been based on the conference presentation "Reconciliation of work and family" by M. Miazek and J. Vainio at the conference Gender and citizenship in a Multicultural Context, the University of Lodz, August 2006.

usually stressed that family life functioned as an important counter-balance to their work.

In the realm of the actual reconciliation of academic work and family life, however, there were certain gendered aspects in the Finnish interview data. In general, Finnish male interviewees saw the family as a private issue and a person's success in an academic career depending on personal characteristics and ambitions. Nevertheless, many of the male interviewees who had a long career in academia admitted that their devotion to work had affected their family lives to the point that their spouses had been forced to take the major responsibility for family related tasks and raising children. By contrast, most female interviewees with a family, considered their family and work inversely related. Even though many had been able to combine having a family and work very successfully, the women were conscious of potential complications in fitting family responsibilities to an academic career, especially in terms of time management and mobility. In the following section, the gendered aspects of reconciling work and family, which emerged in the Finnish interview data, are investigated in more detail.

2.1.1 Time management

Lack of time to invest in the family is generally viewed as a significant problem among white-collar workers in Finland; women, especially, often have the experience of not having spent enough time with their children, spouses or parents. It thus seems that Finnish employees' families are more often affected by their work than the other way round (Salmi & Lammi-Taskula 2004, 118–119). The opposite is true for mothers of small children, however, who relatively often experience problems with such requirements as working overtime or work-related travel (Salmi & Lammi-Taskula 2004, 37). Issues related to lack of time at work were raised by Finnish female stayer interviewees with children who sometimes had the experience of not working enough because of family responsibilities. They considered academia a flexible but demanding working environment; flexible working hours were not seen as

diminishing the actual amount of work. Time management proved to be especially problematic when a person's academic merits were assessed, for example, in obtaining research grants. Some female stayers with children indicated that their publications could be more numerous if they could put in as many working hours as their male colleagues. This, in turn, would make it easier for them to receive research funding. Notwithstanding the high priority given to family, Finnish female stayer interviewees with children expressed ambiguous feelings about balancing family responsibilities and career ambitions. On the one hand they idealised colleagues without family responsibilities who could dedicate themselves to research; on the other hand they found themselves privileged to be able to invest time and effort in their children.

Despite the expressed dilemma of finding enough time for both work and family, Finnish female interviewees expressed a strong devotion to both life spheres and an ability to manage myriad tasks at work and at home. They stressed the importance of working effectively, organising their activities effectively and working flexibly at home (i.e., during holidays and at night time). Shortening and changing plans, taking time off from work as well as limiting informal communication during the work day (i.e., having fewer coffee breaks) were normal ways of coping with limited time resources.

Pressure to control the time used for work was not a strong complaint among Finnish male stayer interviewees. Giving work responsibilities priority when needed was self-evident for all of them: working exceptionally long or irregular hours was not considered a problem but was seen as a normal part of research-work. Many of the male stayer interviewees indicated that they often became so engaged in their work that it became difficult to control the time spent. They also mentioned having sacrificed an important task owing to family responsibilities less frequently than did female interviewees. Similar comments were made by male leavers and also by some of the female interviewees (both stayers and leavers) who did not have families.

In short, both female and male interviewees considered research work to be time consuming, but the genders had different priorities when managing the time used for work and for the family. According to the Finnish interview data, the family interfered with female re-

searchers' work, limiting their available time for work, whereas for male researchers, work was not significantly affected by the demands of their private lives but in some cases even intruded on their family life. However, those female interviewees who did not have children indicated that they were willing to sacrifice their private life obligations for their work. On the other hand, three male leavers in the younger generation identified family obligations – for example, problems in childcare when both parents worked – as a major factor affecting their decision to leave academia. This observation might be indicative of a transformation in family roles: in younger generation families, it is not self evident that the husband's career is given priority, but rather the wife's professional ambitions and the family's wellbeing also count when career decisions are made.

> *Well, this was actually – of course it [co-operation with interviewee's former research institute] continued, I mean I had been there a long time already and I knew a lot of people, so it's difficult to stop it altogether because it was quite fun after all, so – but this was nevertheless sort of like a clear break from the basic research but – it was due to, on the other hand, that doing basic research is by no means an 8 to 4 job. And we have a small child, who happened to come along when we were abroad. And my wife wanted to work more, too, so it, it doesn't really work if the hubby is working from dawn till dusk… So there was like a bit of pressure to look round for other options.* (P229/ML)

2.1.2 Household work and childcare

When asked about the division of household work, most Finnish interviewees in steady relationships had surprisingly similar answers; they stated that household chores were divided very even-handedly, sometimes mathematically, between them and their spouses. These responses were even more surprising when compared with statistical surveys indicating that in Finnish families, everyday household management (laundry, cooking, cleaning) is for the most part done by wives. Taking care of vehicles and minor repairs at home are the only activities taken

care of almost exclusively by men (Melkas 2004, 33). It is difficult to judge whether the statistically untypical division of household work evident in the interview data reflects the real situation or rather shows subjective conceptions of symmetry in family roles and general rhetoric of gender equality in Finland (see Julkunen 2004, 139).

In international studies of family and career, ensuring adequate childcare is considered a core issue for females in reconciling work and family (Reskin & Padavic 1994, 152). Since communal day care is a legal right for every child under the age of seven in Finland, problems related to day-care went virtually untouched by Finnish interviewees (see also Husu 2001, 270). Meanwhile, informal social networks like grandparents were mentioned as the most important source of support when communal childcare services were not available. These networks were especially important for female stayers who worked part-time when a baby was very young and whose work entailed a lot of travel or field trips. Although Finnish female stayer interviewees did not consider taking care of children to be problematic, they saw a difference in how parenthood affects women's and men's working lives in academia: bringing up a child was considered to demand more time and energy from the mother than from the father. The division of caring responsibilities, seldom spoken about in the workplace, becomes visible in such things as attendance at work. '*When children are very small, the men anyway, although they are very supportive in principle, they're here and not there*' (P216/FS) as one of the female interviewees put it.

The Finnish interview data are in line with the observation that despite the equal participation of females and males in working life in Finland, the major responsibility for rearing children still lies with mothers. Organising children's daily lives, communicating with the day-care or school staff, purchasing and caring for clothes, are mainly the responsibility of the mothers in Finnish families. Fathers mainly contribute to childcare by taking the children to the day-care institution, picking them up at the end of the day or driving them to their hobbies (Melkas 2004, 32–33). The interview data also suggests that running day-to-day family life takes up more time in the lives of female physicists than in the lives of their male counterparts. These observations are in accordance with the idea of asymmetrical permeability of

work and family created in the 1970s: a woman's work has to yield to her family's needs whereas a man's family has to yield to his work (Pleck 1977, 423). Thus, the gender differences produced by the division of work in families are also reflected in the context of research work: mothers of young children are often unable to put in as many hours as either their female colleagues who do not have children or their male colleagues.

2.2 Mobility

In the Finnish interview data, the issue of mobility was mostly discussed in terms of long work-related stays abroad. Moreover, mobility proved to be closely connected with the question of reconciling work and family. In this section, I give an account of how these two topics were addressed by the Finnish interviewees.

Taking part in international meetings and contributing to academic collaboration are considered essential parts of a researcher's work; especially in the natural sciences, there is an unwritten rule that in order to advance one's academic career, one has to go abroad to pursue post-doctoral research at least for some period of time. Among the interviewees, 23 had worked abroad for substantial periods, either during their Ph.D. studies or as post-doctoral researchers. Travelling was an integral part of work for most of the interviewees working in nuclear and particle physics because of the large international collaboration projects with which they were involved. In general, Finnish interviewees saw the task of combining family and the mobility required by their work as being complicated. Being single was considered an advantage in terms of mobility, whereas a family was seen as an obstacle or a problem when travelling or working abroad. At the same time, long-distance relationships were not regarded as possible by any of the Finnish interviewees. Both male and female interviewees had turned down work-related journeys and even posts offered in foreign universities for family reasons. In order to solve the difficulty of being in two

places at the same time, some of the interviewees utilised digital communication devices such as the Internet and video conferencing.

When it came to issues of career advancement and working abroad, an obvious difference in men's and women's thoughts arose. Male stayer interviewees in steady relationships mostly took it for granted that they would at some point go abroad and take their families with them, even if they admitted that it was important to find compromises between the family's needs and their own career. Nevertheless, the problems related to long stays abroad were acknowledged by male interviewees. In this group of interviewees there were three older generation male interviewees who had conducted successful international careers in science but whose marriages ended in divorce. In retrospect they could see a connection between their divorces and the long stays abroad. According to their accounts, their spouses grew frustrated at not having the option to create their own careers in a foreign country.

Female interviewees, for their part, mostly considered going abroad with their families to be a rather unlikely option. They often mentioned their children's well-being (i.e. health insurance and schools) as well as the career interests of their spouses as reasons for their decision to stay in Finland. At the same time they were conscious of the fact that unwillingness to work abroad might to a certain extent be a hindrance to their careers in academia. The need to stay in one's native country had in effect been the reason for leaving the university for three of the female interviewees who wanted to start a family after having completed a Ph.D. degree. These young women considered going abroad, as post doctoral researchers, too unstable an option in terms of maternity leave and job security and decided instead find permanent employment outside academia.

> *And that has probably had an effect, that the idea was at that time that it would be nice to have more children, so then going to be a post-doc somewhere and then coming back to have more children, that didn't really seem possible either. So yes, I would say that family has always been a priority for me, a sort of obvious number one, so that has affected my decisions, and that has maybe taken me away from the university world, that is probably true. That is, my daughters.* (P209/FL)

According to the Finnish data, one key to the dilemma of combining an international academic career with motherhood seemed to be *timing*. Three Finnish female interviewees had completed their Ph.D. degrees and worked abroad, establishing themselves as members of the scientific community before starting a family. This kind of sequential model of combining career and family is becoming increasingly more common in Finland, especially in the natural sciences where doctoral studies are often pursued at a relatively young age. The flip side of the model is that it involves a strictly planned and rationalised way of structuring career and private life (see Julkunen 2004, 130–131).

In summary, a gendered tendency can be seen in the Finnish interview data in the willingness to compromise between professional ambitions and family, because family issues seemed to affect more female than male interviewee's career decisions. However, a difference can also be seen between male stayers and the rest of the interviewees (female stayers, female and male leavers). In the interview data, male stayers formed a group that seemed to be willing to devote a great part of their lives to work, which often demanded a lot of flexibility from their families and in some cases led to problems in their private lives. Female interviewees as well as male leavers showed less willingness to sacrifice their family lives to their careers, a choice that sometimes entailed giving up or modifying academic career ambitions.

2.3 Change in university life

The topic of change in the universities is a broad one and can be examined from many different perspectives. In the following section, I will focus on the changes in the university context identified by the Finnish interviewees. These include changes in research infrastructure and equipment, changes in science policies and changes in the work of university researchers.

When asked about the greatest changes that had occurred in their own field of research and in the universities during the past twenty years, the Finnish interviewees generally came up with three types of answers. The first set of answers was connected to the development of

information technology, which has caused qualitative and quantitative upheavals in many fields, especially as the potential of equipment used in calculation and measurement has grown exponentially. Furthermore, the emergence of internet-based communication has hastened the delivery of new information as well as increasing international contacts among physicists. This major transformation, which is still ongoing, was viewed positively by both genders. Both male and female interviewees confirmed the view that the development of information technology has been a great advantage to science in general and for their work. Only one older generation male interviewee indicated that he felt his computing skills to be somewhat inadequate. As to the availability of the newest technology at the university, the interviewees generally saw the research equipment and facilities in the workplace as being sufficient. However, one male leaver interviewee mentioned that the lack of up-to-date measurement equipment contributed to his decision to leave the university environment. However, this proved to be a rather isolated case.

A second set of answers was related to transformations in research policies, especially changes in research funding, which interviewees associated mostly with 'fashionable research'. (P201/FS, P210/FS, P213/FL, P224/FL, P231/FL). The amount of research funding was seen as a function of political trends in society and the public outreach of science. However, the growth of financial resources in particle physics during the past decades was interpreted differently by nuclear physicists and particle physicists. Some of the nuclear physicists I interviewed perceived this developmental trend as a result of effective lobbying, whereas particle physicists considered the growth in their research field to be a natural consequence of the successful large-scale experiments and international collaboration in which Finland is involved. A general observation made by interviewees from different fields of physics was that environmental physics, especially atmospheric science, has experienced an unforeseen boom in the past ten years. The scope and funding of this field has expanded due to increasing public interest in climate change issues, but some of the interviewees also explained the rapid growth of the research field as a function of strong, individual personalities and personal preferences of university department heads.

In any case, it is worth noting that the Division of Atmospheric Science at the University of Helsinki nowadays has some 80 employees, of which nearly 40% are women (University of Helsinki, webpage). With these figures the division stands out as the biggest and statistically most gender-equal unit in the Department of Physics. According to Finnish interviewees, a similar tendency in a rapidly growing research field and one with relatively many female researchers took place in space physics in the 1980s.

The third set of answers explaining university changes was attributed to administrative and financial changes in Finnish universities during the past twenty years. In the 1990's, Finnish universities underwent a transformation from management by budget allocations to management by results, bringing structural changes to university administration and increased reporting and assessment of academic work. One of the most recent manifestations of this transformation is the new university payroll system, which is based on an employee's performance at work and involves an annual assessment of their work. At the same time, the share of those competing for research funding has grown in university budgets, with increased pressure for research groups to apply for external funding. Consequently, project work and fixed-term positions have become the prevailing form of employment. These changes combined with increasing numbers of graduate and postgraduate students, ongoing international evaluation and development projects in higher education have affected the work of Professors and senior researchers alike by increasing the number of administrative and managerial tasks and, in many cases, diminishing the time available for research (Ministry of Education 1996, 37–39, Patomäki 2005, 97–98).

The interview data indicate that male physicists had a rather critical attitude towards the aforementioned trends in academia. The male interviewees, both current and former university employees, talked about the university changes as a predominantly negative phenomenon. As examples, they cited the mass production of Ph.D.'s, the hardened competition and the pressure to publish more frequently as well as the new payroll system. In these interviews, the idea of free and high-quality science was opposed to the dominant ideology of society's effectiveness, which they strongly reacted against. The growing amount

of administrative work was most often cited as a concrete indication of the negative transformations taking place in academia. Administrative work, often equated with bureaucracy, was seen as a compulsory burden by the male stayers, who preferred scientific work. Also some of the male leavers, those who actually left research, mentioned the administrative work at their former university departments as being a clearly negative issue. Some of the younger male interviewees went so far as to state that the growing amount of administrative work in academia might be a reason for them eventually to leave the university.

> *Research itself, I want to do. I would actually have a hard time imagining that I would do any other kind of work. But the question that is research at the university something I want to do, that I am not nearly as sure about _.*
> *Interviewer: Why not?*
> *Well, especially if you look at the older generation of researchers, it doesn't look, at least in Finland, like something that would be very appetizing. It looks like most of your time will be spent doing things outside of research. And it's only increased, this work outside the research itself _.*
> *Interviewer: Administrative work _.*
> *And that doesn't interest me much, at least not for right now. But of course, if you advance in your career, you'll inevitably be faced with that. You have to form your own research groups so there is always administrative, regardless of whether you want it or not. If you want to create your own research group, that always goes hand in hand in hand with it. Right now it feels like there will be much of that which is completely useless when it comes to research, it doesn't advance the research in any way, and it serves to, sort of, stifle research, with trifling matters.* (P217/MS)

The female interviewees talked quantitatively less about university changes than did their male counterparts, but in definitely more positive tones. The changes in Ph.D. education towards a more structured model as well as the growth in the number of students were seen as positive changes by the female interviewees. However, some of the female stayers perceived the lack of permanent positions and the ongoing competition as a general problem in academia. The clearest difference

between male and female interviewees could be seen in their attitudes towards administrative work. Many of the female interviewees considered administrative tasks pleasant or even as their personal strengths; two female stayers and three female leavers indicated that they were professionally more interested in management and administration than in research. Even those interviewees who perceived administrative work as being unpleasant indicated that the amount of administrative work was at a tolerable level, thanks to competent secretarial staff.

> *No, no. I wouldn't do this [physics] if it was like that. Despite the other things that are, like, included in it currently, despite that it is really a lot of fun.*
> *Interviewer: Do you mean this bureaucracy specifically?*
> *Yes, yes. In small doses that is fun too, but when you feel like there is just no time for the research itself, then it is a hindrance. So yes, to a certain point it is a pleasant, different thing. But it of course changes, from time to time it is at a perfectly acceptable level, but then it can go a bit overboard.* (P216/FS)

When looking at the different meanings attributed to administrative work, it can be stated that even though administrative work is done by both male and female physicists, women may be more likely to take over administrative or supportive tasks in scientific working communities because they perceive them to be meaningful and important. This may be due to personal preferences, but for some, the division of work may also be promoted by other members of the scientific community. One example may be the female leaver whose supervisor encouraged her to take up an organisational job and thus abandon her Ph.D. studies.

When examining the issue of administrative work from the perspective of academic structures, the following observation can be made. While the number of administrative tasks in university departments has increased, the position structure has stayed rather stable so that the most appreciated positions (like professorial posts) can be attained mainly on scholarly merit. Consequently, engaging in activities other than research can be seen as not beneficial for the physicist striving for a successful scientific career. Meanwhile, researchers who prefer administrative tasks may distance themselves from scientific work. In the group of Finnish interviewees, the men expressed a stronger need to concentrate

on scientific work only, whereas many female interviewees indicated a willingness to do both research and administrative work. Hence, even though female physicists seem to adapt to the changing academic working environment better than their male counterparts, some may distance themselves from scientific work by doing administrative work and thus lose the change to attain the highest academic positions. This attitude was reflected by one of the Finnish female stayer interviewees:

> *Yes, well, I do think that part of the reason that, these practical jobs, this upkeep of the measuring device net, that they are on my shoulders in such a large amount. It is because of, on the one hand that I'm not a very good researcher, but on the other hand that I'm so good at some of the practical side of things. And that has maybe allowed other researchers more freedom to just do research because I've been more in charge of these practical things. On the other hand, it has been easier for me, because I feel like that pressure of expectation isn't that great on me. So it doesn't matter if I don't have quite so many publications. On the other hand it's a bit of a double-edged sword, because do you then push yourself enough! Because you can always blame the practical side of things, that I can't do these things because I have so much other work.* (P200/FS)

2.4 Identity

In the interview guide there were several questions relating to the interviewee's professional self image, self esteem and role models. Through these questions, it was possible to determine something about the interviewees' identities as physicists, that is, how they define who they are for themselves and for others in the group of physics professionals (McAdams, Josselson & Lieblich 2006, 4). In the following section, three dimensions of physicist identity apparent in the Finnish interview data are investigated. The first dimension covers points of identification, namely, stereotypes and role models as physicist. The second dimension is connected with professional self-esteem, and the third addresses group identification within physics.

2.4.1 Stereotypes and role models

During the interview, the interviewees were first asked to identify stereotypes connected to physicists and relate themselves to that stereotype. Then, the interviewees were asked how they assessed their professional qualities as opposed to those of their colleagues and how they would identify an ideal physicist. The majority (13 female and 15 male interviewees) described the stereotypical physicist as a nerd – an introverted, over-specialised scientist who has little or no interests outside of their own field. The interviewees often connected the physical appearance of the stereotypical physicist with an Einstein-type 'mad professor' with dishevelled hair and shabby clothes, and in most cases, as a male scientist. These stereotypes were presented by both female and male interviewees, and a large majority of them distanced themselves from that image. However, three female and four male interviewees admitted that they fit the stereotype to a degree. The positive attributes the interviewees connected with physicists were thoroughness and the ability to understand abstractions as well as large and complex entities. However, in some cases these attributes carried meanings that were not unequivocally positive. Four female interviewees had experienced being singled out as abnormal. Physics is generally considered very difficult and women in the field are often regarded as somewhat peculiar or extraordinary.

> *No, I don't think that has changed it [the stereotypes of physicists]. But I think that maybe physicists are also seen in the public eye as _ somehow smart and that they know maths and, and that they know something that has nothing to do with me. In general, I mean… And I can very well say this as a woman that _ when I was younger, if I was out, for example, and somebody came to ask me what I did or showed some interest and if I wasn't interested in the person, the only thing that I had to say was that I study physics or that I am a theoretical physicist and that was the end of story [laughter].*
> *Interviewer: [laughter].*
> *Yes, it's like that. And, well, for years, I remember when we were celebrating my first husband's graduation with his like group of engineer friends. And then, it was also in some public restaurant and people come*

> *to ask you to dance and then you chat and there was only one person, it was some American businessman to whom I also told this – he probably didn't realise that I was with a group like that so then he goes "Oh, so you know something about atoms. I like them too!" [laughter].*(P228/FL)

When asked about role models in their career in physics, many interviewees (10 females and 7 males) stated that they had no role model. However, the reasons were different for male and female interviewees. Male physicists typically indicated that they had never needed a role model because they wanted to do things their own way or because they did not find a suitable role model in their circle of colleagues. On the other hand, those male interviewees who identified role models could often name several good examples of scientists they had encountered during their careers. Female interviewees, for their part, said that they had no role model since there were few or no senior female physicists to be found. Four of the younger generation female interviewees, however, had had a senior female researcher as a role model, indicating gender balance transformation in certain fields of physics.

2.4.2 Professional self-esteem and qualities of a good scientist

When asked to assess their own professional qualities, most of the interviewees (14 females and 11 males) described themselves as good scientists. They felt that their work at the university was sufficiently appreciated by both their colleagues and also in the broader field of physics. However, identifying their own strengths and weaknesses as physicists proved to be a difficult task for some. An issue that came up, especially in leaver interviews, was connected to the indirect or vague nature of feedback in academic working communities. In some cases it had been difficult for the interviewees to decide whether their contributions to research were appreciated for the work itself or for other reasons, such as departmental finances.

> *Interviewer: Did you feel in general that people's work was appreciated there?*
> *Well, I don't really _ It didn't show in any way really, it felt more like "If we can just get you guys out of here, so the department gets money". Reading between the lines. That didn't come up directly, but it showed in budgets and stuff, it was always a big point, where money came from. It was like, "wait a minute, that's why we're here". We brought money to the department.*
> *Interviewer: So you felt that you were seen as resources, or.*
> *Yes, kind of _ it felt a little bit like that. And also the lack of instruction showed us about the appreciation, that it wasn't that important what we were doing, as long as we were doing something.* (P207/ML)

Apart from these interviewees, there were four female and four male leavers who had the experience of their personal input at work or their research group/department not being highly valued at the university. These interviewees mostly connected the undervaluation to their supervisor's personal preferences or to university politics on a broader scale, for instance, the lack of resources in certain fields of physics.

Stayer interviewees also referred to the lack of feedback in academia, but perhaps in a less concerned way. Many of them assumed it was natural that positive feedback at work was indirect and came through scientific discussion.

> *And getting credit doesn't mean that someone comes and congratulates you for your great paper. You get credit if someone cites your paper… In some works that come after that.*
> Interviewer: *Yes. I suppose it's quite common in university circles that no one comes and praises you directly, at least not in Finland. Or what would you say?*
> *Yes, it is. The only times I've received direct credit have been these newspaper articles of mine. Someone's called me and said: "It was a good article you wrote in the paper."* (P233/ML)

When comparing themselves with their colleagues, the physicists most typically assumed that their colleagues were more perseverant or meticulous than they themselves. Two female and two male leavers had the opinion that their ex-colleagues were more intelligent or theoretically

and mathematically more gifted than themselves. This was also the case with three female and one male stayer, all of whom had their Ph.D.'s in physics. Some leaver interviewees indicated that they lacked interest in scientific work and found their ex-colleagues more enthusiastic and devoted to physics than themselves. Out of these interviewees, five were female and two male.

Apart from assessing their own qualities as researchers, the interviewees were also asked to define general qualities of a good physicist. Both male and female interviewees put great emphasis on enthusiasm for science, commitment to one's work as well as good communication skills. Apart from these qualities, work ethics such as keeping schedules and honesty were stressed as important qualities of a scientist. However, there were four male physicists who specifically discussed creativity, playfulness and the urge to experiment as a scientist's most important qualities, whereas no female interviewees remarked on these features. (P203/MS)

> *Well, it's an important thing to have a good imagination in this line of work, I'd say. Everything else can be learnt but if you don't _ Because it often requires this sort of, like I said before, like the enthusiasm of little boys regarding something. So then you can _ to have certain kind of, I don't know if it's creativity or what. A little bit creativity, anyhow. And I believe that I possess that, too. I find connecting things interesting. And I think it's quite important and it's something that isn't perhaps _ so much emphasised. I suppose it's… nowadays when you read newspapers, you see a lot of that; like there should be innovativeness in industry and the like. That is emphasised a lot. And I think that many of these guys possess a lot of exactly that quality.*
> Interviewer: *Right, yes. You just mentioned "like little boys" and at some point you also talked about little girls. So were there actually like playful little girls [laughter]?*
> *Well, we didn't actually have many girls there.* (P229/ML)

The quotation above indicates that the interviewee identifies himself with a creative (and playful) group of scientists in which women are almost absent. He also sees creativity as an inherent quality, something that cannot be learned. This observation is in line with Cathrine Hasse's

studies on play in physics showing that male physics students engaging in playful activities were often praised by their teachers and perceived as potential future scientists (Hasse 2002, 266–268). Thus, play can be seen as an unofficial premise for taking part in the research activity that entails identifying with a group of male scientists who have the enthusiasm of little boys.

2.4.3 Group identification and disciplinary boundaries

From an outsider's point of view, all physicists seem to form one, monolithic professional group. When interviewing the Finnish physicists, however, it soon became evident that there are several subgroups within physics. Moreover, some of the physicists did not find it easy to locate themselves in one specific group. This was especially the case in fields of applied physics: geophysics, atmospheric physics and material physics. Many interviewees coming from applied physics defined themselves primarily as representatives of these particular fields and only secondarily as physicists. Even though this definition was made by both female and male interviewees, there appeared to be an interesting qualitative difference in their responses. Some male interviewees who worked in applied physics accounted for having faced 'discrimination' within physics departments; whereas theoretical physics was considered the most difficult and 'pure' field of physics, applied physics was labelled easy and 'not pure'. This categorisation implied that only 'pure' physics was considered real physics. Hence, some interviewees were cautious when describing themselves as physicists.

> *Well, this is about how you define someone as a physicist… Because this is – as we just talked about, our ex-department's professors wouldn't consider them [materials scientists] physicists.*
> Interviewer: *Okay [laughter].*
> *This is exactly my identity crisis. At the university I avoided using the word physicist, as I represented materials science… But here [in current working place] I'm a physicist now.* (P227/ML)

The female interviewees did not report on this sort of identification problem, but indicated that they preferred identification with groups other than traditional physicists. Nor was being between two fields of physics a problem for them, on the contrary, some female interviewees considered collaboration with different fields of physics a professional advantage and some had made a conscious choice to work between two departments.

> *Interviewer: Yes, yes. You have a rather extraordinary position there, sort of in between two _.*
> *Yes. And when you are between the two, you don't have be so – commit yourself and be so much like you belong to a certain group. So, so that's something I've I realised. And I also think that's why my like _ state of being has improved over the years here, between aerosol physics and meteorology, because I'm not so much like _ in it anymore, or like _. I do know what the situation is and people talk to me and so on. But I'm not so much _ labelled _ as anything.* (P222/FS)

Even though the above examples cannot be said to represent a major trend in the data, they may be considered indicative of the inner hierarchies and boundaries within physics and of the different ways of responding. The representations of prestige, power and other characteristics attributed to different fields of physics can be identified as *boundary work* in science where individuals attempt to 'seize another's cognitive authority, restrict it, protect it, expand it or enforce it' (Gieryn 1999, 405–407). On the basis of the interview data, it seems that some female physicists located themselves outside the traditional disciplinary boundaries of physics in rather unproblematic ways, while the male interviewees were more conscious of the prestige and hierarchical structures even while denouncing them in their representations.

> *Interviewer: How would you say that university has changed as a workplace, say, over the past twenty years?*
> *Very little.*
> *Interviewer: Okay. What has not changed?*
> *Well _ let's say that _ there's probably the same basic conception that there's this set hierarchy of positions. And that defines the pecking order.*

> *And then, as there are various divisions, it's all about this "this one for you, that one for me" business. Everything: spending money, distribution of positions. If a position is opened, even if it's advertised for in the paper, in nearly all cases it's clear for whom it's designed. And then the description of the position is just formulated in writing so as to meet with the person.* (P221/ML)

Male physicists thus seemed to be actively involved with the boundary work in their field of science, whereas female physicists either were not concerned about the boundaries or ignored them.

To summarise, the Finnish interview data suggest that physicists' identities are gendered in several ways. Neither female nor male interviewees identified themselves exclusively with the prevailing physics stereotype, an introverted male nerd. However, some male interviewees identified themselves with a metaphor of a playful boy, in other words a good scientist. At the same time there were female interviewees who had encountered negative prejudices towards female physicists. The majority of the female interviewees indicated that they had no role model since there were no senior women physicists around. Moreover, male physicists proved to be rather conscious of the inner hierarchies and boundaries of physics, whereas female physicists seemed to be less concerned with these boundaries and more willing to cross them. The interview data thus suggest that the images and symbols attached to physics and physicists are predominantly masculine and provide few or no points of identification for female physicists. However, it also seems that perhaps precisely because of the lack of professional role models, female physicists are more flexible in relation to the disciplinary hierarchies and boundaries when embarking on an academic career than their male counterparts.

2.5 The workace environment

The issue of the physical working environment was discussed relatively little by the Finnish interviewees. The majority of interviewees expressed satisfaction with their immediate working sites, despite a lack of

space and the necessity of sharing offices. On the other hand, some interviewees perceived large university buildings and physically dispersed working groups as a hindrance to collegial interaction. While the physical working environment appeared rather unproblematic in the interviewees' narratives, the issues of social and psychological working environment were debated. In the following section, I will touch upon the issues of teamwork, workplace atmosphere, gender discrimination and sexual harassment.

2.5.1 Teamwork

In general, the amount of teamwork in physics research seemed to be connected to the field of physics itself: the more experimental the research, the more group work is involved. Many of the interviewees representing experimental physics highlighted the importance of teamwork in modern science as a precondition for any breakthroughs. This is especially the case in particle and nuclear physics, where large-scale experiments essentially require group work. Even so, there were also experimentalists who depicted their work as predominantly individual. These interviewees mainly worked in geophysics and materials physics.

The positive sides to teamwork were mostly discussed by the female interviewees who also frequently referred to the lack of co-operation at work as a problem. Female leavers who had experienced academic research as being too solitary emphasised the interactive nature of their current employment and considered it rewarding. Similarly, some female stayers implied that they preferred group work over individual work; some had also attempted to change their work to a more collaborative mode. Even those female stayers who considered their work mostly individual emphasised the importance of good team spirit and collegial support in the working place.

> *Yes, well, I'm a team worker by nature, so I find it very difficult to do work alone. Or I don't really like to work, like that, alone. I think it's good to talk about those, like, problems. Because of actually, what I just said, that if you have a problem, that is because you haven't formulated*

> *it. And then when you discuss things, it helps in the formulating*. (P210/FS)

The male interviewees indicated a rather different attitude towards teamwork. First, there were interviewees who defined their work at the university as mainly or completely individual, and contrary to their female counterparts, few of them considered it a problem. Some stated that they ended up doing research individually by conscious decision. Some male interviewees described their research as predominantly individual work, even though it was obvious from their narratives that they collaborated frequently with their colleagues. This was especially the case with male stayers, who rarely commented on individual work in a negative sense, but rather assumed it to be the traditional way of doing science.

> *Interviewer: Would you say that your own work is more individual or teamwork, or is it both?*
> *There's some teamwork involved, but mainly it's this traditional solitary toiling of a university researcher. My field of research is, after all, a pretty small part of this division.* (P223/MS)

The question of teamwork is closely related to the issues of workplace atmosphere and collegial relationships, which are discussed below.

2.5.2 Workplace atmosphere

The issues of the workplace atmosphere proved to be of great importance in terms of the interviewees' well-being and happiness at work. There were a few cases in which young researchers had faced such difficult problems with their supervisors that they felt that the only option was to leave the university. In general, though, both leavers and stayers indicated that they were satisfied with their colleagues and with the working atmosphere at the university. The interview data call forth some detailed observations.

Problems in the workplace atmosphere were mostly reported by male interviewees. They had both personal and second-hand experiences in power-play, intrigues and communication problems in academia. Despite these experiences, male leavers often depicted their relationships with ex-colleagues as being close and supportive. Some of them still had contacts with their ex-colleagues, even after several years.

> *It [the workplace atmosphere] was rather open and _ people who worked there were nice and friendly and _ they were quite nice, yes. What I most _ well, I can't say what I miss most of it but it felt like _. A good thing that I left behind were the colleagues.*
> *Interviewer: Yes. Yes. What was best about them?*
> *I don't know. It was just the good group dynamics that we had and good atmosphere and _ it was nice to work there.* (P220/ML)

Male stayers, by contrast, mostly described their colleagues as distant, albeit tolerant and friendly. They less frequently referred to their colleagues as friends and often emphasised that only work-related matters were discussed at work.

> *Interviewer: What is the best thing about your colleagues and what is the worst?*
> *The best thing maybe is how they are quite down-to-earth, and normal. People who can discuss things other than theories. I like this about them. That they are present as real human beings. That's the best.*
> *Interviewer: Ok. What is worst about them? Or negative?*
> *Well, maybe you could think, these aren't the same people, it is the flipside of the above, but there are some people who are so tied to their profession that they seem to be missing all humanity. So it is purely factual. So let's say it like this. There is a number of colleagues with whom you can't make personal contact. Let's say it like that.* (P203/MS)

Female interviewees also reported on inter-personal problems in their university departments, but they generally distanced themselves from these problems. Both female stayers and leavers talked about their colleagues in a positive way and emphasised their close collegial relationships, good team spirit and the sense of belonging to their working com-

munity. These accounts are qualitatively similar to those of male leavers but rather different from those of male stayers.

> *Interviewer: That's nice to hear. How about your colleagues or working mates here, what is the best thing you can say about them?*
> *I think the best thing I can say is that they are all friends, that they are also friends, I mean we will go out for a glass of wine or beer together every now and then, and then we have parties here, we actually do party and have a good time together, everybody is sitting in their corner and eating their chips so I think probably the best thing is that we are friends.* (P215/FS)

2.5.3 Gender discrimination and sexual harassment

The natural sciences often are defined as objective, neutral and genderless; being male or female is considered irrelevant from the point of view of research (Traweek 1988). Especially the young male interviewees confirmed this view by emphasising the objective, tolerant and gender-neutral atmosphere of their working communities. However, at the same time, some male leavers admitted that their ex-working community was rather masculine, even exclusively. Even so, they generally considered success in an academic career to be dependent on personality, not on gender.

> *I think, yes, it is very democratic. I feel that, no, gender doesn't matter. And that you're measured more according to your factual achievements. And I could describe that as more a boring, in a way, environment… So in many other fields, in humanistic subjects, there has been female studies, and now even male studies. And here we are in the natural sciences. So here we don't have a word for male or female, it isn't part of our vocabulary.* (P203/MS)

However, some of the older generation male interviewees who had started their careers in the 1960s and 1970s indicated that physics was a very masculine environment in those decades and even hostile to women. They believed that it would have been more difficult for them to make a career

in physics had they been women. Their point was to show the difference between the past and the present situations in academia.

The female interviewees were also more likely to define academic working community and physics as gender neutral, yet women with children were especially aware of the problems connected with pregnancy and maternity leave in an academic working environment. Many of them assumed that taking maternity leave would not have been viewed positively in their university departments and that young women would therefore be discriminated against in recruitment situations. One of the interviewees had also faced financial problems when taking maternity leave while she was working on a research grant. Because the Finnish maternity benefit is paid on an income-related basis and personal research grants are classified as non-taxed income, a researcher working on a grant is equivalent to an unemployed person and thus entitled only to a minimum maternity benefit. This problem has recently been acknowledged at the political level and will probably be resolved in the near future (Ministry of Labour, webpage).

In some of the female interviews, gender neutrality actually involved playing down one's femininity (Gherardi 2001, 254). In many cases, female physicists indicated that they had adopted a male way of behaving in the workplace. Some female leavers even defined their role in their former working place as being 'one of the guys'.

> *It was really funny situation, he said it _ and after he'd said it he realized _ because that illustrates my position there, my role, because I was so neutral. He didn't even perceive me as woman, I was a good guy. He could say something like that to me, about not accepting women in his team, and only then he realized he was talking to me, a woman. He didn't perceive me as a woman. It was _ it's hard to explain.*
> *Interviewer: Why do you think you were so neutral?*
> *I don't know, I guess because he'd known me for a long time, I'd gained some appreciation. So he could take it. I don't know what it was about.* (P218/FL)

The extract above implies that being male is the norm that has to be met in order to be respected and to function adequately in the scientific community. The male way of behaving is represented as the norm, while

femininity is an attribute to be overcome in order to belong to the group. In these narratives, gender difference is minimised, but it involves simulating masculine behaviour or adapting to the male position, for instance, when jokes were told about women.

In some of the female interviews, gender difference was all but invisible. The women indicated that it is important to take their place as women and draw the line when interacting with their male colleagues by preventing male patronising and sexual harassment with self-assertiveness and 'loudness'.

> *I think that those women who stay on this field are rather self-assertive people [laughter]. They know their place and _ won't put up with indecent behaviour… I suppose you have to have a certain mindset already when you – since it is known that this place is like that.* (P235/FS)

In these cases, gender difference was perceived as embedded in the professional relationships, but it was also seen as the responsibility of the women to maintain the border. Men were represented as rather uncontrolled and irresponsible subjects when it came to interaction with women. Also women who actually had been subjected to sexual harassment tended to emphasise their own agency when fighting against harassment.

Sexual harassment was a theme that, rather unsurprisingly, divided the female and male interviewees rather strongly. The vast majority of female interviewees either had experienced sexual harassment or could relate second-hand experiences. In the cases reported, the harassment was verbal by nature; the interviewees had also been harassed by their male colleagues through e-mail and on the telephone. In most cases, the harasser was the interviewee's close colleague or supervisor, which did not make matters easier for the harassed women. When accounting for the cases where they had been harassed, the interviewees sometimes accepted part of the responsibility, assuming that the harasser had misinterpreted their messages, etc. In these narratives, harassment was represented as part of collegial relationships – neither acceptable nor fatal in terms of workplace interaction.

> *Well, for instance, when I've been in a workshop for a week, with other people from here. When they got enough to drink, I got all sorts of*

> *propositions [laughs]. But of course if you don't _. I don't know. I haven't taken it that seriously. Or taken it anywhere. But somebody might be bothered by it. I can, maybe, take stuff like that a bit more then some.*
> Interviewer: *What have you done in those situations?*
> *Well, I've _. What have I done. I'm kind of _ quick-tempered [laughs], I've probably snapped at them. It's not _ that stuff is never talked about afterwards.* (P206/FS)

The male interviewees rarely reported sexual harassment and those who could give examples emphasised that this was not the case in their own division but somewhere else in the university. However, many male interviewees mentioned that humour in the workplace was sometimes rude, which may have insulted some. The interviewees thus confirmed the idea that talk can also be interpreted as sexual harassment, but in general they saw workplace jokes as harmless. It is also worth remarking that some of the younger female interviewees mentioned that they could take bold humour and could thus adapt to the male working environment. Bold humour and rude jokes were considered a natural part of the social interaction in physics institutions, while being insulted by such jokes was not.

To conclude, from the interview data it is obvious that male and female physicists had rather different conceptions of the workplace realities in terms of teamwork and atmosphere. For female interviewees, teamwork and collegial relationships played central roles when assessing the workplace environment, whereas male interviewees seemed to be less affected by the lack of group work. Many of the male stayers also indicated that their collegial relationships were rather distant and formal. A pronounced gender difference in the interview data could be identified in terms of gender discrimination and sexual harassment. Even though male interviewees were, at some level, conscious of physics as a masculine environment, most still could not identify gender discrimination and sexual harassment in their immediate work settings. At the same time, female physicists largely adapted to the male-dominated environment either by simulating male social behaviour (i.e., being able to take bold humour) or maintaining the border and regulating men's behaviour. Even in cases of severe border transgressions

like sexual harassment, female interviewees tended to understand, while not accepting this male behaviour. This analysis gives a rather gloomy and stable picture of physics institutes as workplace environments. However, some of the scientists indicated that the growing number of women entering physics institutions might result in a new type of collegiality and changes to the masculine social environment. In the words of one of the female physicists:

> *It could be that because there are so few women, they think they are alone with something like this, they're ashamed and don't want to talk about it to anyone. But when there are more women, they start talking around the coffee table, and "wait a minute, that won't do." It could be something like that. But I think the bigger issue is that attitudes were different in old times. Some older gentlemen might still live in an old-fashioned world. But the more this gets talked about, and the university has all kinds of plans for equality, then people realise and change their behaviour*. (P209/ FS)

2.6 Career paths and future

When depicting their career paths, Finnish physicists often pointed to specific events or turning points that had affected their careers. These events were mostly connected to changes in the working environment (i.e., going abroad) or changes in family life (becoming a parent). In the following section, I will concentrate on three central points common to all the interviewees' career paths: the motivation to study physics, the decision to continue post graduate studies and pursue a Ph.D. in physics and the decision to leave physics (in the case of leavers). Moreover, I will illustrate how the stayers view their future in terms of a scientific career. Finally, I will examine an essential feature of the academic working environment which the interviewees discussed in relation to their career paths, namely, competition.

2.6.1 The motivation to choose physics as profession

When asked about their motivational background to study physics, a vast majority of the interviewees identified their experiences in high school as being a strong factor. In many cases, a good physics teacher had inspired the interviewees to study physics at university – nine female interviewees and three male interviewees mentioned teachers as having influenced their choice of career. However, there were also some interviewees (three males and two females) who said that they had decided to study physics *despite* a bad physics teacher. In both female cases, a male physics teacher had shown a chauvinistic attitude towards girls who were interested in physics. Meanwhile, a family member (father, mother, grandparent) who had training in natural sciences had had a positive influence on some of the interviewees' decisions to study physics. In these cases, the interviewees had been introduced to physics as children by their parents while looking at the stars or discussing natural phenomena. On the other hand, there was one group of interviewees (five females and five males) who indicated that their parents had no academic education and who were thus the first in their family to pursue an academic career. This kind of mobility in educational class is observed more often in natural sciences than in traditional elitist fields of study such as medicine, law and social studies (Kivinen & Rinne 1995, 101). There was also a group of interviewees (four females and twelve males) who stated that their initial interest in natural sciences and physics was intrinsic in the sense that they could not point to any one person, hobby or event that had motivated them to choose science. It is worth noting that out of this group, seven were male stayers.

When it came to the decision to pursue post-graduate studies, the interviewees either explained their choice with the so-called driftwood theory or stated that they saw no alternative to a career in academia. The utterance 'drifting' was used by many of the physicists who actually seemed to have pursued a very straightforward and logical career (P213/FL, P217/MS, P226/MS, P227/FL). However, these interviewees often said that they ended up in post-graduate studies because of proper circumstances: either they had a summer job at the department or someone offered them a Ph.D. research topic. Of these interviewees, six

were male leavers, five were female stayers, and seven were female leavers. The group of interviewees who indicated that a career in science had always been their only professional ambition consisted of three female stayers and six male stayers. Thus, there seems to be a gendered tendency in how physicists interpret their career paths. This observation is also made by social psychologist Maaret Wager, who has encountered the phenomenon of academic women often explaining their success by coincidence or good luck rather than by their own abilities (Wager 1994, 244). On the other hand, especially in the case of leaver interviewees, it is entirely possible that the decision to embark on Ph.D. studies was made for practical reasons (i.e., a job offer in a research group) rather than because of a calling to become a scientist.

2.6.2 Decision to leave an academic career

Among the physicists who had left academia, one of the central themes was the moment when they decided to quit their university career. Most of the interviewees could identify at least one reason for their choice, but often the decision to leave was a function of several factors, either in the academic working environment or in the interviewees' private lives. These factors can be grouped into two categories: factors that push individuals away from academia and factors that pull them from outside. The major push factor mentioned by nearly all leavers was connected to the lack of career options in Finnish universities. Other push factors mentioned were motivational problems, bad working atmosphere and competition within departments, low pay and insufficient supervision, poor organisation of work and lack of prestige. These factors were mentioned by both women and men, although problems connected with the working atmosphere and with competition were more often apparent in men's narratives. Factors that pulled leaver interviewees away from academia can mostly be seen as the reverse side of push factors: for both female and male interviewees, family obligations, permanent position, better pay and better career opportunities as well as more clearly defined tasks were major reasons to leave academia.

An interesting observation concerning the leavers was that despite leaving university, quite a few considered returning to academic career as a future option. Some of the interviewees had stayed in regular contact with their fields of research after leaving academia, and two Ph.D. students indicated that they planned to finish their dissertations, even while working outside their home departments. This may illustrate the relative openness of the Finnish university system, which enables part-time Ph.D. studies, for instance. On the other hand, many of the leaver interviewees were representatives of applied fields of physics where the border between academic research and industrial applications of physics is less pronounced.

In the following section, three of the major push factors – career options, pay and work motivation – are examined from the viewpoints of both leavers and stayers.

2.6.3 Career options and pay

When discussing their decision to leave academia, most of the leaver interviewees mentioned that they viewed their career options in academia as few or insufficient. The lack of permanent positions and personal career prospects within science were seen as major problems by both female and male leavers. The position structure in most physics departments was such that the majority of permanent posts for senior scientists (university lecturing and professorial posts) were occupied, and there were no openings in sight. Thus, attaining a permanent position in academia was not in the foreseeable future for most of the leaver interviewees. However, male leavers emphasised the need to advance in their careers slightly more often than female leavers, who in turn stressed the importance of having a permanent position in terms of starting or supporting a family. Both male and female leavers also mentioned the low university salaries as a major problem. They often mentioned that a physicist could easily double their salary by moving from university to industry or business. The wage gap was especially wide in the case of Ph.D. student leavers, who often had difficulties supporting their families on research grants.

The problems of the position structure and financing system in academia were also widely acknowledged by the stayer interviewees, who often mentioned these issues as major reasons that push young talented scientists to leave academia. However, the majority of them did not personally perceive fixed-term positions and the comparatively low pay as major career obstacles in academia. Even though most of the stayer interviewees did not have a permanent contract, they saw the continuity of their career in academia as rather safe. It also seemed that despite family responsibilities, most of the stayer interviewees were able to put up with the pay conditions in academia. As one of the male stayer interviewees puts it:

> *There is much more to work than money. Of course I would like more pay, who wouldn't? But the pay isn't so bad that I would need to go somewhere else for it. This is more a calling, really. So that, no one comes here to get rich, but to do interesting work.* (P212/MS)

In general, both female and male stayers were more or less satisfied with their opportunities for advancement in an academic career: many indicated that they were actually more interested in doing research than in acquiring a high professional status. Among stayer interviewees, however, there was a qualitative difference in how male and female interviewees talked about their future career options. Two female physicists indicated that it was possible or even likely that they would leave academia because research is not what they wanted to do, whereas three male interviewees saw the growing amount of administrative work (and thus the diminished time available for research) as the major threat to their careers at the university.

2.6.4 Work motivation

When describing their former work in the university, many of the leaver interviewees took up the question of the meaning of academic research in physics. In their narratives, work motivational problems arose in connection with the fact that a great part of the research conducted in universities is not directly applicable to industry or to society; further-

more, the research process itself may last many years and is thus unlimited in scope. These interviewees mostly reported that they longed for clearly defined work assignments that would have an immediate social meaning. This was the case both with female and male leavers who had made the decision to move from academic research to different types of managerial and customer service jobs or teaching. In their current professions, they saw their objectives as being more tangible and also more rewarding in terms of goal setting and feedback.

The societal impact and meaning of academic research was also widely discussed by the stayer interviewees, who often made the basic differentiation between basic research and applied research, the latter most often used to apply to environmental and materials physics. The objective of basic research was generally described as to produce knowledge and increase understanding of the world. Applied physics, for its part, was seen as serving the community through environmental research or technology. When it came to the general the importance of the interviewees' own work, an interesting gendered tendency could be observed in the data. Four female interviewees working in basic research indicated that they considered societal applications of physics research very important, especially in the fields of climate change and energy issues. Some of them thus indicated that the basic research they were conducting was perhaps not that beneficial to the rest of society.

> *Interviewer: How do you feel, how would you estimate how your research group is valued within the department?*
> *Well, that has been discussed. Well, you can imagine that at this institute where the hot topic is environmental issues, and then there is us, who are doing basic research. And then when you start to think about the realities of life, is anyone really interested in what is going on Mars, when the earth is under threat of an accelerating greenhouse effect. So there is a little bit of that. Or maybe it's just my group who thinks that we are sensing that.* (P200/FS)

Many of the male stayer interviewees commented on the meaning of basic research rather differently. Even though they admitted that the practical applications of basic research might show up only later, they could attribute a deeply personal, one could even say self-contained,

meaning to the research they did. One of the male Professors I interviewed expressed this meaning in the following way:

> *Of course, many times you think that this too, you could say that it is selfish, because the investment is very large… But, on the other hand, the basic research probably wouldn't exist if you didn't personally believe in what you do.* (P208/MS)

Even those male researchers whose work was very closely connected with current environmental problems considered their role primarily as scientific actors, not as public debaters. They described their work motivation as the classical scientific urge to know more and extend their own limits while doing research rather than fulfilling a societal task, for instance, in nature preservation.

> *Well _ it has been, like, more, like, research science in a classic sense. Wanting to find out things, to understand things. But I couldn't really say that it was any sort of higher thought like making the world a better place. Well, of course, in some sense my field of research is linked with environmental research. So in that way, you could say that with the Baltic Sea which is currently in a very bad condition, so those who research the Baltic Sea, one of the motivating factors behind it is working towards saving a common body of water. But the primary is this classic search for knowledge.* (P225/MS)

Such observations, though limited in quantity, might point to two different groups of interviewees. The first group consists of researchers whose work orientation is practical and societal. Their motivational problems in the academic context were mostly connected with the vague or non-existent relationship of research to concrete applications. As seen above, representatives of this group were physicists who had left academia and some of the female stayers. The second group consists of male stayers whose orientation can be said to be more epistemic than practical (cf. Miettinen 2005, 59). Their work motivation is mainly generated by the need to create new scientific knowledge about the object of their research. They thus defined the meaning and importance of their work primarily in the context of science and secondarily in the context of society as a whole.

Unlike the first group of interviewees, these scientists did not indicate that they suffered from motivational problems, even if the results of their research could not be directly applied to praxis. In terms of work orientation, they seemed to be well adjusted to the traditional ideal of free and uninterested academic research.

2.6.5 Competition

Academia in Finland is often considered a competitive working environment, in which talented individuals compete for scarce financial resources and positions. When asked about competition in their working career, however, female and male interviewees came up with rather different answers. Female interviewees often mentioned that the competition was generally fierce in academia, but they found it hard to point out competitive events in their own careers. Nearly all the female interviewees (eight leavers and eight stayers) said that competition had had little or no influence on their academic careers. Interestingly, some female interviewees indicated that they had stayed out of the competition because they did not want to compete; some interviewees also stated that their non-patricipation in competing gave their colleagues' access to financial resources. There were also female interviewees who defined competition as a predominantly male issue and assumed that competition is harder for male physicists than for their female colleagues.

> *I don't know if maybe their [men's] fight is bloodier [laughs]. About who's smarter. It seems sometimes that they're trying so hard to be something super-intelligent. Some of them at least. A huge need to prove themselves to the younger ones.*
> *Interviewer: So women don't necessarily do that?*
> *Maybe some do. I don't.* (P205/FL)

Male interviewees, on the contrary, revealed a very different perception of competition. Five male leavers and seven male stayers stated that there was a lot of competition in academia, and most of them were of the opinion that competition had affected their personal career paths. Competition was generally seen as inherent in the academic world, both

in a positive and in a negative sense. Competition was seen as a career booster that motivated both individual researchers and research groups to maximise their efforts when doing science.

> *Interviewer: Do you think that competition has had an effect on your career, or will have?*
> *I'm sure it has had an effect, because when you want to become a graduate student, you need good grades, apparently it's good to be at the top of the list so you get to choose where you go. In that sense there is competition.*
> *Interviewer: So how has this fact affected your career, or, were you so good that you got to choose _.*
> *Well, pretty much, but _ In any case, you felt back then that there was competition. So in that sense it has affected, maybe it motivates you even more when there is competition.* (P204/MS)

Competition inside academia and between research groups had also affected some male interviewees' careers negatively, both at formal and informal levels. Male leavers often said that they got tired of the on-going competition for scarce resources. In one case, a male interviewee had to leave academia because there were no longer any jobs available in his department. Competition in academia was also seen as childish play with humorous aspects, as the example given by one of the male stayers showed:

> *In Finland, if you earn more than what is the norm, it is a terrible thing. And once when I came from abroad, I brought a brand new car to the department and parked it there. And after that a friend of mine said that it was a very foolish thing to do. That he drives an old, ancient Golf, but his friendships do work. And this also connects to the male-dominated framework that we work in. This is definitely a competition. Which is measured with such concrete things as that. It is, it is like, like a sandbox with toys- And it isn't necessarily, the research evaluation side isn't always about what is being examined but –.* (P208/MS)

The interviewees' comments thus show a gendered tendency in how individuals position themselves in the context of academic competition: female physicists generally had little or no personal experiences of competition in their careers, whereas male physicists clearly recognised

competitive situations in their professional trajectories. It thus can be stated that the female interviewees opted out of the competition, at least on a narrative level, whereas male interviewees perceived the idea of competition as being more natural and even positive. On the other hand, there were male interviewees whose careers had been negatively affected by competition. It can be concluded that male physicists participate in the ongoing competition in the academic world more consciously than their female counterparts, where the possibility both of advancing one's career and the risk of losing the competition are played out. Keeping away from most competitive situations, female physicists on the one hand play it safe career-wise, but on the other hand may in some cases be hindered from advancing up the academic hierarchy.

To conclude, there seemed to be rather few gender differences in the Finnish physicists' career paths. The structural problems of Finnish academia (low pay, lack of career options, lack of permanent positions) seemed to affect male and female physicists' careers similarly, but there was a difference between stayer and leaver interviewees as to how to put up with the circumstances. With the outer working conditions being more or less the same for everyone, some gender differences could be identified in intra-personal issues, such as motivational factors and work orientation. In terms of competition at work, female physicists proved to be rather unaware of the competitive situations in their careers and unwilling to enter the competition. Male physicists, by contrast, accepted competition as an integral part of academic work with both positive and negative implications and can thus be said to be better adapted to the practice of advancing a career in academia.

2.3 Conclusions

The Finnish interview data indicate that male and female physicists not only discuss certain aspects of their careers differently, but also are affected differently by certain social practices at work and in their private lives. These practices, also called gendered processes, may contribute to the fact that male and female physicists tend to follow different

career paths. In the interviews with Finnish physicists, the clearest gendered processes could be identified at the levels of division of work, workplace interaction and identity formation.

According to the Finnish interview data, a family seems to intrude on female physicists working lives in terms of time available for work and their mobility, whereas in the case of male physicists, work is more bound to intrude on family life. The gendered division of work in families can be said, not surprisingly, to be one of the major factors contributing to the fact that many female physicists either move away from academia or modify their academic ambitions to fit their families' needs. Moreover, the division of work within university departments may produce gender differences in physicists' careers. The interview data, though limited in quantity, suggest that male physicists prefer research over administrative tasks and may thus be more likely to pursue a purely scientific career. Some female physicists, for their part, seemed to be more willing to take care of administrative and managerial tasks in the department, which may lead to another type of career path with fewer academic merits.

The most visible examples of gender difference in the Finnish interview data can be found in workplace interactions. In general, female interviewees expressed more positive attitudes towards teamwork and collegial interaction than male interviewees. Meanwhile, discrimination based on gender and sexual harassment seemed to concern female physicists much more than their male counterparts. Male standards of behaviour are largely accepted as the social code in university departments, and it is left to the women to adapt to this norm or to control the men's behaviour in cases of sexual harassment. These tacit rules of behaviour, often misleadingly interpreted as indicators of gender neutrality at work, may in fact result in the marginalisation of feminine modes of interaction in physicists' working communities.

In general, male interviewees seemed to be more concerned with the inner boundaries and hierarchies of physics than their female counterparts. On the other hand, it seemed to be easier for male physicists to find points of identification and role models within their circle of colleagues. Meanwhile, male interviewees viewed competition as a natural part of their work, with both positive and negative implications,

whereas female interviewees rarely recognised competitive situations in their own career paths or else deliberately avoided competition. It can be concluded that in physics, gender difference is also produced on the level of identity formation as hierarchies, power structures and ideal types of a scientist are mostly recognised and reproduced by the male physicists. Female physicists seem to stay out of these discussions to a large extent, which in turn may make them freer to cross disciplinary boundaries in their careers. However, by opting out of competition at work, female physicists may in some cases lose the option to advance in the academic hierarchy.

When considering the differences between stayer and leaver interviewees, some general observations can be made. Leaver interviewees seemed to be less satisfied with the working conditions in academia than stayers; many of them preferred the job security, the good pay and the wider career options available outside the university. Most leavers also indicated that their work orientation was pragmatic and societal rather than epistemic. The same type of work orientation was expressed by some female stayers, whereas male stayers seemed to be motivated by the epistemic goals of research.

Even though the emphasis in this report has been on determining the different ways of producing gender difference in scientific work settings, it must be concluded that women and men in the Finnish interview material do not form any monolithic groups. Indeed, differences can be identified within these groups. Female interviewees without children seemed to be more willing to invest time in their careers than female interviewees with children. On the other hand, there were male interviewees who decided to leave academia because of problems in reconciling work and family. In this respect, these male interviewees resembled female interviewees rather than male stayer interviewees, who were less bound to compromise their careers for family reasons. These observations suggest that further research on different femininities and masculinities (Connell 2005, 76) in science is needed.

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Appendix

Table 1. Finnish interviewees according to age group

Age	29–39	40–49	50–59
Female	11	5	2
Male	12	2	4

Table 2. Finnish interviewees' academic degree and status as a university employee

Academic degree / Status	Ph.D. student	Ph.D.	Docent or Reader	Professor	Currently employed at university	Left university
Female	4	10	2	2	9	9
Male	5	7	4	2	9	9

Table 3. Finnish Stayer interviewees' working position

Position	Ph.D. student	Post-doctorate researcher	Senior researcher	University lecturer	Pro-fessor	Technical, Administra-tive
Female	2	2	2	–	2	1
Male	2	2	–	2	2	1

Table 4. Finnish leaver interviewees' current employment

Current employment	Research and Development	Manage-ment	Teaching	Other
Female	4	3	2	–
Male	5	2	1	1

Table 5. Finnish interviewees' parental status

	Female Stayers	Male Stayers	Female Leavers	Male Leavers
Has children	4	5	7	7
No children	5	4	2	2

UPGEM National Report
Italy

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1. The research

The '*leaky pipeline'* is the metaphor which scholars use to describe the large numbers of highly-qualified female scientists who leave the research system prematurely, whereas the '*glass ceiling'* is the one used to explain the fact that women who stay – in all types of organizations, academia included – seldom reach top level positions compared with their male colleagues (Alper 1993, Osborn 2000, SHE Figures 2003, Hasse 2002). These situations can be found in different organizations, but they are most apparent when we enter hard-science research contexts, like physics.

The UPGEM research project aims at analyzing local cultural-historical processes behind the 'brain drain' of female and male physicists. Indeed, a deep understanding of the 'brain drain' and of the 'glass ceiling' can only be obtained by looking at the way they originate and the way they are maintained by the people involved in social practices that take place in specific cultural-historical contexts (e.g. a specific research institute or research group or family).

In our report we will analyze the complex phenomena mentioned above regarding Italy, taking into consideration several factors that could play a part in their development. In the end we will propose, for the benefit of politicians and academics, some measures we think could help change the status quo. With this purpose in mind, we will refer to data collected through in-depth interviews with physicists in Italy.

1.1 Complex social phenomena require complex research questions

All statistical surveys concerning the 'brain drain' of European scientists emphasised that female scientists leave the research system prematurely

in greater percentages compared to their male counterparts[1]. However the percentages of women leavers in the south of Europe, including Italy, are not as high as in the north. Moreover, the number of female students in higher education and in the early stages of their career is higher than in many countries world-wide. However, as Molinari et al. (2002,181) stressed in their publication, 'the percentage of women *among physicists* decreases very rapidly with increasing career levels; also the presence of women in positions of power is generally negligible'. In our country this trend, also called the 'glass ceiling' effect can be recognized inside all the faculties of physics in universities and inside all other public research institutes involved in physics research.

Among the factors that prejudice women's careers, Molinari et al. cite:

a) *unfair mechanisms* for the evaluation of research and teaching, and for the selection of people in governing bodies and positions of power (the latter called by the authors the "mechanism of the old boys' network");
b) the *comparatively late age*[2] of access to the first step in their careers and permanent positions do not help women who would like to have children, since maternity can affect the possibility to compete and is sometimes felt as an alternative to a career by young women physicists. Moreover the authors stress the fact that maternity leave is not provided for by the most common fellowships;
c) the *organization of working time and the climate* inside working contexts together with the great efforts required of all people involved in research activities;
d) very *few female role models* achieving success in physics have a 'normal' life, i.e. with friends, families and other interests in addition to work. Molinari et al. (2000)

An interesting study concerning female researchers' career paths inside public research institutes in Italy (Palomba, 2000) showed the 'glass

[1] We refer to the following surveys by the European Commission: ETAN Report 2001, SHE Figures 2003 and 2006, and those by the American Institute of Physics: Women Physicists speak 2001 and Women Physicists speak again 2006.
[2] When they are around 35–40 years old.

ceiling' effect is present in all the institutes and calculated that the simple fact of being a woman halves the chances of winning a competitive examination, all other conditions concerning seniority, discipline and the number of publications being equal (see also ISTAT, 2001). Palomba (2000) suggested that the following factors taken together could explain the 'glass ceiling' effect in Italy.

1. *Gender asymmetry in families*: in Italy, women are expected to take care of their family (children and ageing parents) and of their home more than men, hence the need to manage the life of their families determines more absences from work, fewer opportunities to take part in conferences, and difficulties in being part of international scientific networks. It is not easy for female researchers to combine their highly demanding job with their families, and hence it is hard to climb the career ladder.
2. *Gender and publications*: several studies revealed that women publish fewer articles than men and we know that publications are of great importance for a career in research. This trend has been explained by the greater involvement of women in their family lives. However, Litido (2000, 83) stressed the fact that differences in the number of publications can be found not in all research fields but only in some, while the variability in the publishing activities of scientific researchers can be better explained by taking into consideration factors such as who is responsible for a research group (mainly men in Italian research institutes), and in which discipline research is done.
3. *Old boys' network:* several studies emphasized the importance of informal networks created by men both at work and outside their working hours, because these have positive impacts on the careers of their members. Moreover, Palomba (2000, 172) stated that in Italy belonging to the right networks and groups is one of the most important factors for those wanting to climb the career ladder. Since the higher positions in the hierarchies of research institutes are mainly male-dominated, as are the examining boards of competitive examinations, male researchers belonging to the right networks are at an advantage to the detriment of females.

4. *Working styles*: following on from this, there is a difference in working styles between females and males: the former are considered more oriented towards activities carried out inside research institutes, which do not put them in the public eye as much as those carried out by males outside institutes, like conferences, meetings and so on.

Physics institutes were part of the research institutes analyzed in the study mentioned above, and even though the *'brain drain'* was not analyzed in that study, we think that the factors the authors have given to interpret the 'glass ceiling' effect could also help to explain the *leaky pipeline* of physics institutes in Italy. Regarding the ways in which competitive examinations are organized, Palomba stressed that female researchers have been at a disadvantage due to the fact that the recruitment criterion of 'belonging to the right network' has often been adopted by examining boards (Ibid., 173), and this has discouraged and directed women away from research. Moreover, Palomba emphasised on several occasions (Ibid., 48, 51, 76, 170) the importance of collecting data through *ad hoc* studies in relation to some of those factors, such as working styles and gender asymmetry in families, that could help to understand the social phenomena of horizontal and vertical gender segregation in Italian public research institutes. In order to obtain clarifying answers, those studies could analyze researchers' *curricula vitae* and – through interviews – the social practices taking place in the contexts where researchers live and work.

As for horizontal and vertical gender segregation[3], the analysis of social practices in the specific cultural-historical contexts in which our interviewees live could allow us to discover factors that explain the 'brain drain' of physicists. *Pushing factors*, i.e. factors that play a part in "pushing" researchers out of academia, could be found by going deeply into physicists' career paths in order to analyze all the processes that either helped or hampered them in obtaining a position and moving up. As for the 'glass ceiling' effect, the pushing factors could also be found by analyzing the way physicists combine their demanding job with their private life (children, husband/wife, spare time, etc), and how they

[3] i.e. the 'glass ceiling' effect.

describe the working environment they participate in (the way they relate with their colleagues, boss, head of department, etc.).

In order to analyze the 'brain drain' of Italian physicists, we decided to conduct in-depth interviews with physicists who work in academia and in public research institutes, who we called *stayers*, and with those who have left, called *leavers*. Through the interviews we wanted to answer the following research questions:

Could we find any pushing factors that compared the stayers with the leavers concerning:

- **career paths**
- narratives about the way they **combine family and work**
- narratives about their **working environment**
- opinions about the **identity and the stereotypes of the physicist**
- **visions of the future**

Furthermore, in order to understand the part gender issues could play both in the 'brain drain' and the 'glass ceiling' effects, the analysis of our interviewees' narratives will be made on both the gender and the stayer-leaver axes. Hence the broad research question we want to answer while reading the interviews is: what kind of information can be found by comparing **women**'s accounts and histories with those of **men**?

The seven themes that UPGEM partners decided to discuss in their reports are: changes in universities from 1960 to the present, career paths, the workplace environment, family, mobility, identity and the future. Our own five research questions highlight the five main issues we decided to analyze in depth in the report concerning the Italian context: university changes and mobility will be treated as sub-themes since they carry less weight in explaining why Italian researchers leave physics.

1.2 The theoretical framework: cultural psychology and gender

During the interviews our informants gave us their accounts of their personal and professional life and they re-constructed episodes and

actions in the socio-cultural and historical contexts they had lived in. In our conversations they gave meanings to these episodes and interpreted them by using all the cultural meanings and models (Holland & Cole, 1995) they had learnt to use when taking part in social practices in different cultural settings, such as their workplace environment, their family, their nation and so forth.

As *socio-cultural psychologists* we agree with Bruner that "to understand man you must understand how his experiences and his acts are shaped by his intentional states (…) the form of these intentional states is realized only through participation of the *symbolic systems of the culture*. Indeed, the very shape of our lives – the rough and perpetually changing draft of our autobiography that we carry in our minds – is understandable to ourselves and to others only by virtue of those cultural systems of interpretation (…). It is culture (…) that gives meaning to action by situating its underlying intentional states in an interpretative system. It does this by imposing the patterns inherent in the culture's symbolic systems – its language and discourse modes, the forms of logical and narrative explication, and the patterns of mutually dependent communal life" (Bruner, 1990, 33).

This is why for Bruner a "cultural psychology, almost by definition, will not be preoccupied with 'behaviour' but with 'action', its intentionally based counterpart, and more specifically, with *situated action* – action situated in a cultural setting, and in the mutually interacting intentional states of the participants" (Ibid., 20).

Socio-cultural psychologists conceive *gender* as a social construct, not as an attribute residing in one's personality, or traits that determine gendered roles and actions. Gender does not exist in persons but in transactions: we do, we perform gender while we talk and act (Gherardi & Poggio, 2001; West & Zimmerman, 1987). In this perspective Crawford and Chaffin (1987) stress that gender is a salient social and cognitive means – hence a specific cultural model – through which people filter and selectively process information they obtain during everyday interactions and situated actions, to act upon differently to produce self-fulfilling prophecies about women and men.

In our research we aimed at analyzing the ways gendered cultural models influenced our interviewees' lives and choices, and to do so we

referred to Crawford and Chaffin's theoretical model concerning the *gender system* (Ibid.).

Considering gender a social construct as well as a social and cognitive means, the authors looked upon gender as a social system for organizing relations of power and status which works on three levels – socio-cultural, interactional and individual – to produce and maintain itself.

On the *socio-cultural/structural level* gender functions as a system of *power relations***,** because gender ideologies (which we consider gendered cultural models) are disseminated and reproduced through the representation of gender stereotypes in the mass media, patriarchal structures of family and religion, the structuring of the workplace around gender inequality, etc. Crawford and Chaffin underline that a person who holds a position of power within academic disciplines participates in the social construction of gender through rhetorical practices, publication policies, theoretical bias, etc. On the *interpersonal level* gender functions as a *cue*, since people treated differently in ordinary everyday interactions come to behave differently in their turn. At this level, researchers look at how people enact, negotiate and recreate gender. On the *individual level* gender is considered as *masculinity* and *femininity*, because people come to accept gender distinctions that are visible on a structural level and enacted on an interpersonal level as part of their self-concept. They ascribe to themselves the traits, behaviours and roles that are the norm for people of their sex within their culture (Ibid., 82–95).

The attention of socio-cultural psychologists (Crawford & Chaffin, 1987; Caplan & Caplan, 1987; Unger, 1979) has always been directed towards complex socio-cultural factors in seeking to explain observed differences between the cognitive performance of women and men.

For us it is of great importance to take into consideration the peculiarities (not necessarily the differences) in the accounts of our female interviewees compared to those of the males, how their decisions, for example, concerning their careers and their family lives (which from a theoretical point of view can be considered as a personal level) have been influenced by gendered cultural models which function at the structural and interpersonal levels.

1.3 Sampling

We interviewed 59 people in all, 32 of them perform research (stayers) and 27 had left physics (leavers). Interviews were conducted from April 2006 until September 2007. Interviewees either do or did perform research in the following research contexts:

- University Sapienza of Rome
- University of Udine
- University of Trieste
- University Federico II of Naples
- SISSA (International School for Advanced Studies) in Trieste
- INGV (National Institute of Geophysics and Vulcanology) in Rome
- INAF-IASF (National Institute of Astrophysics) in Rome
- INFN (National Institute of Nuclear Physics) in Rome, Frascati, Bari and Torino
- CNRS (National Scientific Reserch Center)
- CEA (Commissariat à l'Énergie Atomic – The French Atomic Energy Commission)

There is a combination of experimental research and theoretical research in the following fields: astrophysics, cosmology, geophysics, high energy physics, biophysics, didactics of physics, physics of matter, solid-state physics.

The sampling procedure was quite complex, as was the interview process[4].

[4] We contacted the stayers by e-mail and by telephone; concerning the leavers, we procured their telephone numbers and e-mail addresses from the stayers they had worked with before leaving. None of the people we contacted refused to be interviewed; rather, our biggest problem was to find leavers, since often the stayers who knew them did not keep their e-mail addresses or their telephone numbers. We conducted the interviews in the stayers' offices, and in all the places where leavers agreed to meet us: in our office at the Faculty of Psychology 2 in Rome, at their homes, or in external locations. Despite the difficulties in carrying out some of those interviews in public places, we gave priority to suiting leavers' needs, for example, meeting them close to the place where they worked when this place was far from our offices, to preparing an appropriate atmosphere for the interview.

Tables in the Appendix show the age of Italian informants, stayers' positions[5] and leavers' new jobs from a gender perspective. Table 3 shows that 17 out of 25 leavers had changed their job; they had decided to work outside academia, whereas 8 out of 25 had decided to leave Italy and to do research abroad. Table 4 shows the new positions held by researchers who are abroad.

Many renowned scientists leave Italy to conduct research abroad for several reasons. Even though this would be labelled as 'mobility' by the European Commission, for Italy it is very important to understand in depth why many brilliant Italian physicists decide to go abroad and seldom come back. Actually, for Italian researchers, going abroad is not a free choice made in order to improve their curricula and to have better career options when they decide to come back, as happens in other European states. Instead they are forced to leave because they cannot find a position inside academia, or because they find conditions for doing research in Italy unacceptable (mainly low pay, poor research funding and difficulties in climbing the career ladder); lastly, they seldom have the opportunity to return to Italy with the same conditions they had abroad (in terms of position, pay and funding available for their research). As we will highlight in the following chapter, the term '*intellectual emigration*' would suit many Italian cases better than the '*brain drain*'.

In the Italian context many researchers work in academia without any pay, wherefore we consider them as stayers in our report. Concerning those who leave Italy to do research abroad, we decided to consider them as leavers because – as we'll explain in Chapter 2 – often their choice to work abroad is a forced one due to the bad working conditions for physicists in our country, and because it is very hard for Italian physicists – and for researchers in general – to come back and to find a job in academia after they have worked abroad for years.

In some of the research institutes where Italian physicists find a position, like the CNRS in France, there have been many positive

[5] To establish stayers' positions we referred to the type of contract they hold and to their responsibilities inside research institutes as explained in the Information box concerning University contracts that can be found in the UPGEM website.

actions in recent years for women in science; so we grasped the opportunity to interview Italian physicists who do research at CNRS in Paris, thanks to an ERASMUS scholarship won by one of our research assistants.

As we will demonstrate in the following chapters, information obtained from physicists who had moved abroad is precious, since it gives deep insight into the main differences between the Italian public research system and those abroad.

Lastly, Table 5 shows the parental status of Italian interviewees.

1.4 The interview

The interview we conducted with physicists is a semi-structured interview which allows the interviewer to ask questions without following a strict order, and to ask questions that are not planned and which the interviewer thinks could be useful in order to understand better the subject under discussion. In choosing this type of interview we aimed to investigate more closely some broad issues that could help our understanding of physicists' jobs and the 'brain drain' of female and male research physicists. The interview guide consisted of the following parts: career path, family, working environment, identity and future.

The topic of the career path is an open question in order to obtain a short autobiography of our interviewees, whereas the other questions are more specific with the aim of obtaining narratives of episodes in our interviewees' lives, other people's lives, and opinions or expectations as well.

The interview questions were decided during the UPGEM Innovation Seminar in Copenhagen: therefore the questions were first written in English and then translated into Italian. It was necessary to interview physicists in their mother tongue in order to get accurate answers and genuine thoughts, because they were allowed to think in their mother tongue and to express themselves more easily. Moreover it allowed us – as Italian speakers – to grasp deep meanings related to the Italian culture while analyzing interviews.

Each interview was tape-recorded, transcribed and translated into English: this way all information gathered could be shared with all project partners in order to compare the data and to make a cross-cultural analysis. For ethical reasons, the names of the interviewees and any other people, and any places mentioned in each interview were coded.

1.5 The data analysis

During the UPGEM mid-term seminar held at the University of Tartu, the research assistants and the project coordinator established a code-list to codify interviews translated into English through Atlas.ti, computer software for qualitative data analysis (Muhr, 2004). That code-list was used to code the interviews and compare the data for the cultural analysis that will be published later in 2008.

In order to analyze data gathered from Italian physicists, our research group made a new *code-list* (we used more codes and more specific ones). Through our new code-list we coded the interviews transcribed into Italian – which the Atlas.ti software calls Primary Documents. In this way we were able to understand all the shades of meaning frequently to be found in spoken language, which are hard to translate into a different language.

After the coding process we made *super codes*, tracing them from the broad issues we wanted to analyze in our study: career path, working environment, family, identity and future.

Subsequently we used the Atlas.ti *query tool* to analyze quotations (i.e. excerpts of interviews) coded through the super codes, which were extracted and grouped into several Primary Document families traced from physicists' positions (Full Professors/research managers, Associate Professors/principal researchers, Permanent researchers, Researchers with scholarships, Ph.D. students). The quotations grouped in this way were read in recursive ways by Italian research assistants, with the aim of analyzing the common features and differences in the interviewees' narratives (Silverman, 2005).

1.6 Summary of findings

The main *reason for leaving physics* given both by the stayers and the leavers is the lack of funding for research in Italy. Due to the low investment of the state in research, physicists have to work on short-term contracts (whose duration can even be for just a few months) for many years until they win a competitive examination and become permanent researchers, but this usually happens when they are 35 to 40 years old. Moreover, their salaries are very low and some of those who work on scholarships said that they also work some months without being paid, while waiting for the scholarship to be renewed[6]. All this is linked to the problem of class mobility and to the need for research assistants to get financial support from their parents if they want to stay on.

Because of this situation, the decision of many Italian physicists to move abroad is not a free choice in order to improve their curricula and to have better career options when they decide to come back to their country. Rather, they feel forced to leave in order to find better conditions for doing research and they are also aware that it will be hard to come back to Italy with the same conditions they had abroad. We consider these leavers 'intellectual emigrants'.

Concerning the *career path*, it is worth noting that family members, mainly male relatives, and physics teachers influenced our interviewees in choosing physics as a career, or at least as a university discipline. Moreover, it has been easier for older researchers to climb the career ladder than for younger generations: the former were employed on temporary work contracts for only a few years, whereas the latter complained about the long, stressful periods of temporary work.

When talking about their professional life, men said they were driven by ambition at the beginning of their career, whereas women's demands were 'modest' compared to those of their male colleagues.

The importance of teaching and of having good relationships with the younger generation was emphasised especially by women stayers.

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[6] The types of contracts that physicists have during their career paths are explained in the Information box concerning University contracts that can be found in the UPGEM website.

Concerning the different areas of physics, Italian interviewees stressed that the didactics of physics is considered the "Cinderella" of the discipline, and that most of the funding has been assigned to particle physics because of the low interest of politicians and businessmen towards applied physics.

All our interviewees, including leavers, irrespective of the research area and of gender, say that they liked their jobs as physicists. As far as their *workplace environment* is concerned, stayers said that they are not satisfied in terms of their working contract conditions. All interviewees insisted that the biggest problem is the competitive examinations, which are described as few in number and with little regard for meritocracy in the procedures for assigning places.

With regard to competition, Italian interviewees said that it is part of the game: they all experienced both 'good competition', which offers positive challenges, and 'keen competition' which, on the other hand, they consider to be unfruitful.

Women spoke about discrimination more than men: the main discriminating factor between men and women is domestic because the tasks related to the house and the children are mainly assigned to women. Staying away from research during maternity leave is considered as a disadvantage for women in comparison with their male counterparts, because they publish less and fall behind the men. Some women told us they felt under pressure in their research group when they decided to have a baby. Moreover most fellowships do not provide for maternity leave. Female physicists (also those on non-permanent working contracts) perceive their career as being at risk when they decide to have a baby; at the same time maternity is considered as a threat by their managers and colleagues, who believe that female physicists who are also mothers are less reliable.

Concerning the possibility of sexual harassment in the research institutes, the older interviewees related unfortunate episodes, while others said that they would be very surprised because they had never heard of such episodes. Some women in Italy feel they cannot be themselves while relating to their male colleagues, so they are forced to wear a sort of 'invisible western burka' to draw the line unequivocally.

Concerning *family*, we considered both the domestic family and the new 'family' of physicists. Parents are of great importance in Italy because they support their children when they try to enter academia and start working with temporary contracts and low salaries, and because they later compensate for the lack of day nurseries when they become grandparents.

Our interviewees said that the birth of a baby makes their lives more 'complicated', but women have to face the biggest problems. Researchers are aware that having a family will not help their career, so many young researchers decided to postpone becoming parents. Most women travel less when they become mothers, especially when the child is little. Endogamic couples are at an advantage concerning mobility compared to other types of couples. Taking leavers into consideration, we found a connection between the decision to quit research and the desire to have a family: many leavers said that it is easier for them to combine their new job with family responsibilities.

With regard to the *stereotype* of the physicist, the physicist was described as a male genius, creative and not understood, a person who 'lives in a world apart', absent-minded and shabby in appearance. Most male interviewees said that they recognize themselves in this stereotype, while most female interviewees stated that they do not.

For both women and men the *role model* was a man, mainly because so far there have been few women physicists. As for their *qualities* as a physicist, women seem to underrate themselves and underestimate what they have achieved. The qualities women admire in physicists they esteem, in addition to scientific capacities, are often human qualities, such as being faithful and reliable, whereas men, on the other hand, generally admired mental and professional abilities.

Concerning the *changes in the university*, the most quoted in the interviews is the shortage of funds allocated to research, with all the problems that ensue, and the one which concerned the interviewees most being the lack of work prospects in this sector. According to our findings, another visible change is the fall in the number of enrolments in the disciplines of physics, which is part of the consequences of the problem of funding: a career in physics does not to date promise the prospect of good, stable work. Regarding university as a formative

agency, emphasis is given to the fact that the so-called "3 plus 2" reform has lowered the level of the students' qualifications.

In *physics* in general the *great changes* reported concern the progress made regarding equipment and the dimensions of experiments, which at present can involve thousands of people, thus modifying the working dimension and the functional structure of the universities and research institutes.

As for *future expectations* regarding a career, those of the women seem to be more varied compared to those of their male colleagues: the women, in fact, often speak about the possibility of being involved in activities different from research and of having a family of their own.

In general, without an evident distinction of gender, some interviewees express the desire to continue working as researchers, whilst others would not be averse to a more managerial and administrative role in the future.

In this part of the interview, too, there re-emerges the problem of funding and remuneration, which must be increased in order to make a career in physics more attractive.

The leavers, at last, could be described as "*intellectual emigrants*" in as much as it emerges from their narratives that they often feel forced to go abroad because of the lack of career prospects in research in Italy. Like the emigrants at the beginning of the twentieth century, they nurture a strong hope to return to their home country in a not-too-distant future. Together with this hope, however, there is an acute awareness that in order to return to work in the context of Italian research, they would have to agree to worse working conditions than those in which they are carrying out research at the moment.

2. Reasons for leaving

The main question we aimed to answer through our research is: why do physicists leave research? In our interviews we approached this question from several points of view. We think that stayers' and leavers' opinions

and narratives are the main research data from which we should start reflecting upon the 'brain drain' issue in order to plan future solutions.

In the following paragraphs we will describe stayers' opinions concerning why physicists leave research and the reasons that leavers give for abandoning research or deciding to continue it abroad. However, we will dedicate the following chapters to the analysis of physicists' personal and professional lives, to highlight other possible pushing factors.

2.1 Opinions about leaving

Stayers' and leavers' opinions about reasons for leaving reveal that the main reason is the lack of funds for research and, related to this, short-term contracts, which are the only type of contract available for researchers until they are about 35 to 40 years old. The short-term contracts themselves would not be a problem except for the fact that they entail very low salaries and a short duration, sometimes just for a few months, as emphasised in the following extract:

> *(…) but it's obvious why scientists leave Italy: the salaries are so low and there's almost no chance of getting a permanent job, (...). Those who stay have to fight for jobs and to keep those jobs, and the chances of success are very low, and so people leave. Research is a fascinating field but when your salary is 1000, 1500 euro a month, when you want to get married, to have a family, do things. Once it was about travelling and seeing the world and meeting people, but not even an economist who lives in New York can have it all.* (P24/FS) [7]

After the contract expires, some researchers have to work without being paid while waiting to sign a new contract, due to the lack of funds. Other opinions about reasons for leaving are related to bad working relationships with colleagues, and especially 'certain kinds of barony' and discrimination on the part of the group coordinator who, for example 'takes possession of an article written by someone else' (P32/MS).

[7] Explanation of interview abbreviations: P stands for physicists interviewed, I for Interviewer, F for female, M for male, S for stayer, L for leaver.

The following extracts stress that it is important to be part of a research group where the manager is sincere with those who have a short-term contract, because they can then plan their near future, and decide whether to stay or to leave. Often Professors do not tell young researchers that they do not have money for the future: they are not sincere about the financial situation of their research group.

> *(…) Whenever the research group has some problems with money, I am warned that something is not right; and this is very important. I can see around me that other managers don't follow this policy; so what happens is that maybe those who have already got a contract, after a month do not know whether it will be renewed. Then, here we are talking about people with temporary contracts who may even be middle-aged, with a family and children; so one should feel responsible, I'm not saying for a contract renewal, but responsible for being sincere when it has to do with seeing problems that do exist.* (P21/FS)

To 'avoid' financial problems one must be a member of the 'right' research group: a group with a politically powerful manager who should not be close to retirement, otherwise they might not be interested enough to find research funds or Ph.D. positions.

Why Professors do not speak frankly to their research fellows about their group's financial situation and that of physics research in general? And why, as several interviewees told us, do they try to keep their research fellows, even though they know it will be hard to pay them in the near future? The answer may be found in the following extract:

> *In the (Italian) field of physics it is considered normal not to know whether, how much and how you will be paid (...) This is considered part of the efforts you have to make; you are expected to rise through the ranks (...) if you want to be taken on, you have to do your best and show your skills and abilities, like I did. (...) It's necessary to make many sacrifices for a long time in order to demonstrate that you are indispensable and the others cannot do without you. Of course, some people may not accept these conditions, because they don't want to sacrifice their private life. (…) So the lack of job security requires sacrifices and efforts, because when you work on a short-term contract (…) you have to be ready all the time to make your skills available.* (P13/MS)

The interviewee says that academia thinks it is ‘normal’, it is ‘part of the efforts you have to make not to know whether, how much and how you will be paid’, because you are expected ‘to rise through the ranks’. This means that those who have short-term contracts have to demonstrate that their work is ‘essential and necessary for the research group’, so that the manager will make efforts to find money to pay them. In the end this means that they have to sacrifice their private life and this is something that could drive people away from university. It seems that the research system as a whole pretends to ignore the economic aspects concerning its functioning.

Coming back to reasons for leaving, stayers said that some people decided to leave because they gave priority to their family, and low salaries and heavy workloads were hard to combine with this priority; those who are sure that a family is their priority leave quite early, at least after their Ph.D.

Some interviewees emphasised that because of compromises that women often have to make between their job and their family, a woman’s career is delayed and sometimes they give up:

> *Women also have to deal with the fact that if you want to make a career out of this job you need to be there all the time (…) This job requires a constant presence, not only physical but also mental and that, well, you are almost never allowed a break from work, you know you're always involved and so if you have a family this could be a problem you know, for women. (…) The truth is, in fact, that there aren't many woman researchers in my field and those few are either elderly or they don't have a family or if they do have a family they have either few children or no children at all.* (P25/FL)

As we will analyze in Chapter 5, all interviewees talked about heavy workloads and how hard it was for them to come to compromises between work and the family. None of them suggested any change in their working context, to improve it and make it more family friendly: it seems they perceive it as being unchangeable.

A great deal of the answers physicists gave us emphasised the importance of having parents who could help young researchers both at

the beginning of their careers, because of the low salary, and later when they have children, since public services are not good enough. This is another issue we will highlight in the Chapter 5, about the family. This raises the question of class mobility since in Italy working at university has been a privilege for wealthy people from the very start of academia, and our data show that this is still true. An example is the following extract from an interview with an Italian physicist who works in France:

You might be a victim of a social selection in physics, because if you don't have a family supporting you when you don't have a contract or a scholarship and you really need some money, you have to change your job. (P41/ML)

2.2 Reasons for leaving Italian academia

Many of our leavers' narratives made us realize that usually more than one factor played a role in driving them away from research. In addition to the lack of job opportunities inside academia, several leavers, both women and men, emphasised that they did not like the strong competition in physics and the huge sacrifices they were required to make in terms of their private life, like travelling abroad: in other words, they did not accept the fact that they had 'to pursue research as the main aim of life' (P49/FL).

Leavers also stressed the importance of having economic support from parents, especially in order to have the opportunity to stay and have a family; in other words, they emphasised the importance of the class mobility issue for those who want to start a career in Italian academia:

> *(...) I wanted to have a family, I wanted to take a path that I needed at some point. Some people need it less because they might have a better economic situation, or some might decide that this is the right way, and obviously without obligations or other things that should be considered, it is possible to resist and to follow this passion. And this is the right way, because I admire these people in a sense, you see? I did not have this courage because at some point I thought "I want to get married, I*

> *want to have a life, let's say like everybody else, so I can't go on working without pay hoping that sooner or later something will change". Some people can afford this though*. (P27/ML)

On the other hand, the following extract supports the importance stressed by stayers of working with a powerful Professor, usually a full Professor, to have more job opportunities, hence more chances of staying:

> *I mean I would have preferred to stay there. I tried to do a Ph.D., the problem was, when I graduated Professor xx was about to retire, I mean he was, let's say, about to leave, and so he told me straightforwardly that he had no, let's say, power to, political as well, to obtain a Ph.D. position for me, because unfortunately it was rather a political question (...) He said to me: "Look: try to refer to xx" this other professor, my professor told me: "Even unpaid, you go there once a week anyway, show up, do something!" In the end he made me dust the dissertations.*
> *Interviewer: Are you joking?*
> *No. It's true! (laughs) Making coffee (laughs), all things like that. I wasn't one of his human resources, let's say, in quotes, 'I did not graduate with him,' let's say, it was already a favour that he let me be in his lab, you see what I mean? Hoping that one day he would offer me something, you know?* (P28/FL)

As we will point out in Chapter 4, concerning the workplace environment, competitive examinations for Ph.D. positions (and other types of positions inside academia) described by our interviewees are not based on merit, because usually the more powerful Professors decide to give positions to research assistants who have been working with them for a longer period compared to newcomers. This is an informal practice, since in Italian university regulations it is stated that people who win the competitive examinations have the right to attend the Ph.D. courses. Moreover, this has been described by our interviewees as a widespread practice in our public research institutes and it has been a pushing factor for some leavers. What is interesting for us, at this stage of the report, is to stress that the interviewee does not challenge this informal practice, and this could help to understand why the practice has been perpetuated inside academia for years:

> *(...) In the end it lasted a couple of months, because at the same time I was about to get married, so I put my CV on the Internet and sent it to various big companies (...). Before signing a contract, which was permanent, by the way, so it was a good contract (...) I went to talk openly about it with the professor. I told him that I would be happy to make sacrifices, and to wait some time if he could guarantee me a Ph.D. and he pretended not to understand and said: – Well, this job is great, it's a great opportunity, congratulations, good luck with your job in zz! (laughs)* (P28/FL)

We do think it is important in this report to explore the options that physicists who think about leaving have in Italy. One might think that an option for someone who does not want to abandon research is to try to find a job in a different research institute. From what our interviewees say, it seems to be very hard to find a position in another research centre because, as one interviewee explained, 'you find yourself in a line, behind all these people with temporary contracts that are already there: you've got to make yourself known' (P20/FS). She meant that a physicist might start working and waiting at the end of the queue for their chance to find a permanent position, because at the new research institute they would 'meet' people who have been working in temporary positions, waiting for a job before they tried to enter. This could explain why there is no mobility between research centres, as we state in the chapter concerning career paths, which in turn raises the question of recruitment.

Another option for those who do not want to work with the job insecurity described above is to find a job teaching, and many of our interviewees told us that leavers start this new career path in the Italian educational system, especially in the high schools. However, many of them referred to this choice as "second best"; actually not all of them are happy in their new job: this raises the awkward issue (and the problem) of the genuine motivation of physics teachers at school.

In the chapter concerning the physicist's career path, we pointed out that high school teachers influenced our interviewees positively in becoming physicists. Hence it is worth noting that work motivation for physics teachers is an issue which must be handled carefully by all those interested in attracting the younger generations to the subject of physics.

We have no reason to depict the situation of physics leavers in Italy as being worse than it is. Actually we think it is very important to depict it as closely as possible to reality. What's more, as we stated in the first chapter, we consider "real" what our interviewees – both stayers and leavers – had to say about the reasons for leaving and working opportunities in general. Having said this, we may continue our journey in the Italian labour market together with the physicists.

Concerning work inside private companies, all interviewees stressed that unfortunately in Italy companies do not invest money in research, so those who leave to work in a firm know they will not do research anymore. Being aware of this and of the passion they felt for physics, several leavers described how hard it was for them to leave research, while several stayers said they preferred to do research with bad working contracts rather than to do another job, like selling, even if this would entail a better contract.

It is important to stress that those who think about abandoning research have to take their decision soon after graduation, or at least after taking a Ph.D., otherwise it will be hard to find a job in a private company because 'the mentality of a private company is quite different. They would prefer to take on a younger person, who has just graduated, as they can pay them less' (P27/ML). This is very clear in the next extract:

> *Unfortunately I graduated late and finished my Ph.D. when I was 33 years old. This means that you are becoming too old to enter the labour market and unfortunately, there is no meritocracy here in Italy. I have been told during job interviews that although I was 33 years old, I had the same experience as a new graduate. Four years of Ph.D. teach you how to be a researcher, but it is not the same thing when you walk unaided. This aspect disappointed me, because it means that things which require more energy and efforts than other jobs are not recognized outside university.* (P2/ML)

It is well known that a highly qualified researcher would expect a salary in keeping with their professional experience. Besides, they would expect to be free to take decisions and responsibilities, in other words they would be less malleable than a young graduate.

Recently several surveys revealed that in this historical period in our country young people are also offered mainly temporary jobs outside academia, and this is a big change in the Italian labour market (ISFOL, 2007; Censis, 2007). It is worth noting that in Italy people are considered "young" until they are 40 years old, hence this situation, together with the previous factors, could explain why many researchers who are about 40 years old complain that they have badly paid temporary jobs, but in the end they stay in academia.

Another option that our leavers envisage is to do research abroad, but many of them did not like this option as it entails living like a nomad, travelling around the world searching for better job opportunities, after which it will not be easy to come back to do research in Italy, as the following extract underlines:

> *(...) I know from the experience of some friends who took their Ph.D. abroad that the more you stay abroad, the more difficult it is for you to come back and find a job (…) because you are not known anymore (by Professors you worked with in Italy). If you manage to stay in Italy, then there may be a chance for you. I haven't been helped to find something in Italy: it would not have been a problem for me to move somewhere else in Italy. However, I also wanted to settle down, have my own house.* (P2/ML)

Actually it has been stressed that, besides the 'brain drain' of excellent physicists going to do research abroad, another contemporary issue that Italian academia might take into consideration in order to start a renewal process is that there is no incoming mobility of Professors and researchers from abroad. Besides the lack of funding for research, hence the temporary working contracts, a secondary explanation resides in bureaucracy, which has frequently impeded those universities that tried to attract Professors and students from abroad (Ichino, 2007).

As already stated, many leavers stressed the importance of having the opportunity to plan their private life in Italy. On the other hand, the option to do research abroad is taken into consideration by those who would like to go abroad because their partner is also a physicist:

> *(…) After these 2 years, I am looking around and looking for something, maybe abroad, as it's easier abroad, like a contract in Geneva. One person told me that if I wanted, I could go there (…) and then especially because there is my boyfriend. There are two of us and we want to do research; he is a theoretician, I am an experimenter and so I think we will move together, I mean, we will look for something, a place where they will take both of us, I mean I hope, then if it does not work out …*
> *Interviewer: And what if there was a public examination for you?*
> *Well, we'll see then, I mean, we'll consider it. Obviously if one of us manages to get a place with a contract, through an examination, the other will have to find a proper solution.* (P33/FS)

Several interviewees emphasised that physicists who have an endogamic relationship with other physicists could manage to find a good job abroad together, whereas it is far more difficult for non-endogamic couples. Moreover, abroad there are more job opportunities for physicists compared to Italy, hence physicists who are partners in an endogamic relationship both have good prospects of advancing their career abroad.

However, in the end, the above interviewee says that she and her boyfriend would stay in Italy if one of them found a permanent position as a researcher, and even though they would earn less in Italy than abroad, they would prefer to stay.

2.3 Reasons for joining foreign research institutes: 'intellectual emigrants'

All leavers who decided to do research abroad clearly said that the main reason for their decision is that if they had chosen to stay, they would have had low pay and very few would have found a permanent position before they were 35 to 40 years old, because there are few competitive examinations. None of them encountered difficulties in finding a Ph.D. place and a post-doctorate scholarship in a foreign university, whereas some of them did not win a public examination for a Ph.D. position in Italy, even though they graduated with brilliant marks (one of them was

awarded a prize by one of the most important National Research Institutes for the best thesis in cosmology).

From their narratives it is evident that universities abroad, both in Europe and in the USA, allocate huge amounts of resources for physics compared to the resources allocated to physics in Italy. Moreover, the fact that the research system rewards its scholars through open and meritocratic mechanisms could explain why it is also possible to advance in a career abroad in a way that would be unthinkable in Italy. This is what happened to a brilliant 34-year old physicist, who became a Professor in France after three post-doctorates abroad: several surveys, such as ISTAT (2001), state that in Italy he could at the most have aspired to a position as a permanent researcher. This leaver himself clearly underlines the differences between France and Italy this way:

> *(...) In Italy the situation is desperate.*
> *Interviewer: And what is the reason? I mean –.*
> *There are no jobs available in research!*
> *Interviewer: Ah!*
> *There is no funding, there is no recruitment in the field, I mean if we only take into consideration Paris xx University, they have more jobs available than in the whole of Italy: I am talking about recruitment in physics, in my discipline, in Paris xx, one single university; I know it is the biggest in France but the number of new staff is higher than the number of new staff of all Italian Universities put together in the same year, so that makes it obvious: 30% of the new staff here is Italian, in Paris xx!* (P43/ML)

The Italian Ministry of Research tried to attract Italian 'brains' back from abroad by promulgating a law for the so called 'rientro dei cervelli'[8], but unfortunately few scholars opted to come back for the reasons explained in the following account:

> *So I left for a Ph.D. and I got a chance to do it here, in Paris, in France. Then, once I finished my Ph.D., I tried to come back to Italy and the offers I got from Italy, – I had an offer from Italy, to work in zz, and*

[8] Decree 13, 26-01-2001, cf http://cervelli.cineca.it/

> *another offer to work in xx, in France, and there was absolutely no comparison from the economic point of view, so I stayed in France.*
> *Interviewer: I see.*
> *As it was definitely on much more favourable terms, so I first did a post-doc here (...) I did another post-doc in ww, in ss (abroad Italy but not in France) (...) and then I tried examinations again the following year, at the same time considering a return to Italy, thanks to the 'rientro dei cervelli' law and the maitre de conferences position here in Paris: I had both and I chose the maitre de conférences position, as returning to Italy again was poorly …*
> *Interviewer: Paid.*
> *And it was a fixed-term contract, while this is a permanent position and so that's it.* (P44/FL)

The problem of insufficient funds for research in Italy is related to poor funding for the educational system, since, as several interviewees emphasised, teachers also work on temporary contracts with low salaries, even for 15 years, without paid holidays.

These considerations raise the critical issue of poor funding allocated for science and culture in Italy, and therefore, we reluctantly add the low social recognition for science and institutions advancing culture in Italy.

To conclude the chapter about reasons for leaving, we want to stress the fact that when referring to the situation of Italian public research, the words 'brain drain' have the effect of 'sweetening the pill', of alleviating grim reality. Many of those who leave Italy to do research abroad, as affirmed by the leavers and stayers interviewed, take this decision not only because they are attracted by the better conditions they find abroad in terms of pay and research funding but also because they do not find any concrete opportunity to stay. Hence they can be considered as 'intellectual emigrants' and even though they do not go abroad feeling as desperate as the emigrants in the last century, they share with the latter the dream of returning, as we will explain in the chapter concerning the future.

3. Career paths

In the following paragraphs we will analyze physicists' personal and professional lives, to highlight other possible pushing factors in addition to those elaborated on in Chapter 2.

The first question we asked interviewees was an open question in order to tell us about their lives from when they started to be interested in science to the present, tracing their career path as physicists.

3.1 Getting into physics

As underlined in several surveys, such as *Women Physicists Speak Again* (2006: 4), parents and other family members influence children in choosing physics as a career, or at least as a choice of university discipline. The physicists we interviewed confirmed that their parents started their interest in science in general and especially in physics. Their parents promoted their interest in a 'direct way', providing them, when they were children, with hands-on scientific experiences, sharing with them exciting scientific events, such as observing stars through a telescope, or visisting the science museum for children and youngsters.

In all the narratives we collected, physicists in their youth shared their interest for science with significant adults, like their father, their grandfather or one of their uncles, who were experts in science or just fond of science and physics. Hence interest for science seems to be promoted by male relatives, and this could have contributed to creating in those children's minds the idea and the stereotype that science is something mainly for men. Later we will analyze the stereotypes that women had to face when they decided to study physics at university.

Other narratives of our interviewees highlighted 'indirect suggestions' that relatives made for their children, ensuring there were all the important resources available at home – like the 'right' books and magazines – and in this way they encouraged their children to pursue science.

Nonetheless, some females interviewed said that their parents did not encourage them to pursue science but rather tried to hinder them both directly and indirectly. Some of the female full Professors and Associate Professors told us that their parents prohibited them from studying physics. This type of obstacle gives us a 'glimpse' of the cultural stereotype of physics as a 'difficult career which is for men only' that can also be found in high socio-cultural level families, especially some years ago:

> *I had the chance to be examined orally by xx: he's one of the greatest existing physicists in Bologna and after my graduation he came to me saying "I would like you to seriously consider registering at the Normale of Pisa". My physics teacher was already insisting that I go in this direction and so I decided to face this challenge despite my family's being strongly against me, particularly my father, who claimed that, eh, if I absolutely had to study scientific subjects, it would be better to study mathematics, as it was better suited for a girl.*
> *Interviewer: Why?*
> *Eh, because it was more suited for a girl; he could not accept my doing things which were so strongly emmh characterized by a man's perspective (...) I mean it was considered a man's job.*
> *Interviewer: Physics.*
> *Above all experimental physics.*
> *Interviewer: I see, mathematics instead was more …*
> *It was more speculative, more suited, eh, for serious and well-bred girls you know?* (P39/FS)

Evelyn Fox Keller's (1987) consideration of cultural stereotypes as bridges between internal and external motivations that guide scientists in their career development, thus still remains in force. Fighting against such social expectations is not easy, yet some of the women interviewed demonstrated that it is possible when there are internal pressures as competition with a father:

> *Interviewer: What inspired you to choose physics, was it a person, an event or a book ?*
> *I have to say, my father had a degree in physics. My father was born in 1902, so he was among the first people to get a degree in physics, in xx, or at least there were just a few of them, so he did various jobs in his life*

> *and in the end he became a maths teacher, but I think he regretted giving up (pause) physics, research. My relationship with him was a bit (pause) it was not very easy and so it is as if there was a, I don't know, it's something I figured out later, as if there was competition, I mean I told myself I wanted to make it.*
> *Interviewer:* Instead!
>
> *Exactly*. (P24/FS)

While describing the way they chose which discipline to attend, some female interviewees emphasised that they had to face the idea that the discipline of physics was one of the most difficult, an idea widespread both among schoolmates and parents. Many interviewees confirmed that this idea bore relation to reality. They told us that the studies absorbed all their energies, especially passing exams during the first years they attended the discipline of physics.

Some interviewees even told of episodes when Professors told their students during first year classes that after a few months only the best students would stay. The following extract underlines that in this way Professors put pressure on highly motivated students to quit the discipline:

> *Actually, at that time xx, the university of xx, was a particular place, because there was a lot of competition (…) especially the Professors, who believed they belonged to a cultural elite and had to keep the level high. Therefore, there was competition among the students (...) Many people dropped out but this was precisely what the Professors wanted.*
> *Interviewer: They wanted to make a selection.*
> *Yes, from the first day. On the first day (...) the Professors said: "In three months there will be just 30% of you attending the courses" It was the professor of 'Physics 1' who said these words, and all the students became demoralized. During the exams we were also told so and we felt discouraged, because if we didn't pass an exam we were told to give up physics and study something else (...) In effect only 30% of the students enrolled are attending the courses at present. Many have dropped out (...) Many people who have shown they have the necessary skills and knowledge to do this job and have won important prizes were victims of this brainwashing. They attended university there and were about to drop out.* (P13/MS)

The physics teacher our interviewees met during high school also had great influence on their decision to study physics at university and to become physicists. Most of them told us they had good teachers who roused their interest towards physics through interesting experiments that allowed them to understand physics theories deeply. Moreover, some interviewees underlined the guiding role their teachers played when they had to choose which discipline to attend; the teachers helped them to realize they had great abilities, that they were gifted for physics, as they demonstrated during their high school years. Like relatives, teachers also encouraged reading books and magazines, and interviewees' interest for science was roused through reading the lives of great scientists, such as Fermi.

However, it is worth noting that for some interviewees it was a challenge against an incompetent teacher that incited them to take an interest in physics, as the following account highlights:

> *I decided I would study physics at my senior year in the classical high school, three months before the final exams*
> *Interviewer: How come?*
> *Because, it's a very weird reason, because I started betting on how many mistakes our physics teacher would make. At that time I was living in Spoleto that year. I had a terrible, terrible physics teacher who just didn't know what she was talking about, so we laughed during class until people starting betting that I knew more physics than she did so (laughs) I made a little money.*
> *Interviewer: You, you began studying.*
> *I started to read, yes to study, I realised I really loved it and in the last three months I changed, I had originally chosen Italian and Greek as examination subjects because from being little I had thought of becoming an archaeologist.* (P34/FS)

3.2 Career paths and mobility

The narratives of the older researchers, i.e. full Professors and Associate Professors in the universities, research managers and principal

researchers in the other research institutes, accentuate that they were temporary researchers for a few years and that at the most they would become permanent researchers after their post-doctorate. Moreover, they described the periods when they were on fixed-term contracts as not being particularly stressful for them.

Thanks to the population increase and to the increasing prosperity in Italy during the 1960s, all the social classes in the 1970s and 1980s had access to university. This led to the necessity for new Professors and researchers, who had to teach. Successive governments made many new positions available; so many research assistants grasped the opportunity to have a permanent position.

However, some Professors and Associate Professors told us they worked for many years as temporaries because of unfortunate co-incidences, and in some cases because they were discriminated by members of academia. This happened not only in Italy, but also abroad, where people had to fight for a tenureship. This is what happened to one woman – today a research manager in an Italian research institute – who married a physicist, a lecturer in the same university in the USA where she had a part-time teaching job. They lived there in the States for fourteen years and she kept on writing articles throughout these years together with her husband, because at that time you had to pay if you wanted to publish: only some years later was her research financed. When her second baby was born she decided to try to improve her situation: she wanted to have a proper job, but her request created many problems for the discipline, as she told us:

> *They liked me as a Professor's wife, doing small jobs by myself and some teaching when needed, but my request for a proper position, taking somebody else's place, it was a kind of brawl, a crisis between me and the faculty, where everybody seemed to be friends with me, as I thought (...) The faculty offered me a position for 3 years, saying that it would only last for 3 years: even if there is a law that after 3 years there should be an appraisal of whether the position is to be offered permanently, they would not offer it to me, as I was not the right person (...). I came to know that there was another female candidate from xx, who was put forward (...). There were local pressures from someone who was already a Nobel prize winner in physics (...) and what could I offer? Italian*

> *recommendation letters. It's not that there are no important Italian physicists, but still, the battle for a tenureship is about tears and blood in the States, you have no idea how many people have been destroyed by those battles.* (P22/FS)

The narratives of Ph.D. students and researchers with fixed-term contracts (e.g. post-doctorate and other scholarship fellows) emphasized how they had to put up with long, stressful temporary periods before gaining a permanent contract at a university or in other research institutes. Our interviewees told us that since there are few competitive examinations for assigning permanent positions to physicists, they have to work with temporary contracts for many years. As we emphasised in the previous chapters, those years are stressful because scholarships entail very low pay and because the researchers often do not know whether or when their contract will be renewed when their scholarship expires.

Seldom did our young interviewees give positive narratives about those short periods working on temporary contracts: the happy ending, i.e. they gain a permanent position as a researcher, occurs only when in addition to their capabilities, the candidate has a stroke of luck because of fortunate coincidences:

> *Certainly I've always done my best and worked hard, but many people doing the same have failed. I'm no better than the others, but I've been clever and lucky enough to seize the right opportunity. I preferred to take the competitive examination, even though I knew I was not a likely winner. However, I got a mark close to the winners' and therefore I was given the qualification. (...) Therefore, many people started to support my career and promotion (...) and finally I was taken on, since they (the Ministry of Research) decided to recruit from the examination lists those people who hadn't won, but had been recognized as qualified. Moreover, I was lucky because the Finance Act in force at that time, which provided for a freeze on appointments, wasn't applied. So I was taken on.* (P13/MS)

As for the mobility issue, all our interviewees say they are used to moving to other research centres both in Italy and abroad, mainly for

short periods, for meetings, conferences and data gathering. Some of them went abroad for some years but after that experience they were ready to come back to Italy, mainly because they missed their city, their family and friends.

Moreover, as highlighted in Chapter 2, moving and doing research abroad is a matter to be considered carefully by Italian physicists. Italian researchers, especially those who work abroad, stressed the fact that if a physicist wants to come back to do research in Italy, they should not stay abroad too long (in terms of years). Actually those who stay away from Italian public research centres run the risk of losing their contacts with the Professor or the research director, whose support is necessary in order to win a competitive examination for a permanent position.
Women stayers stressed the difficulties of combining family and work because of mobility abroad and the heavy workload; moreover, before making choices about their career women, both stayers and leavers, and some men leavers, weighed up the price that their family would have to pay because of those choices. We did not find any reflections concerning these issues in our male stayers' narratives, including those who have a family, and in our male and female stayers who do not.

In the following extract a male leaver is comparing his new job and that of a researcher, concerning the need to sacrifice private life for work:

> *(...) When they did experiment x, they went to xx (a country abroad) for 2 years and then they spent 6 months in the Antarctic (...) I would not feel like leaving my wife and my daughter for 6 months; in any case, I would regret it, I would miss the way she grows in 6 months. She would be a different person when I came back. I don't want to do this! Anyway, if I had made this choice I would have had the responsibility for the consequences, so being away when it's necessary, working for 24 hours and this is probably not (…) sacrificing your life, but it is definitely sacrificing your private life.* (P27/ML)

3.3 Women's choices

From women's narratives of their career choices, we can easily recognize that they have been affected in several ways by other people, such as

colleagues and relatives who told them which were the right decisions to make. For example, one female stayer emphasised that it was thanks to her colleagues that she decided to enter a difficult competitive examination, and that she decided to resign a permanent position for family purposes, which she preferred not to explain in detail.

It is worth noting that in some women's narratives, but not in any of the men's, it emerged that to humour their partner's wishes they made choices different from those they would have liked to make, like the following female stayer. She was a researcher for about three years in a famous European research centre, but after her baby was born, her husband told her to come back or he would leave:

> *But then as usual when the husband goes somewhere the wife follows him without saying a word and if it is the wife instead who goes somewhere (...) and your husband isn't there, you need to go back (...). We still have fights on this. I had to come back because in the meanwhile he had been hired here (in an Italian university). I had the misfortune that one year later there was a vacancy here so I had no excuses. I came back (...) I still have a number of responsibilities at xx (a research centre abroad) and this is why now you know my family is happy, because I'm here and then once a month I go back there for a week.* (P34/FS)

She explains how she took her decision to come back to Italy referring to what we call the gendered cultural model of 'women who have to follow men'. She says that when it is the husband who has to move somewhere for his job, such as a city different from the one he has been living in with his family, his wife follows him 'without saying a word', even though she has to quit her job, whereas the opposite rarely happens. We know that this situation could occur in several European countries and especially in Catholic countries like Italy. This cultural model is widespread in Italy on a cultural level and is very much linked to that of 'men as breadwinners, and women as nurturers'. Bearing in mind Crawford and Chaffin's (1987) theoretical model[9], to start analyzing these gendered cultural models on a socio-cultural level we will take into consideration several studies that have contributed to

[9] See Section 1.2.

highlighting the fact that although the number of dual-income families has risen tremendously in recent years, the notion that men are 'breadwinners' and women are expected to take care of the children remains prominent. The media's reinforcement of the idea that men are naturally better-suited to prestigious professional jobs is illustrated through the overall greater media coverage of males in powerful positions. Furthermore, women are almost always the subjects of commercials concerning the house, kitchen appliances and baby products; and when career women are represented, they are usually shown in the traditional female occupations, such as teaching and nursing (Creedon, 1989:17). A recent survey has stated that 'in most Southern European countries (particularly Italy and Greece) characterized by low optional maternity leave and poor child-care facilities and very limited part-time options, women do not have the option to use child-care facilities, and need to rely on family support in order to continue work when their children are young' (Del Boca, 2005:19). Indeed, only 30% of those women who have a baby come back to work (Boeri & Del Boca, 2007). In fact 10 million Italian women do not have and are not searching for any job (ISFOL, 2007). In the end, if we look at what happens inside the home, Italian men on average dedicate 115 minutes per day to household chores compared to the 173.9 minutes of German men, whereas Italian women work for 347 minutes per day for their home and family compared to the 311.8 minutes of German women (Monti, 2007).

If we return to the interviewee's account, we realize that she recognizes the gendered cultural models above as widespread in our country and underlines that they were 'used', hence re-produced, on an interactional level by her husband (and by the broad family that 'is happy' for her decision) to convince her to come back for the sake of their baby. In the end, on a personal level she decided to accept the gendered cultural models and to take on the job in Italy: even though this meant earning a very low salary compared to what she earned abroad; in short she agreed not to be the breadwinner. This was not a choice without conflicts for her, since in the interview she said that she still has fights about this with her husband, and that she often tells him that he has destroyed her brilliant career. However, with this choice she also contributed to reproducing the same gendered cultural models.

Through the question 'What difference did you hope to make in physics?' we wanted our interviewees to think about their professional past experiences as physicists. Interestingly men and women answered this question in different terms.

Men (stayers especially) spoke about ambitions that motivated them at the beginning of their career and they also use the word "ambition" when talking about their contribution to the work of their research groups, like the following:

> *The dream, well, this kind of physics is team work that has enlarged from fifty to three thousand people (...) My ambition is to contribute to xx project, especially in a specific field. I have the ambition to give a contribution that may be recognized by the international community*. (P24/MS)

On the other hand, we did not find the word "ambition" in women's answers. In fact, despite the positions they hold, women spoke in different terms about the difference they hoped to make in physics and their attitudes are 'modest' compared to those of their male colleagues, as we can see from the following account:

> *In terms of a continuous interest in scientific research, I've never felt disappointed. I liked some things that I've done more than others, and you will probably think that I am a very humble person, but I've never set any goals. I just wanted to do things I liked, hoping to get significant results, hoping to never get it wrong. I am happy I've never had incorrect results*. (P31/MS)

Moreover, we found 'modest attitudes' about how they advanced in their career in many female stayers' and female leavers' narratives, but in none of the male leavers' narratives. These issues are connected with self-esteem, which will be analyzed more deeply in Chapter 6, concerning identity.

In the end it is worth noting that the issue of career choices affects interviewees' lives in many ways: from relationships with their partner to taking care of the children, and to the need to travel as well.

4. Workplace environments

4.1 Working conditions and recruitment procedures.

Our interviewees in both categories say that they liked their job as physicists, irrespective of the research area and of gender. They liked it because of the 'interesting and non-repetitive' aspect and because they are requested (and allowed) to think, to ask challenging questions and to find the right answers. Often interviewees told us that for physicists it is important to think in creative ways, to find solutions to complex problems and to devise strategies and survey paths. These are the reasons why, despite the harsh economic and contractual conditions, all stayers, from full Professors to Ph.D. students, go ahead with their research.

Interviewees said that they are satisfied with their job in terms of mobility: they can travel and take part in conferences and meetings, but recently funding for mobility has been cut. On the other hand, our interviewees are not satisfied in terms of their working-contract conditions because of low pay and few competitive examinations to advance in their careers. Moreover, those who have temporary contracts complain because of their 'precarietà', a word that could be translated by 'precariousness' in English. In Anglo-Saxon countries researchers have non-permanent positions until they achieve a tenureship but they are well paid in the process. They also find good job opportunities outside academia; moreover they can do research outside academia, for example in private companies. This is not so in the Italian context, where researchers have non-permanent positions but can rarely obtain a permanent position as a researcher before they are 35 to 40 years old and then earn about 1,000–1,200 euros per month. Moreover, what non-permanent researchers complain about is that they feel that they are living in a precarious situation with very few guarantees and no cover, such as maternity leave and National Insurance contributions[10]. The

[10] The INFM (National Institute for Physics of Matter) promoted positive actions to promote equal opportunities, like paid maternity leave for non-permanent researchers and the opening of nurseries inside some of the offices (Betti, 2002, 680).

exception is the so-called “articolo 23”, a type of contract which gives the same guarantees as a permanent contract. Because of the lack of a policy of long-term investment for the Italian research system, they cannot foresee what their professional future will be. All these issues together can give those who are not Italian an idea of what ‘precarietà’ means.

As already analyzed in Chapters 2 and 3, in the part of the interview dedicated to working conditions, interviewees spoke of the difficulties involved in facing many years working on temporary contracts, and the difficulties in trying to find funds to renew their scholarships. Having a temporary contract for as much as 10 years, and sometimes being forced to work without a contract while waiting for it to be renewed, is a real test of researchers’ motivation to stay in the public research system. In the following account a female researcher accentuates the fact that the recruiting system in research in Italy works in the opposite way to any other type of job: the State evaluates whether you are able to teach and research as a state employee only after you have been teaching and researching for the state for 10 years, almost for free.

> *I have worked for ten years and after I’ve been doing research and teaching for ten years, you turn up and decide whether I can do research or I can teach, only because at this moment you need someone to do so. Do you want to check on me because you have to pay me? When it costs nothing, everything was all right, but if you have to pay me you want to check on me after ten years. There is no job in which you work ten years without pay. Tell me about another job where this happens!* (P35/FS)

In Italy permanent positions (Professors/research managers and researchers) and some temporary positions (Ph.D.s and post-doctorate scholarships) are assigned through competitive examinations, which on the one hand are described by interviewees as few in number, and on the other as organized without transparency and meritocracy. In fact interviewees told us that to win a competitive examination you need to know very well the members of the board who have to support you, because

the winner of the examination is decided by Professors[11] through informal agreements among themselves, which are usually well known by the people taking part in the examination:

> *We can't accept a system which is said to be democratic because the examination is open to everyone, and everyone has the same opportunities, assessments, titles and exams, but actually it's already decided who will win it. (...) I noticed this during the two competitive examinations I took part in. In my second examination the winner was a person who "had to" win. It had been decided that this person would be the winner for political reasons, although he didn't do very well in the exam. Therefore this is the first thing to change, in my opinion*. (P13/MS)

As sincerely described by the following Professor, sometimes because of conflicts between the university's Professors, those who should win the examination are excluded and this could happen also for positions as full Professors. As a consequence, those who do not win could behave, and be considered, as victims, so everyone knows that the next examination 'will be for them'.

> *When I won the competitive examination for the post of full Professor it was indeed, well, you know, I won it through a way, I mean there's another way to win a competitive entrance examination, the way of the victim. Here the post of full Professor had been created especially for me but then, because of internal conflicts, they didn't assign the post to me. After that I became a victim, they said: "Ah, no xx must win the next one!"* (P26/MS)

In the end some of those who work in huge universities emphasised the problem of 'overcrowding' and of small offices shared by several researchers or Professors, since this situation does not make it easy to work.

[11] Professors work at universities, research managers at public research institutes; they are both at the top of the hierarchy in their work places so in the following pages when we refer to Professors, we mean both Professors and research managers.

4.2 Publications and competition

Publications are an important matter for every researcher who wants to have a good career so we also asked interviewees to talk about this issue. Every interviewee said that they mainly sign their publications together with all the members of the research group, especially experimenters. The latter usually publish after they have been working for some years on a specific experiment, and usually all those involved in the experiment put their signature to the article. So while an article on experimentation can be signed by as many as a hundred physicists, those about theoretical physics can be written by only one physicist.

Some interviewees argued that during competitive examinations the boards of examiners mainly consider the number of publications presented by each candidate, rather than their quality, stressing that this is not a meritocratic way to evaluate and to recruit researchers. Moreover, in this way those who have been actively involved in planning an experiment but still cannot analyze data can be at a disadvantage compared to those who started to work on an experiment when data had already been gathered, because the latter can publish more than the former.

Concerning competition, irrespective of gender, Italian interviewees are aware it exists among researchers and they all considered it as 'part of the game', something they have to cope with. Moreover they experienced both 'good competition' and what they call 'keen competition'. The former was regarded as important because it 'brings up positive challenges', 'it gives the stimulus to get better' hence 'to achieve results'; instead the latter was considered as unfruitful. The following informant analyzed competition from a cultural point of view, and argued that in our culture it has acquired a negative meaning:

> *Competition in my opinion means saying "Ok, I'll try to do this; if someone does it better than me, it is better; I acknowledge their ability, merit, and, ok, I did it in the best way I could". (...) Usually, when we talk about competition in Italy, we always ascribe a negative meaning to this word and we experience it as something negative at every level, from*

> *school to everything else (...) Very often, we waste time demonstrating how badly the others work and not how well I work.* (P17/FS)

As reported above, we did not find a clear gender pattern concerning this issue, since many female interviewees said that they do not like competition and that they do not feel comfortable in competitive research groups, whereas other women emphasised that competition is necessary in order to achieve goals. At the same time some men also said they do not like competition. However, it is worth noting that only a certain number of female interviewees spoke about the importance of how you face competition and how you feel about it. Some argued that it would be hard for women to feel comfortable in a very competitive working environment, while men would be more accustomed to it because they have been trained to fight and compete in order to succeed:

> *This competition is positive, if you can handle it, it's very positive, as sometimes it's really hard to handle it psychologically, especially for women, or at least it's always been difficult for me. I am competitive, but then when it gets to the point that you have to demonstrate what you can do, to show that you are brilliant, to say clever things when the moment is right, I get shy (...) Public examinations are always about competition and also if you want to be a leader you must be competitive, it's always there. Men are very competitive so it's hard, sometimes you just can't make it, sometimes I had to give up even though I knew a man would not, I could not simply face it, but there are people who don't like competition, both men and women*. (P22/FS)

Young interviewees spoke about competition among young and temporary members of groups, because the shortage of positions and competitive examinations drives them to compete with each other. The following leaver emphasised that in her new job outside academia people work with a clear position established by managers, hence people compete less because they feel less vulnerable to coercion than in academia:

> *(Inside academia) Every one tried to draw attention to themselves somehow, because of course everyone knows that when you start this career not every one gets through to the end, you know (...). I found myself deeply involved in a situation where you always wanted to be first, to show you were skilled and you wanted to do more things (...).*

> *When you have contingent work, well, you feel more vulnerable to coercion somehow, but in this case (in the new working context) well everyone has his/ her position, role (...). The person in charge gives well-established roles so in the end no one steps on anybody's toes*. (P25/FL)

Concerning leavers, some of them said that they were mainly inhibited by competition in general, instead of being stimulated to do their best, so it clearly did not make them feel comfortable. Moreover, 'keen competition' played a role in driving some interviewees to quit research and to chose jobs with a more tranquil atmosphere, as the following informant emphasised:

> *There is a lot of competition, but it is never positive (...). This happened to me at a conference in xx. There was someone who came from zz (a place in the USA), but he was from Sardinia. He is a person who has done a great deal and is still young: he must be in his forties. Anyway, on that occasion he asked me a first question, a very specific question. It was evident that I was a Ph.D. student who had not achieved any important results yet. Therefore, I didn't represent a danger to him and his reputation. Moreover, he put the question with a marked American accent. I asked him to repeat his question and he repeated it with a more marked American accent. These are things which are the order of the day (in physics).*
> *Interviewer: Do you think that this competition might have influenced you ?*
> *Well, I have to live a peaceful life if I can. I do not want to be stressed*
> *Interviewer: Is there much competition where you are working now?*
> *(...) In the group where I am working the atmosphere is relaxed. In addition, there is no competition in my workplace, because we all work to do what is good for the company.* (P2/ML)

4.3 Discrimination against women

During interviews women spoke about gender discrimination more than men, even though men whose career paths are longer are aware about the difficulties met by women in advancing in their career in physics.

However, both those who did not talk explicitly about gender discriminations, and women who reported discriminating episodes, recognized the family as the actual discriminating factor between men and women, because women 'have to think about the children and the ageing parents'. In other words they have all stressed that the tasks related to the home and the children are mainly assigned to women, proving that they accept the national cultural model that 'women take care of children and of the family', as we explained above. Having a child is perceived as the main obstacle for female physicists' careers by our interviewees because they 'have to give up some work to dedicate their time to their child' (P10/FS) and they are assigned less-responsible tasks in the research group; in the end they lose the opportunities for climbing the career ladder and their careers are delayed compared to those of their male colleagues. The following extract is a clear example of gender discrimination against a young female researcher, based on the cultural model "men are breadwinners", while women can work for free and be maintained by their husbands. Hence it is also possible to recognize the prejudice that women are worth less. Actually the following informant is an elderly permanent researcher, who could not advance in her career because her Professor preferred to back the men in her research group:

> *"Let him go far, he is a man, he has to marry and set up house: women always find someone to maintain them". (...) These are the precise words that someone told me at the beginning (...) when you feel like taking competitive examinations, working hard (...) And in such a situation you become demoralized (laughs), and you think: "What's wrong with me? I was not born a man but one must look at people's value, you must not think whether he/she is a man or a woman, but I often find myself in such a situation" (...) There is a difference between a man and a woman because of prejudices but also because of practical things, because you know, a woman must take care of children, parents.* (P35/FS)

Staying away from research during maternity leave is considered as a disadvantage for women if compared with their male counterparts, because they have less responsibility, publish less and fall behind men. As we will analyze in Section 5.4, some women told us they felt under pressure in their research group when they decided to have a baby. As a confirmation of Molinari's analysis (2002) of reasons behind the gender segregation of female physicists, which we explained in Chapter 1, Italian female interviewees, stayers especially, considered motherhood as a threat for their career and the solution they envisaged if they wanted to stay is either to postpone having a baby until they find a steady position, or to deny themselves motherhood. In fact they mainly came back to work soon after the baby was born, often because they were requested, if not forced, to do so by their colleagues and managers. Otherwise they had to leave, as the following informant decided to do:

> *She was a woman and she was one of the first ones to have children there (...) and she was really punished for it. I remember she came back to work as she felt forced to do so, practically three months after giving birth (...) She was still breast feeding. She had to use a milk-pump. I mean, if I think of it now, and also if she thinks about this period, it was so stupid to go back to work, and still, you felt forced to. So since some people had this experience before me, I managed to protect myself, partly because I was leaving anyway, as I had finished my Ph.D. thesis, partly because I was absolutely convinced that this was something (having a baby) I wanted to do and that I would not give up on it.* (P16/FL)

In the following chapter we will consider how motherhood and children are considered a risk for female researchers' careers and a 'threat' for the whole research groups they are members of.

Female interviewees also told us they felt discriminated against during everyday working activities, even though not all of them could tell exact episodes. They referred to the fact that often male researchers proved sceptical concerning their working capacities; as a consequence they felt they had to demonstrate they were good enough to be accepted as members of the group. In the following extract a female full Professor, who has always been aware of the gender prejudices her male

colleagues held against her, explains how she tried to keep her colleagues' attention on her research findings:

> *In everyday work, side by side with our colleagues (...) you know what happened was: "But you're a woman! You'd better do this rather than that!". Or being violently attacked because of an error in the setting-up of the experiment. I made far fewer mistakes than my male colleagues but, if I made a mistake it was a tragedy (...). They never trusted that the observations we made were significant. So (...) when I knew something was important, I tried to write it and send it to more than one so they would consider it (...) so it would be considered as a work hypothesis towards which we could direct the next assignment. Because very often the fact that it was one of us who presented it, we were two or three young women in the research unit, it was almost certain they would not take it into account (laughs).*
> *Interviewer: And this happened when and at what point in your career, mainly at the beginning or when you were still a (researcher)?*
> *Yes sure, now it's difficult for them not to consider what I say (laughs) (being a Professors entails) a status which plays a role that helps you a little*. (P39/FS)

'Luckily' (we think we are allowed to use this word in this case) since she became a full Professor she has acquired the power to command the attention of her colleagues, and her research is nowadays regarded without gender prejudices.

Other female interviewees told us that in some situations they had to behave aggressively towards their male colleagues in order to compete with them, or just to have their attention, for instance during meetings. One said 'I became aggressive' after she experienced gender discrimination, underlining that the workplace climate forced her to change, to behave in more a masculine way just to have attention, hence to be considered as a researcher by her male colleagues.

In our sample, Professors of the older generations showed more awareness of the discrimination against women compared to the younger generations; they told us that women, in the past especially, had to demonstrate they were more competent than their male colleagues, in order to hold the same positions as the males in the hierarchy. Our data confirm those described in the report of the DIVA project funded by the EU: also in the discussion groups among female researchers coordinated

by Palomba during the project, it emerged that 'there is a difference in the perception of junior and senior women scientists about the impact of gender on their careers. 'Young women believe that gender discrimination was "solved" in the previous generations and would not touch them' (Palomba, 2007, 33). As in our research young women became more aware of the price they had to pay, both personally and professionally, because they were women, so during the DIVA project young scientists became aware of gender discrimination during the discussion groups. Hence we want to stress the fact that one of the most important results qualitative research in science can achieve is in raising the awareness about gender issues, women's especially.

4.4 The 'invisible western burka'

During the interview we asked questions concerning the possibility that sexual harassment could happen inside research institutes where our interviewees work. We collected several opinions and narratives on this critical issue, with no differences between male and female interviewees, while we found the main differences that did exist occurred between older interviewees and the younger generations.

Some older Professors unequivocally told us about unfortunate episodes they had experienced, but none of them talked about pressing charges against the harasser: they preferred 'to put them in their place straight away' through strong verbal reactions (P13/FS), or as this interviewee explained:

> *I've often found myself in situations where the language that was used would be defined today as harassment. Since I always reacted, people stopped.*
> *Interviewer: Was it in Italy or abroad?*
> *It happened more often in Italy than abroad. It almost never happened abroad, maybe just once; in Italy it was several times.*
> *Interviewer: But do you think it's something that hasn't changed over time? Is it continuous?*
> *No, people today are more careful as, luckily, people started to react to it.* (P48/FS)

Some of our interviewees told us they would not be surprised to know that sexual harassment takes place in their research institute, since they have heard about episodes concerning that issue; on the contrary others said that they would be very surprised because they had never heard about episodes on that count. These interviewees justified this by referring to the stereotyped idea that physics is exempt from such problems, because physicists are a sort of elite and they would not behave like that, annoying people. Some of those who have faced sexual harassment are aware of the widespread stereotype of physics as a 'pure' working environment, where neither sexual harassment nor mobbing episodes would ever take place.

Some interviewees pointed out that sexual harassment episodes can mainly occur when the victim is in a lower position in the professional hierarchy compared to the harasser.

We want to stress the cultural differences between countries concerning what sexual harassment is and what the right punishment is for the harasser. It is interesting to compare two narratives, one from a male full Professor, the other from a female permanent researcher, who both speak about the way Americans consider and treat sexual harassment.

The Professor tells of one of his male colleagues who thinks he does not cause any embarrassment to his graduating students by kissing them on their neck when he meets them at university, and actually those women do not complain. Then the Professor told the story of another colleague who teaches in America: he was suspended for a year because he cracked a joke to a female student who had not done her homework, saying: "Don't spend all Sunday screwing, do your homework instead!" The interviewee emphasised that his colleague wondered why she pressed charges against him and the Dean suspended him: he did not consider his joke as sexual harassment. Our informant recounted these episodes because he wanted to clarify what in his opinion is, and what is not, sexual harassment. Actually he starts answering the question about sexual harassment by asking in his turn, "What do you mean by sexual harassment?" (P26/MS). He ends his reflections saying that he considers the episodes concerning his colleagues as sexual harassment, while he does not consider in the same way the vulgar jokes he makes during informal conversations among his male colleagues about attractive

female students, though he is not sure if the interviewer agrees. In fact in the end he says: "(...) There are different extremes, that's why I'm asking you what you mean by sexual harassment" (P26/MS). We think that many of our interviewees said that in their opinion sexual harassment has never happened and can never happen inside the research institutes where they work because in our Catholic country some kinds of behaviour, like telling jokes, are not considered sexual harassment, while in other countries they are. This raises the issue of how people set the cultural boundaries between sexually harassing and non-sexually harassing behaviours.

It is worth noting that during the interview the full Professor confirms what we have already stressed concerning women in Italian universities, who seldom press charges for sexual harassment, and he believes this happens because there is a tacit agreement concerning power differences between the victim and the harasser: victims are afraid of talking because they could be harassed and discriminated against in their job.

On the other hand, the other interviewee taken into consideration, the female permanent researcher, tells of a technician in the United States who was suspended from his job because of a joke:

> *In the USA at zz, they are a little bit obsessive there (...) I remember there was a technician from yy when I was attending my Ph.D. course who was on a staircase. An American secretary passed by and he said in Tuscan: "Ah bella!" (What a beautiful girl). She pressed charges against him and he found himself in the newspaper! The first thing we said was: "That woman could have thrown something at him!". So, these were exaggerations, true stories, honestly, serious episodes (...).*
> *Interviewer: But this never happened to you?*
> *No.*
> *Interviewer: Not even jokes.*
> *No. In fact it's a little bit worrying (laughs).* (P34/FS)

In Italy such a joke would never be considered as sexual harassment and women would not press charges, since it would be considered rather as a compliment. In addition to saying that she considers the woman's reaction exaggerated, our informant says that she has not been the victim of sexual jokes and she considers this 'a little bit worrying',

meaning that she might start thinking why they do not happen to her: does she not look attractive anymore? It seems she would somehow be happy to be 'the victim of sexual jokes', because men tell sexual jokes mainly to attractive- looking women.

In addition to the issue of what can be considered as sexually harassing behaviour in our country, we also want to stress another issue emerging from our data, i.e. that of responsibility. Some of our interviewees think that the victim is somehow guilty and responsible when sexual harassment takes place: they believe that women who behave in a professional manner are able to avoid sexual harassment, because their male colleagues would not misunderstand their behaviour. It is even more interesting for us to note that only women raised this matter and that those women thought that "it never happened to them" because they were able to draw the line.

> *(...) I think that it also depends on the way you behave with a person who could, potentially, be your molester. You see what I mean? That never happened to me because I think, when I'm here, with my colleagues, I always behave in a professional way, I mean, there could be a colleague who can be my friend and we can chat but the very fact that we are friends depends on the fact that I know that this is a person who respects me*. (P15/FS)

In other words some women in Italy feel they are forced to wear a sort of '*invisible western burka'*: they cannot be natural while relating to their male colleagues; they have to behave like detached and un-emotional people, otherwise men could feel they are permitted to transgress the boundaries. However, this can be explained only because they feel that sexual harassment is an actual risk for them, something less unusual than expected. Moreover, from a socio-cultural point of view, these thoughts can be linked to how the media in Italy sometimes represent these situations, such as stressing the fact that the sexually harassed girl wore a mini-skirt and accepted a lift from boys she had just met at the disco. The message the media often sends is that harassment happens when women behave in equivocal ways inside places where it is better not to go, implicitly considering female victims of sexual harassment as 'guilty', attaching less importance to the seriousness of

the fact itself. On the contrary, very few news programmes on Italian TV and articles in the newspapers concern sexual harassment that takes place in the home, the percentages for which are so high that this is considered as an emergency by Italian women's associations[12].

If we consider public discussions about gender issues like discrimination and sexual harassment in the Italian context, we could depict them as a continuum. Imagine drawing a line and putting gender discrimination on the left, sexual verbal-harassment in the middle and physical sexual-harassment on the right. The left is related to collective matters, problems well-known and shared by people who actually talk about them: Italian interviewees for example recognized that women are often discriminated against when they become mothers. The more we move towards the centre and to the right of the line, the more the problems are considered as individual problems: people are less aware of them. Those who are sexually harassed do not talk about it with colleagues and try to solve the problem by themselves.

Gender discrimination and sexual harassment are hidden issues in general, but in Italy even more so: like our interviewees, people do not like to talk about them; they treat them ambiguously; they have difficulty in naming and recognizing them. We ourselves had to resort to a metaphor, the 'invisible western burka', to describe the ways women draw the line when working with their male colleagues. All the metaphors, also those about gender, like the 'leaky pipeline' and 'the glass ceiling', concern ambiguous phenomena recognized by people with difficulty. In Italy these issues are still taboo and people do not have the words to talk and think about them. Hence people are not aware enough of how they pervade women's lives. In other words, our culture must elaborate much more on these issues.

[12] On November 24th 2007 several women's associations organized a national demonstration in Rome to denounce both violence against women and the fact that the media and politicians do not inform the people about it, in addition to the lack of measures to stop it.

5. Combining motherhood with a career: a gender trap?

From the analysis of the narratives of our interviewees, it was evident that family issues and reasons for leaving physics are connected, even though some of those connections were not directly emphasised by interviewees.

In this chapter we will discuss the family, meaning both the domestic family and the new family of physicists.

5.1 The pivotal roles of (grand)parents

Parents often serve a sort of protective function towards the career of their son/daughter. Physics has been described as a difficult discipline, so many students do not have the time to work; they study all day long, so parents help their child by financing him/her while they attends university. Parents also support their children during the first year or two after they have graduated, when they try to enter academia and start working with temporary contracts and low salaries. As already highlighted in previous chapters, physicists may have to wait some months before the contract is renewed, or a new scholarship is found by the project manager, or they win a Ph.D. scholarship. In the meanwhile they often work for free.

Many interviewees emphasised that their parents also supported them psychologically when they had problems with their Professors or in passing an examination: another facet of parents' protective function.

Parents take another pivotal role in their children's lives when they become grandparents. In our country there are few day nurseries, especially public ones, even though the number of families applying for a place for their child in a day nursery is higher than the number of places available. Thus each municipality establishes criteria for making a list of children who are entitled to a place at day nursery. Income is one of the criteria adopted to put children on the lists, and seldom are

the children of dual-income families on the list, because the total income of these families is usually higher than that of one-income families. In Italy dual-income families can choose either to pay a private day nursery, which is more expensive than the public one, or to ask for grandparents' help. In the case of almost all our interviewees, grandparents compensate for the lack of day nurseries.

Grandparents' willingness to help with their grandchildren is pivotal also when the children go to kindergarten and primary school, because they close at 4.30 p.m and our interviewees emphasised that it is not easy to leave the office so early in the afternoon. Therefore grandparents often pick up their grandchildren after school, and take care of them when they are sick, or when their parents have a meeting late in the afternoon, or a last-minute hitch. It is important for those who help physicists in taking care of their children to be very flexible because of the physicists' flexible working hours and unexpected tasks, typical features of so-called 'brainwork'.

When grandparents are elderly or live far away from their children, physicists, like all busy working people, have to find another solution. Many of them pay a babysitter to take care of their children, but this creates an economic problem because of their low salaries.

Our data give a clear picture of a broader issue, because Italy is characterized by little optional maternity leave, poor child-care facilities and very limited part-time options. As stated by Del Boca et al. (2003, 15): 'Given the low availability of childcare and the limitation in daily hours, a large proportion of Italian mothers have *to rely on family support systems, mainly on the help of grandparents*. The role of the extended family on women's *decisions to work and to have children* is relevant, and the *substitutability between formal childcare and informal help by the family is fundamental* (Del Boca 2002). These results indicate, in fact, that the participation in the labour force of women with children is affected by childcare availability, as well as the availability of informal childcare. Family support, both in the form of transfers and in the form of help with the children, increases the probability of women's participation as well as their probability of having children'.

Before taking into consideration female physicists' desire to have a baby, we also want to stress that some surveys reveal that in Italy there

is a hostile attitude towards the idea of taking children to day nurseries (Boeri & Del Boca, 2007), an attitude that was found not only among women, but also among men: in other words, Italians generally think that no-one should take care of children until they are around 3-years old, except mothers or grandmothers. Here we have touched upon the gendered cultural model 'mothers as nurturers', which we will encounter again in the following paragraphs.

Following Crawford and Chaffing's (1987) model[13] (which considers the socio-cultural level of the gender system, which for example comprises laws, and the individual level, with individuals' decisions, as 'mutual shaping'), we sustain that the fact that, broadly speaking, people prefer not to put their children in day nursery is one of the reasons why the Italian State has not invested enough money in building new day nurseries, and nowadays in our country there are few nurseries, both public and private.

5.2 Money matters and future planning.

Creating a new family is one of those factors that drove some physicists to find the solution to their problems outside the research system. Low salaries entail difficulty in paying the rent or a mortgage. Moreover temporary contracts, like the most common fellowships, do not provide for maternity leave, sick leave and the possibility to accumulate pension rights. Those who are at risk of leaving physics are not those who have a permanent contract since, as shown in the previous chapter, although they are not satisfied with their salaries, they seldom quit for this reason. On the other hand, low salaries are a problem for those with a temporary contract, irrespective of their gender, especially when they want to have a family and a baby, because they need to plan their future. As emphasised in the following extract, the problem of low and temporary pay raises the issue of class mobility, already touched upon in Chapter 2:

[13] See Section n. 1.2.

> *What I'm trying to say is that financial stability is important for everyone. When you're young you can make sacrifices, especially when you're very enthusiastic about something. But then you run out of resources (...) It's usually because people decide to have a family and have to look after their children This is why you need to make a decision, you need money at the end of the month. Unless you have a family that can support you, but then it's just a hobby and not a job (smiles).* (P19/FS)

5.3 Who takes care of children today?

Our interviewees said that the birth of a baby makes their lives more 'complicated', but they also stressed the fact that women have to face the biggest problems since they have to play many roles. The following female stayer highlights that to combine her demanding job with domestic chores and the responsibilities for her daughter and her ageing parents she, as a divorced woman, had to sacrifice her time for herself:

> *Interviewer: And you, how do you reconcile your job with your family responsibilities?*
> *I double myself, I am here, I am there, I am everywhere (...). I have no time for myself, I am either here or at home working as a housewife or something else (...). I have always had very little time for myself (...). I am fifty six and I have begun taking stock of my life (laughs), and I can tell you that I could have thought a bit more about myself.* (P35/FS)

Concerning looking after the children, Italian interviewees share this with their partners in several ways that we divided into the following three categories.

In the *first category* we find male physicists, mainly male stayers, completely absorbed in their work, who *do not share any responsibility* for the children and the house with their wives. Actually if we consider stayers only, both males and females said that their colleagues do not give enough importance to their families because they give priority to research:

> *No, they do not. Men who work here stay here all day long, and I often asked myself: "What do their wives think about it? Have they got a family?"* (P35/FS)

The reasons given by the men interviewed is that they work all day long, weekends included, and they can do so because fortunately, as the following male stayer puts it, mothers can provide for children's needs:

> *Interviewer: And so you were saying that you don't give enough priority (to your family). How do you combine, then, your family and working responsibilities? Do you stay here in the (office) a lot ?*
> *Yes, I work hard. I am lucky that my daughter's mother always makes up for everything.* (P26/MS)

This is the largest category of Italian interviewees in relation to this issue, because here we consider both male stayers, who depict themselves as fully devoted to science, and those female physicists, both stayers and leavers, who take care of the children without the help of their partner.

In the *second category* there are the men who *try to help* their partners 'a bit'. If we borrow the 'community of practice' metaphor (Lave & Wenger, 1991), we could describe men in this category as 'peripheral' in taking care both of the children and of the house, compared to their female partners, who are in the centre of the community and in the eye of the storm.

The *third category is* to share family responsibilities. We noted among our interviewees, there are partners who try to *balance* their tasks concerning children and home. This appears to be the sharing-family responsibility model that allows women to combine their job with the family and to advance in their careers. The following is an example given by a female Professor:

> *Well, when the children go to school and there are also some activities in the afternoon we try to share our tasks equally, of course. But obviously, if I work here for 8 hours, of course he has the main burden and then it may also happen, that happens to me not to him, it may*

> *happen that I must go abroad because of my job, but I always try to stay away as little as possible.* (P15/FS)

Interviewees in this category are sometimes partners in *endogamic relationships* and we found examples of this category also in older-generation physicists. Interviewees said that endogamic partners are more sympathetic to and tolerant with the 'busy' partner, hence sometimes this type of union helps the parents in combining family duties and chores with a highly demanding job, despite many sacrifices. For this reason endogamic couples are described as being more stable compared to non-endogamic ones:

> *Private life does not even exist (laughs) (...). If I had a family it would be far more difficult; (...) there are couples who work in the same branch because in any case they understand each other very well. On the contrary, if your partner has a normal job, as a clerk for example, then you travel abroad, you come back after a week, twenty days, you work until 10 p.m., no one is going to tolerate you; so, as regards private life, such a job is a bit difficult.* (P20/FS)

If we consider the issues of day nurseries and household chores, it is evident how the *cultural model of women as nurturers* (when children are little) is widespread in Italy. This model is very much linked to that of *men as 'breadwinners'* analyzed in Section 3.3, which concerns men who maintain their families and who dedicate their time mainly to work compared to their female partners. Considering the way our interviewees described taking care of children and the home, we can say that these two models are widespread in our sample; in other words physicists accept them without a clear awareness, irrespective of gender and of being stayers or leavers. However, as already emphasized in this report, female stayers especially spoke about the great sacrifices they had to make to reconcile the care of children with their demanding job. In the next paragraphs we will see that many of them faced the question of 'reconciling' by choosing either not to have families or to have just one child late in their lives.

Considering Crawford and Chaffin's (1987) theoretical model, several sociological studies help us to underline how these gendered

cultural models are widespread on a socio-cultural level in our country. As stated in Chapter 3, Monti (2007) showed that Italian men play a very peripheral role in household chores compared to women. In addition to household chores, women in Italy take care of children and of ageing parents because care facilities are expensive and insufficient, as in the case of day nurseries. Moreover, those who prefer to use care facilities in order to dedicate their time to work are often *socially punished.* Boeri and Del Boca (2007) argued that this situation creates a vicious circle in our country, with a low level of female participation in the labour market and low fertility rates. Actually only 30 % of women work after their baby is born, and low family income forces them to have only one child. In order to stop this vicious circle, authors stress the importance of the role of public policies, which should help women to pay for care facilities for ageing parents and for their children, even when their low incomes would not allow them to do so. At the same time the authors stress the importance of changing people's way of thinking about women who choose to entrust their parents and children to care facilities: only in this way can women clear the hurdle of social sanctions against them and pay for these facilities.

In accordance with Crawford and Chaffin's (1987) theoretical model, decisions people take on the individual level are influenced by gendered models widespread on the socio-cultural one. To confirm once again this model, we want to stress that few of our interviewees, except those we place in the third category explained above, consider the sharing of child-care and chores between wife and husband as a solution for helping women to combine career and family (since in Italy welfare does not help enough[14]). Some women even believe that they have to look after their children because of 'the laws of nature', like the following female stayer:

> *I mean when a child is two years old he cries. You might also be a feminist but you don't give him to the father, I mean, because usually he's not there (laughs). That's not a matter of education that you can change. I mean, if your baby's face is red because he's got a fever of 40*

[14] We refer to the low number of day nurseries and to the opening hours of schools, for example, which close at the latest at 4.30 p.m.

> *degrees, he wants his mother (laughs). You can put on a moustache and the father can put on a wig but it won't work.* (P34/FS)

The interviewee opines that when her baby cries he wants only his mother, and in any case, even supposing that he would like to be with his father, usually he is not there and she thinks this is a situation that cannot be changed. In other words, most women in our sample do not complain about the lack of help they get from their partners in child-care and chores although they do take this situation for granted, like the following female leaver:

> *(...) He isn't someone who doesn't do his duties; he is not someone who is never there, but clearly I am the one who is in charge of these things (...) Let's say, housework. In the end, I can see that in 99 per cent of cases housework is done by women, more or less that's the way it goes, in our family too. (...) This does not mean that he is completely absent, like many, I mean, that come home at 7.30 in the evening and no longer exist, hum, but for the most part, managing these things is practically in my hands, and he takes them (children) every now and then; on Saturdays, for example, when I used to work he would take care of them.* (P16/FL)

She is satisfied with her husband taking the children 'every now and then', and doing none of the domestic chores because she had no choice. From our theoretical point of view, thinking and acting this way, the female physicists we interviewed accept and reproduce on an individual level the gendered cultural model that women are naturally the nurturers and 'the angels of the hearth'. A few women in our sample, mainly young women, seemed to be more aware of the cultural model of women as nurturers, and one of them in particular criticizes one of her female colleagues, who does not leave her children with her husband because she does not trust him:

> *It's always women's fault, it's often the case! There are men who really don't want to, I mean, I've seen many women who don't want to leave, I mean, I have a colleague that you say: "Oh, let's go out for dinner!", and she goes: "But who will I leave my child with ? No, I don't want to leave him at my mother's again, no, no","Well, leave him with your*

> *husband then!", that was my spontaneous reaction, and she said that she did not trust him!* (P28/FL)

She says that if men do not feel as responsible for their children as women do, it is women's fault, meaning that this happens because women do not ask men to be responsible for the children. In other words she is confirming Crawford and Chaffin's (1987) model, because in this way women accept and reproduce on an individual level the gendered cultural model that women are naturally the nurturers.

5.4 The motherhood threat

From our interviews it is evident that being a female physicist and a mother makes it difficult to advance in one's career, but what astonished us more is that female stayers and leavers perceived motherhood as a threat for their career and for their job. Taking care of their newborn baby means staying away from research, as a consequence of which their careers are delayed when compared to those of people without children. Many of our female interviewees spoke about motherhood as an experience they had decided to deny themselves: in order to keep up with their colleagues many of them did not take maternity leave even if they were entitled to it.

> *I didn't take my maternity leave because…*
> *Interviewer: You mean you went back right after 28 days?*
> *Yes, yes, I went back for a seminar. Whereas I didn't take my maternity leave because, it was a stupid reason. Because I wasn't supported by the group*. (P48/FS)

Researchers are aware that having a family will not help their career, so many young researchers told us they had decided to postpone starting a family while giving priority to their career, some of them preferred to give up any emotional bond or to have a child. As for women, many of them decided to postpone maternity until they had a permanent position, i.e. until they are about forty. They do so in order to compete with the

other researchers who do not leave their working context for maternity, even though in this way they run a high risk because it could be difficult to have children when a woman is over forty.

On the one hand we interviewed women, both on permanent and non-permanent work contracts, who did not take maternity leave because they felt they were part of a research context where it is important to be the first to make new discoveries. On the other hand, we met non-permanent contract researchers who did not take maternity leave because they felt coerced by the fear of not having their temporary contracts renewed, as the following informant explains:

> *(...) Here there are many girls who have children. There is A., there is I., there is a girl who has a scholarship like mine, but she also has the right to maternity, she has the right to work five hours per day, but, obviously, she stays here longer because she has a temporary job and she must go on with her work. She has to write articles because, if she does not, everything will turn against her. Even if the head says: "Ok, don't worry, you can stay at home". Then it is something personal, it is something that you decide, you say 'No, I must do it'; but if you had a steady job, maybe you could allow yourself to work for a certain number of hours per day and to devote more time to the family*. (P20/FS)

As stated in Chapter 1, Molinari et al. (2002) stressed that one of the factors that could explain the 'glass ceiling' effect in all physics research institutes in Italy is '*the comparatively late age*'[15] when the access to the first step in a career and permanent positions occurs', since 'maternity is sometimes felt as an alternative to a career by young women physicists' and because 'maternity leave is not provided for by the most common fellowships'.

As the previous extract showed, women whose temporary contracts do not provide for maternity leave usually postpone maternity until they have a stable position, whereas those who are temporary but are entitled to maternity leave usually stay away from work for just a few months after the baby is born. Temporary female researchers, compared to their permanent colleagues, perceive motherhood even as the biggest threat to

[15] About 35–40 years old.

their job, and this could be a pushing factor for some of them, as some of our interviewees emphasised:

> *Therefore, during the time you don't have a job with a regular contract, and in Italy you don't usually get one before your 40s, it is very hard to think about starting a family. I didn't mention it before, but this is another reason why many women abandon research. (...) I believe it is motherhood, because at a certain time women physicists start thinking that they cannot concentrate just on their careers and therefore they choose to look after their family. So they take their maternity leave for one year, but during that time they don't publish anything, whereas their male colleagues may publish ten articles. Therefore, when researchers are selected for promotion, male physicists are favoured.* (P41/ML)

Economists and sociologists have analyzed the issue of maternity leave, arguing that in Southern European countries like Italy 'maternity/ parental leave regulations usually only guarantee entitlement to permanent workers, while the extension of the benefit to part-timers and temporary workers is still quite limited' (Del Boca, 2003:13). Moreover, 'the growth of the proportion of youth with temporary and unstable jobs has increased uncertainty, causing delays in marriages (or cohabitation) and postponement of fertility due to lower coverage in terms of parental leave and benefits' (Ib). As a consequence, young women may wait for a stable and protected job before deciding to have a child, especially in areas where the unemployment rate is high. 'Postponement may result in a lower fertility rate' (Ibid.).

Even though almost half of our interviewees have children, our data confirmed these analyses, since many Italian interviewees postponed marriage and parenthood, women especially. Concerning maternity, our data also confirmed what Gherardi and Poggio (2003) found in their research that maternity is a kind of 'ghost' hanging over women's careers in several organizations in Italy. Moreover, we have shown that female physicists believe that taking maternity leave and having children in general means taking risks for their careers, because they could be delayed, and for their job, since those with temporary contracts fear that they will not be renewed.

But why is it so hard to be a mother and a physicist? All women interviewed described the physics research system as a 'male world', with men who either do not have a family or do not find enough time to take care of their family, fully absorbed by their job.

> *Here they are all men. I talked about this with some women who were a nine days' wonder in this group. They graduated and then they went away to do something else, and it is always so. I have been working in this environment since 1970 but I think that nothing has changed for women.* (P35/FS)

Physics has been described as a discipline and a community of practices formed by men, hence it is organized by rules and roles that take into consideration men's needs only. Physics is a sort of religion, the physicists being its priests (Rolin, 2007; Noble, 1994) who have to promulgate its laws rather than modify them. Actually none of our interviewees suggested modifications in order to improve the ways public research institutes organize research activities. Nobody challenges the way physicists organize their work; it seems that physicists have internalized this way of working and women too. It seems that these working environments do not allow stayers to combine research activities with other responsibilities, like motherhood and a family which could explain why many women have decided to give up the idea of maternity or by contrast those who have decided to have a baby subsequently suffer the consequences.

> *Interviewer: Do you think your physics colleagues attach enough priority to families?*
> *No. I'd say, what do you mean, they don't give any priority at all in the sense that (laughs) (...) they don't ask if you will manage to come at seven p.m for tonight's meeting or do you have any problems with your daughter? No, they just say there's a meeting at seven o'clock.* (P34/FS)

The narratives of women who succeeded in their careers and of those who are at the beginning of theirs led us to reflect upon some contradictions we found in the way physicists organize their work: we are mainly talking about flexible working hours and self time-management in general.

These issues do not concern physics only, but many types of professions because of the enormous changes in the labour market in all western countries. However, flexible working hours have always been part of working practices for physicists, who often work nights and during week-ends as well.

Our interviewees' narratives emphasized that in many research contexts the time they spend at work is judged as a merit by managers and Professors, though researchers (especially those who are young and temporary) are forced to stay at university, to work hard but also to let others see that they are there, that they are 'ready and available', that they prioritize their job.

Other narratives emphasised that in some places face-work (Goffman, 1955, Fuchs Epstein, 1998) is as important as the "real" work if you want to advance in your career.

Not only do researchers who stay late in the evenings have credit for staying longer than other colleagues, but they also have the opportunity to maintain relationships with their colleagues. As many scholars argued, people who can stay late in the office are mainly men, who start the so-called 'men's clubs' where a great deal of information concerning the research context is shared.

As a consequence, these practices confine the women who also give importance to their family to a kind of ghetto. Actually women who become mothers and decide to spend less time in the laboratory in order to take care of their children are often considered by their bosses to be less reliable than those who do not have children. In fact motherhood is also perceived as a threat by the research groups themselves, because productivity in terms of research results and publications could slow down. It is worth noting that sick leave is not, by contrast, considered any sort of threat.

It is hard for those women to compete with their male colleagues, who spend almost all day at university or in another public research institute.

> *If you are a woman (unclear), the fact is that you need get home a bit earlier, if you've got a family, it definitely changes you.*
> *Interviewer: Have you heard if your colleagues with families give priority to their families?*

> *Well, if you've got a family, you should give priority to your children then (unclear) I mean your attitude towards work changes, and when your attitude towards work changes, other people's expectations of you change as well*. (P11/MS)

Physicists who are mothers are considered to be less committed to their job and, hence, their colleagues expect less from them. Absence for maternity and family reasons is considered to be a problem for the research group but none of our interviewees mentioned either any practice implemented by the group itself to combine motherhood with a career, or paternity leave. In this respect the following extract is very interesting, since it is about a research group in France that decided to promote family-friendly working activities:

> *Interviewer: And do you think your colleagues would dedicate enough time to their families?*
> *It depends, generally you can't say, in this team, many of us are women, and we are a team trying to support a private life. We all work successfully and we all work a lot, but at the same time we are trying to support private life. We organize meetings and often you see some of us arriving with their kids, because they couldn't leave them.*
> *Interviewer: Really?*
> *Yes, we are a team thinking that way. So, there is not any problem but usually it is not always like that, and it's mainly with men. Someone told me that if I wanted to be a physicist I had to work up to sixty hours per week and I couldn't have a family. These people do have a wife who cares for everything*
> *(house, children, etc), they just deal with it the old way*. (P38/FL)

It is no coincidence that this type of family-friendly research activity has only been referred to us by a female Italian researcher who works in France, and that the members of the group are mainly women. France is a country where there are many public services for children: day nurseries are inside public research institutes too, and they are organized in ways to support working mothers. In this way they also help physicists who have children to stay. As we stated previously, in accordance with Crawford and Chaffin's (1987) theoretical model, decisions people take on the individual level are influenced by gendered models

widespread on the socio-cultural one. On the socio-cultural level in France, women are not socially punished because they decide to leave their baby at the day nursery until 6 p.m. because they want to work, as the same female leaver above stressed during her interview. Care facilities are organized to help them in this decision, and when they cannot help them, female researchers change their working practices to allow them to take part in meetings.

However, in the extract above the female leaver also stressed the fact that not all research groups in France think that way, confirming that physicists in several countries have a high level of commitment to their job, because what is considered to be important in their community's practices is to make discoveries before other physicists. Rather than challenge and modify the non family-friendly research practices, physicists, both women and men, take them for granted.

One could argue changes will occur when more women reach top-level positions in the hierarchies inside research institutes, but we think it will not be easy to change a male dominant working environment, where male values and attitudes have historically been necessary to climb the career ladder. Some female interviewees told us women are more sensitive towards colleagues who have family responsibilities and tasks, like the following one:

> *Interviewer: I see, why do you think it's more common to discuss this (family responsibilities) with women?*
> *Well, because there is a gender comparison that, Donald Duck would say, that it passes through the feathers of my feathers.* (P48/FS)

Could a rise in the percentage of female physicists with children promote important modifications inside the male world of physics? Is this enough? How long will the change take?

In countries like Italy, in order to change the working environments in physics, several changes must take place all together: more women need to gain access to the top levels of hierarchies inside research institutes, more female physicists with children and physicists made aware that research practices could change if they want to be both physicists and mothers. These changes might happen at all levels, socio-

cultural, interactional and individual, of a culture. Hence politicians, managers and researchers all need to be involved in the process of change. Moreover, a broader change must take place in our country in order to change the physics working environment, i.e. women must change their way of considering child-care and chores. They must start believing that they have to share those tasks with their partners, that they can trust them. As the following female informant underlines, in order to give women the same opportunities as men, the latter should be forced to take paternity leave and family responsibility in general:

> *They (women) should let men take optional paternity leave. If there were men like this in xx (inside the private company where she works), if there were men who stay at home on paternity leave, things would be different (...). If women could start leaving their children, could be less protective and say: "Darling, it's your turn now: 3 or 4 months at home, I am going to work!" this discrimination would automatically disappear. I mean you are inevitably left behind, because it's always a woman who stays at home, then a man, the employer wouldn't say: "I prefer hiring a man!" (...) But there are women who stay at home for 2 years and the husband is working, but why? (Laughs) It's our fault, that's what I mean!* (P28/FL)

If we start thinking that the family is not only a woman's responsibility and that it is not a question of helping women to find ways of combining a family with a career 'which is their problem,' we could avoid reconciliation policies becoming gender traps (Gherardi, Poggio, 2003).

5.5 Family and mobility

As already stressed in the report, the interviews give the appearance that travelling and moving from one research context to another is part of physicists' work; they travel for a few days and for months and sometimes they have to move abroad. However, mobility complicates relationships and especially family life. The following extract, for example, reveals that in order to climb up the career ladder physicists have to stay

abroad for years and to move in several research institutes, hence they are also forced to abandon relationships with people in their home country:

> *Interviewer: Do you plan to have a family in the foreseeable future?*
> *Yes, but not the near future, because the last girl I was with, and with more than one girl (...) this problem came up dramatically. (...) A long-distance relationship is really tough for me and for any possible partner, and because I just can't bring myself to demand that the other person move; I may try to find something in the same place (...)*
> *Interviewer: So let's say that your working conditions imply…*
> *"Imply" is the right verb. You can say they imply a willingness to move*. (P42/ML)

Most Italian female stayers travel less when they become mothers, especially when the child is little. With respect to the mobility issue, endogamic couples are at an advantage compared to other types of couples because the partner knows that physicists are requested to travel a lot and they do not complain.

Taking into consideration leavers, we already said that we found a connection between the decision to quit research and the desire to have a family. Several leavers stressed that especially because of moving abroad, physics is a highly demanding job which is difficult to combine with having a family and children and seeing them grow up. However, some of them said that they gave up good job opportunities abroad even after they had left academia, because they realized they would have been so busy that they could not see their family at all:

> *Interviewer: Would you give up an important job to stay with your family?*
> *I have already done so twice, and I've no regrets. I might have taken it a little bit better, but twice in my life I had the possibility to radically improve my situation. It's not even that I gave up: I tried, but I realized that too much was at stake, so …*
> *Interviewer: Was it here, in the xx? I applied for a job twice and I went abroad both times.*
> *No, it was abroad, but I realized that the sacrifice was not to emigrate, as I knew I would get used to it, but to ask my family to move because of me (unclear) to move to another place and then not to see me at all because I would be very busy*. (P27/ML)

Many leavers, both females and males, said that it is easier for them to combine their new job with family responsibilities. Hence from our analysis it appeared that female stayers and leavers who have children weigh up the price of their decisions and make sacrifices to try to combine their career with having children.

6. Identity and stereotypes

6.1 The stereotype of the physicist

During our interview we asked the physicists to say which stereotype of the physicist, in their opinion, is widespread in our society. This stereotype seems to have universal features: the physicist is a genius, creative, not understood, and "lives in a world apart". The genius-physicist is also absent-minded and shabby in appearance. Some interviewees emphasised that to be part of the community of physicists, some people think they have to behave and to perform like the stereotype, so they intentionally behave that way. Some interviewees emphasised that males often tried to be as untidy as possible and women tried to hide their femininity so as not to be judged as someone who "only thinks about her appearance". However, it has also been stressed that in the younger generations 'the mentality has changed' because nowadays you can also find attractive female students, who care about their appearance.

Several interviewees pointed out that physicists, like Einstein, wanted to be considered eccentric because they knew how people looked at them and so they consciously projected their public image:

> *Look, apart from those who give themselves airs because they're physicists or those well, they've always been (...) and they consider themselves geniuses and maybe they also let their hair grow (laugh) well these kinds of things (...). I know many of them, there are many of them and it's fun (...). But Einstein, too, was well aware: his hair, his socks were part of the character, he was well aware of it, he knew this (...) it wasn't caused by his carelessness.*

> *Interviewer: Was he aware of it?*
> *He was well aware of it, he played a little bit with his appearance*. (P32/MS)

Most male interviewees said that they recognize themselves in the stereotype. It is worth noting that men refer to a stereotype that does not make feel them uncomfortable, even if they soften some aspects of the 'classical stereotype'. They have a positive opinion of mould-breaking physicists who have a lot of fantasy because they invent something, for which people say, "Yes, you definitely are a physicist if you thought of something like that".

Among male interviewees we also found some exceptions, because some of them said that they do not fit at all with the stereotype. Some of these interviewees seem somehow to put the idea of the physicist as a genius in its right perspective. In one of the interviewees' words, the overall increase in the cultural level enables people to understand that:

> *You're not dealing with a monster with God-knows-what intellectual capability but he's just someone who studied and has different cognitive tools, which are not necessarily better than yours. That's all*. (P8/MS)

On the other hand, most female interviewees stated that they do not recognize much of themselves in the stereotype of the physicist devoted to work and science only, who sacrifices their life and family to be only a physicist. This kind of job is definitely often described as fascinating by women, though many of them stressed the fact that it's important "to see things in the right perspective". They consider research in physics as a fascinating job but then there is a whole life outside. Some of these female interviewees complain that some physicists only "hang around" with other physicists and always talk about physics. It seems that this applies to men more than women.

In their narratives women often put the stereotype of the physicist, which is widespread among students and Professors inside academia, back into its right perspective. They also make ironic comments about those who think they are "the Elect", the only ones who hold the "pure science" as perfect masters. The females interviewed seem to be more critical with respect to this stereotype and one of them even stressed that the physicists

themselves "should be the first to stop thinking about physics as a superior science, whose access is limited to a few chosen ones".

During the interview we also asked about the changes in the stereotype of the physicist in our society over the years. A lot of interviewees said they do not think that this stereotype has changed over time, because in the past people did not know what physicists do, what kind of job it is, and they still do not know now. There's a kind of fog around the image of physics researchers that still leaves people wondering, "What exactly do physicists do?"

6.2 A suitable model

In our interview we asked interviewees to elaborate their role model. For both women and men the model was a man, the main reason being that so far there have not been many women physicists, especially in the past. As the following woman underlines, female physicists have only a few female role models in physics, and this could cause problems concerning their identity.

> *Interviewer: Is there any woman that set an example for you?*
> *Well, unfortunately no, because I've never happened to have a chance to work closely together with other women*. (P4/FS)

However, it is worth underlining that a woman thinks that role models are usually male because geniuses in science have always been men!

> *Interviewer: How come that you don't, that no (no female physicist) came to mind, I mean …*
> *Because I think that a genius or anyway (...) at the moment I feel like saying every, in every field, the best, the geniuses, were men (...) I think, not women*. (P33/FS)

Interviewees, both men and women, referred to the good physicist as the one who dedicates himself body and soul to physics, who does not care about all the rest. However, they also emphasised that women are able (and forced) to play several roles – to be a mother, a wife, a physicist, a

daughter, etc. and thus she is also interested in many more things compared to most male physicists. One woman stated that her male colleagues devoted to physics have bookshelves full of books on physics, whereas her bookshelves are full of books on physics, philosophy and many other topics. She also thinks that a woman's mind has to be open to different ideas, because life requires her to care for others, like her children. Concerning the brilliant colleagues she admires she also said:

> *They're extremely clever and very particular, and they're also fathers but I don't admire them as fathers (smiles). They're very exceptional people but their wives worry about everything else, because they're also a bit absent-minded, they don't really care about other things in life. Do you understand?* (P19/FS)

As already stated in Chapter 5, women underline that male physicists devoted to science are not worried about what happens outside their places of work because many of them delegate family responsibilities to their wives.

6.3 Professional qualities versus human qualities

During the interviews we asked interviewees which qualities they think they have as a physicist. In women's narratives we found a tendency to underrate themselves, like the informant who, talking about a male physicist that she admires, said:

> *Definitely one of the things about him that I remember most is this, as I said, I mean, his intellectual vitality. I don't think I am that intelligent!* (P16/FL)

It is worth noting that often women underestimate themselves and the aims they have achieved. Some say that they feel insecure about the reasons why they are esteemed by their colleagues and involved in important research work: they think that maybe others chose them not for their capacities but because they were pleasant, attractive, or simply

because those who selected them made a mistake! The following extract from the interview with a full Professor who had a brilliant career is an example:

> *I worked, but I've always felt that the others were more intelligent than me, therefore I don't want to give the impression that I consider myself particularly clever. I believe that I have the ability, but mainly through persisting, I succeeded in many things: many people are smarter than me. Among my colleagues as well, because they might be deeper as theoreticians, I am less. I have different abilities or I'm interested in other problems. I don't consider myself smarter than the others, I don't want to give this impression.* (P22/FS)

As in the extract above, several of our female interviewees described themselves modestly in terms of their efforts and results in their job, and this attitude is widespread even among highly regarded physicists, to the extent that we can conceive their modesty as insecurity about their working abilities.

Another woman claims that there is a difference between those who have only taken a degree in physics and good physicists, and she puts herself in the former category:

> *The ones I met were really fascinating and you could listen to them for hours. A true physicist is really fascinating, plus a very nice person. But then if you consider someone who's graduated in physics, that's another thing: I graduated in physics.* (P19/FS)

During interviews, we asked which qualities they think other physicists have that they think they themselves do not have. While answering this question, women talked more compared to men and often went through a process of strong self-criticism, which in some interviewees showed a low level of self esteem for their professional capacities. Most of them stressed the fact that they themselves do not have the qualities they mentioned.

Concerning the qualities they admire in physicists they esteem, in addition to scientific capacities, women often admire human qualities, such as being faithful and reliable:

> *And, I truly admire him because besides being extremely skilled and qualified he is however a very simple person and above all I followed some of his classes and so I was able to experience first hand the fact that he didn't put himself on a pedestal as many others do.*
> *Interviewer: He had a human dimension too?*
> *Yes, very human for sure, so he was a person who, well, I must say, I admired very much from this point of view*. (P25/FL)

Men, on the other hand, referred mainly to mental and professional abilities in the physicists they esteem, such as intellectual versatility and dynamism, the ability to master highly different sectors. Those who also consider human qualities put them on a lower level compared to intellectual abilities.

From a gender point of view, in our interviewees it appeared that women give greater importance to relationships in different ways.

First they underline the importance of communication between different research groups, for instance by arranging meetings and seminars together or even simply coffee breaks, in order to exchange and compare ideas and to get positive stimuli for their work.

Women also stressed the importance of communication between members of the same group. Those working inside research institutes, for example, emphasised that physicists and technicians working in the same group have difficulty in communicating, because often communication between them is too formal and this does not help them to work well.

Lastly the female interviewees thought the quality of relationships with colleagues, hence working in a friendly and peaceful working environment, is important because "otherwise you just have a boring work relationship". The importance of working in a warm working climate has also been stressed by some male physicists.

To conclude on the qualities of good physicists, in addition to intelligence and qualifications, both for female and male physicists, a good physicist must have the gift of intuition, imagination and keen insight in order to detect the structures of problems and to solve research questions.

Concerning the qualities of physicists, interviewees, especially women, emphasised the importance of divulging science and physics, in order to let people know what it is about, emphasizing how involving it is

and how interesting it can be and that people have to have a lot fantasy to deal with physics 'because it is not an arid field, as a lot of people think'.

Finally, we want stress, too, that in this part of the interview also, most of our interviewees explicitly told us that to advance in her career a female physicist has not only to be good, but also to work a lot and to sacrifice her family life. This seems to be a *conditio sine qua non* for women wanting to climb the career ladder:

> *She's very skilled now she's the director of the experiment, one of the few women to have reached such a high rank, but she's one of those people I admire from an intellectual point of view because she's smart, skilled, quick-witted: she dedicated her whole life to this job because indeed she gave up the idea of a family*. (P34/FS)

7. Past and Future

7.1 Changes in Universities

The change most quoted in the interviews, starting from Ph.D. students up to Full Professors, is the shortage of funds assigned to research in Italy, with all the problems that ensue. In this sense the situation seems to be worse at university, compared to national institutes of research, in terms of the quantity of financial resources.

As regards funding, the observation of a leaver, who is at present doing research in France, is interesting. This physicist maintains that the lack of funding leads to a deterioration in the quality of research, having an impact also on the selection of staff: if economic resources are insufficient, there would seem to be a tendency to distribute them only according to a logic of acquaintances, "among friends", to the detriment of meritocratic procedures.

In this sector the lack of job prospects is connected to the lack of funds; this point is also brought up frequently by interviewees with respect to changes for the worse. In their narratives the opportunities for employment and insertion with a permanent contract are greatly reduced compared to past years; even after gaining a Doctorate, there is no

certainty of then having the possibility to continue working in research, while in previous decades the paths were more linear and defined, as has been highlighted in Chapter 3.

An enormous contradiction reported here is the number of people who succeed in winning a scholarship and doing a doctorate compared to those who afterwards manage to continue, obtaining further allowances or research contracts.

> *Conditions have changed over the past twenty years. They were already bad twenty years ago, because I hear the accounts of my father and I hear a lot of Professors who were in similar conditions before me. Thus they have got worse – worse in all Italy and also in research (…). Because they have cut a lot of funds. Therefore there are no more competitive examinations, with all the problems*. (P50/ML)

The difficulties of the temporary researcher's condition have been well described by the physicists on temporary contracts that we interviewed, who naturally have a close interest in the subject. It emerged from their narratives that, besides a practical, objective difficulty in trying to "manage" in the time that passes between one contract and another, which at times can even be several months, there is a feeling of demotivation regarding their role and the importance of their work; as a temporary worker it is also difficult to make plans on the work level, because in actual fact there is no certainty as to how long one can follow an experiment, which can last several years.

In recent years the numbers of enrolments into the discipline of physics have decreased and this again has probably some connection with the economic and contractual matters just described. Other scientific courses are preferred, for example those more oriented towards information technologies, because they guarantee more certain and remunerative work prospects.

> *The first thing that you see, what everyone knows, is that there has been a drastic drop in the number of physics students. When I came to the university there were 400 students, and six years later this was cut by half, to 200, and now it's even less.*
> *Interviewer: What's the reason, in your view?*

> *I think the reason is that Internet and information science have taken students away from more or less all the faculties, but especially physics, because somehow the earnings prospects are a lot better, the chances of getting a job after graduation are clearly better and there's also a much better chance of staying in Italy, because computers and information science are needed everywhere, and all governments and private-sector firms, too, are willing to pay information science experts, but those who are prepared to pay researchers on GRBs or pulsars in Italy are few indeed, somewhat more abroad*. (P42/ML)

Finally an interesting change quoted by a female interviewee refers to social mobility, which concerns both research in physics and other areas of research in general in Italy. In the past a university qualification, or at least a good cultural background, was an important factor in allowing people to "climb" in terms of social class, whereas now this does not seem to be so: it is very difficult for someone from a lower class to move to a higher one, even with a high cultural level of education, and this seems to be particularly true for research contexts, connected to their working as systems of paternalism and patronage, already mentioned in Section 4.1.

> *We have a different and serious problem of social mobility. I mean when the job of a father influences the job of a child, there is a correlation between the job of parents and their children. In my day there was greater social mobility, as schools were a means of social mobility: bright students could improve their social and cultural conditions through education; schools were a powerful medium of self-affirmation in civil professions of a highly civil society. When this situation changed, what happened is that children coming from well-off families could afford to face the future regardless of education and this harmed the students and their social promotion greatly, as being bright no longer guaranteed a better life. Schools used to have the power to expel the worst elements of the middle classes, that would have power in society anyway, and to promote the best elements of the working class who would not have had any chance otherwise and would have probably continued to be poor.*
> *Interviewer: It's sad.*

> *That's how it is, ISTAT*[16]*, for example, shows a very strong correlation between the education of parents and their children*. (P24/FS)

In the interviews changes inherent in the university as a formative agency were recorded. The Bologna Accord university reform has changed the structure of university formation from the unitary system to the "3 plus 2" , increasing the number of examinations, but at the same time sharing out the workload by reducing the syllabus for each exam. Often this change has been referred to in a negative sense, because it has apparently lowered the level of the students' qualification.

Furthermore, a female interviewee spoke of the great historical change in the university system, which from being elitist has become a sort of mass phenomenon, and this, too, besides bringing positive effects, has seemingly lowered the average level of the quality of the students' qualifications.

Considering the university as a work-place, the interviewees have often emphasised the lack of a generational change, regarding both the positions of Professors and those of researchers, and this situation seems to be mostly due to low recruitment for university appointments.

Regarding this, a leaver underlines the difference between Italy and France, where he is working at the moment and where at a certain point people can retire and are substituted by the new generation:

> *In my opinion, very little has changed in the last twenty years. You can realize this by looking at the Professors teaching there, who look like zombies. There are not many young researchers; therefore, what really strikes me is that there aren't many young people entering the university system.*
> *Interviewer: Is this what strikes you most?*
> *Yes, there is no replacement of Professors and researchers.*
> *Interviewer: Do the other physicists share your opinion about these changes? What do the people working in your institute think about them?*

[16] ISTAT is the Italian National Institute of Statistics. This institute has been working since 1926 as the main supplier of official statistical information in Italy. It is a public research body acting in full autonomy to collect and produce information on the Italian economy and society and to make it available for study and decision-making purposes.

> *Well, the situation is different in my workplace. In Italy, the situation is worse, because researchers think that this field is completely full, there are no renewals and no job opportunities. Here, it is true that there are some complaints, but the situation is much better, because every year there are competitive examinations and people retire*. (P41/ML)

7.2 Changes in Physics

A change in the physics sector often reported in interviews regards equipment, as here extraordinary progress has been made, which allows physicists to make ever more precise and refined investigations, with time requirements definitely reduced with respect to the past.

Often there are also narratives of an evolution in the dimension of experiments, which in the past involved a dozen people at the most, whereas today we are talking of work groups involving thousands of people.

The size of experiments has changed the working dimension, so that there has been a passage from small groups, where everybody knew each other and everybody knew the experiment in all its parts, to very large groups, composed of subgroups, where it is impossible to be involved in all parts of the work, but only in a small part of the "whole".

The change in the dimension of experiments would make it necessary, especially for very large groups, to have people managers, as in companies.

This change is linked to a subject, which more in general concerns the university as a work-place; but especially as regards research activity and the dimensions that this has taken on. Managerial figures, or at any rate people with managerial roles who deal with aspects such as the coordination of human resources and the finding and allocation of funds, are becoming more and more necessary. Thus there is a necessity for structural changes in the university which can facilitate its adequate functioning as a research institute.

> *A collaboration of thousands of people, you see? So this is a big change, I mean, 20 years ago, when I started, practically the experiment would*

> *involve 50 people at the most, and it was a huge thing. You knew everybody, spoke with everybody. It's not like that anymore, it's not like that anymore, and the way these big projects are run has also changed, because now, if you wish, you actually need, and there are not in reality, I mean, I would not say managers, since manager seems an inappropriate term, but I mean, people able to evaluate people for what they can do, you see?* (P4/FS)

According to one interviewee the large size of research groups may also have an irrevocably negative effect, because it allows people whose contribution is poor or inexistent to "hide" within the group, while in the family-sized groups of the past, this was more difficult, because the situation was more easily identifiable.

In the interviews, reference is also made to changes concerning the different areas of physics. Particle physics, and more generally the whole sector of nuclear physics, had its golden age in the past, particularly between the 1960s and 1970s, when sensational discoveries were made and the road forwards was clear. Today we have reached a point where the direction to take is no longer very clear and advancement in new discoveries seems to be increasingly difficult. By contrast the sectors of geophysics and astrophysics seem to be having a period of great development.

Many interviewees emphasised that most of the funds for physics have been allocated to particle physics and only a small amount to the other areas, especially those in which physics is combined with other disciplines like medicine, biology or geology. For our interviewees the reasons lie in the low level of interest of politicians and businessmen towards applied physics.

A physicist of matter, for example, emphasised that there have been no long-term projects and investments either on the part of the state or the private sector, mostly medium and small companies. He also said that several agreements his research group had made with companies were interrupted immediately after they had given their scientific contribution, which were studies of practicability, because the companies did not seem to know what to do with the results, even though the possible applications for those results had been explained. Moreover, with his colleagues he tried to contact companies to suggest the

use of a new system for the localization of wind systems, but he did not get any replies, as he explained:

> *It was an alternative way, it was a model that identified in advance which were the best areas to take action.*
> *Interviewer: To take measurements or to plant?*
> *Where to take measurements then, because at the moment they are usually taken randomly, these measurements, where to plant, so maybe you go there with an instrument, you take measurements for a month and then you decide if there's wind or not and how much (...) The model was more interesting because it gave you a more general picture (...) but that time too it went badly, I mean there weren't any orders.* (P32/MS)

Despite this situation, other interviewees emphasised that particle physicists – after advancing their career in the physics area which gets most funds – do research in biophysics, astrophysics or physics of matter since those are the more promising research areas in terms of scientific results.

It has also been emphasized that physics in general seems to be moving towards an ever greater interdisciplinary nature, which leads to "crossing the borders" not only between the various areas of physics, but also between physics and other scientific subjects, like biology and medicine. This leads to the necessity for uniting different competences, as described in the following extract:

> *A physicist only speculated with other physicists and no one else, while now we are opening towards biologists, physicians, chemists. It is an opening due to the necessity to work by having more competences. If we want to deal with a wide field and not only to "tend our garden", we absolutely need to talk with other experts and to face different competences and I think that it is beautiful, it is something really constructive and fun, I will often use the word fun (laughs).* (P35/FL)

Concerning the didactics of physics, only two female Professors in our sample do research in this field and they both emphasised that this research field has been considered the 'Cinderella' of physics by the other areas of physics. They explained that this was due to the fact that at the beginning this area was a refuge for those who had grown too old

and could not carry out research anymore, or who had never reached a good research level and as a consequence were excluded by others. Nowadays, interviewees stressed, there are still people from remedial courses but there are also people who have achieved high international qualifications and who are highly considered worldwide for the research they carry out and publish in the most important international reviews, and also in Italy. That is why one of them said that she decided to work full-time on didactics of physics after she had established herself as a good experimental physicist and became a full Professor, because as she emphasised:

> *It's important for those who have achieved high qualification levels in physics to dedicate themselves full-time to erasing any doubt about the qualifications for this kind of research and also to outlining guidelines on this research*. (P39/FS)

7.3 Future visions

In the last part of the interview the interviewees were asked a series of questions concerning their prospects and expectations for the future, both regarding their own career and the sectors of physics in which they conducted their research.

To the question how they imagine themselves 10 years from now, the women referred to more varied, and in a sense more uncertain prospects, not taking it for granted that they would remain in the research sector, but also speaking about the possibility of being involved in different activities. This could in some way be connected to the tendency for women to have different interests, already discussed in the Section concerning identity, because called upon to cover different roles.

In the future prospects of many young women interviewed, there is also the idea of having a family and children; some of them even bring a reasoning in terms of how they will redistribute their time on the basis of family commitments. This appears less frequently in the future expectations of young male researchers.

It is interesting to note the difference between some interviewees, who say they hope to continue in research without having anything to do with the more organizational or managerial aspects, and others who, on the other hand, would not be averse to having a more managerial or administrative role in research groups in the future. In this sense, differences in gender, age or role do not seem to emerge.

From the narratives of some of the interviewees, there also emerges the prospect of having a group of their own in the future, or in any case of being able to transmit in some way their knowledge or experience to young researchers.

> *Right, so after all, one might become a clever physicist, head of group, I mean, someone who transmits knowledge and information and then all of a sudden has to become isolated, you know? As at some age certain work capacities slightly decrease, so you no longer manage to follow some, so you have young people around you that create a group; you get rid of some responsibilities and they give you, I mean, they might be faster or smarter than you in some things. Or there is an exchange and so these things grow, but without this exchange, I mean, as I see it, some people are isolated already at the age of 60, before retirement, I mean, you see: they don't create anything anymore…* (P4/FS)

The interviewees were also asked to think up a way to make a career in physics more attractive. A career in physics in itself is attractive, according to the majority of those interviewed, and the problems reported are linked to the conditions in which the job of a researcher in physics is carried out. It emerges, therefore, that more funds must be allocated and consequently there must be the opportunity to have adequate remuneration with better contracts, both from the point of view of the amount of pay and from the point of view of guarantees offered by the same contract.

Thus the fundamental issue seems to be how to create the opportunity for people to have a career in this sector: to have positions, the possibility to obtain them for merit and to have a salary adequate for the commitment required of this kind of work.

> *But I don't think it's not attractive: I think it's not possible, which is different.*
> *Interviewer: Why isn't it possible?*
> *Because there aren't any positions, there isn't any money. That is, I don't think a career is unattractive when you are expected to be a researcher, a Professor or a full Professor.*
> *Interviewer: If it could be done …*
> *Exactly, if that path were practicable (smiles), I think it's quite attractive. Actually it attracted me for many years, so in the first person I can say that it is attractive (smiles). It is impracticable, that is, it is so difficult to cover that you think, understand, that there are other paths.* (P51/ML)

Among the women interviewed, and only a few young men, reference was made to the importance of making people understand, for example through a campaign of divulgation in schools, in what research work in physics consists and so what is the attraction, the inviting aspect of this job and the importance that physics has in everyday life, what "use" physics is. In the Section on identity, this aspect of the importance of divulgation was discussed.

> *I would spend more money on (unclear) because little money is invested in it; maybe I would also let schools interact more with other research bodies, with the universities, to let young people know what it means to study physics, astrophysics, to be a researcher.*
> *Interviewer: And do people really do it? Well, I do not know whether –.*
> *Yes, we did. We did it because it has been done here, but in my opinion it is still not enough: people should participate more. There are few people who (unclear), well, a new planet was discovered, no, it is not true at all (laughs); well, in my opinion, we should let people participate more in events; there should be more "making known" in Italy, because in my opinion many people do not even know what research means, that is, there are people that do not even know what a Ph.D. is. It is absurd – in other countries things are different; here, once someone asked me "Is it a short-degree ?" (they laugh).* (P20/FS)

Another interesting aspect which emerged in some of the interviews is the fact that in Italy somehow the importance of a scientific culture

compared to a humanistic one has been neglected: not knowing mathematics is not really so serious, but not knowing Italian is a clear sign of ignorance.

> *Eh, ok, well, I registered during the registration boom and at the xx in Rome. There were almost 350 students, that was nothing compared to the literature, law, economics, engineering students*
> *(…) I think that engineering has even something like three, four thousand people. So physics' appeal is a limited appeal because, clearly, a little bit because of widespread ignorance about physics in our culture. We have a, you know, humanistic culture, so, there's nothing we can do. Indeed, if you say "I hate maths" – "Ah, me too". If you say , "I hate Italian", you're considered ignorant, as if someone who doesn't know maths on the contrary were someone who's a little close parenthesis*. (P8/MS)

With respect to leavers who carry out research activity abroad, as already emphasised above, it is important to specify that we are not talking about their geographic mobility as the result of a free choice, but rather as an obligatory choice, dictated by the lack of a clear, satisfying work prospect in research in Italy. In this sense the leavers are called "intellectual emigrants", and in many of them transpires the hope and desire to come back to their home country.

In the interviews only some of them speak explicitly about the hypothesis of returning to Italy; however, although it is rather clear from their narratives that the working conditions of a researcher, at all levels, are better abroad compared to Italy, it emerges that for some of them there is a desire for, or at any rate a consideration of, the eventuality of returning.

For some of them, in their future prospects there seems to be clearly a plan to return and settle in Italy.

> *Interviewer: How do you see yourself in ten years?*
> *I imagine I'll have travelled a bit more and I imagine I'll have settled down with a family in Rome.*
> *Interviewer: Rome?*
> *Yes, and I'll still be doing this job, either at the university or at the observatory*. (P42/ML)

It is interesting to note that in some narratives, along with the prospect of returning, there emerges in any case the awareness that they would find themselves in worse conditions if they came back to work in Italy. Some openly express their desire to return, but only at certain work conditions, and above all that these do not constitute a step backwards with respect to the situation in which they find themselves working abroad:

> *Interviewer: And in your opinion, what will your place of work be like in ten years?*
> *Look, probably I have no idea. Well, it could be this one I have now, because it is a permanent job, my husband has a permanent job, or it could be abroad because both of us had decided to move, or it could be in Italy because maybe we are going back to Italy, but in any case, not as researchers in Italy, because it is not worth it, but maybe in another position, with another role, or maybe with another job.* (P47/FL)

Closing remarks

In the final part of this report, we will concentrate on some of the data which emerged from the research carried out in Italy, which, in our opinion, require further investigation. Furthermore, we will suggest measures in order to promote a positive change in physics research in our country. First, however, we would like to mention some of the problems we have had to face throughout our research in the light of that self-criticism necessary in order to improve one's work. The most difficult point to manage was the sampling of people to interview, as we were not able to follow rigid rules of statistical representativeness. We opted for a theoretical sampling[17], which had to reckon with the willingness of physicists to be interviewed and the difficulty in tracing leavers. This procedure would certainly have benefited from a longer period of time in order to obtain a wide, systematic sample. We also had to reckon with the difficulty of tracing data which was up-to-date and separated according to gender, from the sites of many of the research institutes considered. There is still much to be done on this last point in Italy, the importance of which has been emphasized by many researchers (Marolda, 2002, 25; Paciello, 2002, 159; Palomba, 2007, 35).

In the following paragraphs we will analyze some of the research data we consider useful for initiating a systematic dialogue between scientists, gender scholars and policy and decision-makers in order to plan actions aimed, if not at the solution, at least at "a reduction in the negative consequences" deriving from the abandonment of physicists and from gender discrimination in physics, for the benefit of individuals and science.

Reasons for leaving

The main reason which induces Italian researchers to leave physics – irrespective of gender – is the lack of funds allocated to research in

[17] In qualitative ethnographical research this means choosing the categories to study on the basis of their relevance to the research questions, the analytical framework, the analysis procedures and above all the explanation or description which is being developed (Mason, 1996, 94, cited in Gobo, 2001).

Italy. The lack of funds has, in fact, determined a drastic reduction in the number of competitive examinations for researchers (the first level of a university career) besides a reduction in funding for the purchase of instruments – intended in a wide sense – essential for doing research in physics. Physics is one of those scientific disciplines which require considerable funds for carrying out research and, given that often the results of some of these research projects will not be applied in the immediate future, it often happens that the national governments invest funds in these areas. However, recently there has been a reduction in government funding for research, not only in Italy but in all European countries, and research institutes have been driven to seek funds for individual projects from the private sector and outside their own country. In Italy, however, investments in research by private companies are rare and not sufficient to guarantee carrying out those studies whose applications are not immediately applicable on the market.

Alongside these changes in Italy, other changes inherent in the labour market have followed. In the last ten years short-term work contracts have been introduced which do not guarantee the same rights, for example, in terms of pension contributions and paid sick leave and maternity leave, as permanent contracts. To all this, add the very low level of pay of those who work in public research institutes, beginning with those who are at the lower levels as researchers. For all these reasons Italian researchers work on short-term contracts, renewed sometimes only for a few months, until they manage to pass a competitive examination for the position of researcher, which rarely happens before they are 35 or even 40 years old, with a very low salary[18]. This is why many of the interviewees emphasised the importance of the economic support they receive from their families, confirming that nowadays it is above all those belonging to the middle-high social classes who can aspire to a career in research.

Alongside the shortage of funds and the comparatively late age at which they have access to the first step in a career as a researcher, the interviewees, irrespective of gender, position and whether they are leavers or stayers, have criticized the system of physics research, and

[18] About 1,000–1,200 Euro a month.

Italian public research in general[19], because it is based on personal rules and relationships. In other words, physics institutes have been described as organizations based on paternalism and patronage, in which being a temporary worker is seen as an even more precarious situation by researchers, in as much as they are not subject to explicitly meritocratic rules, but to unspoken rules connected to the free will of those who have the power and the funds, in particular full Professors. Women are among the weakest elements on the Italian labour market, where they experience a situation of horizontal and vertical segregation (see Section 1.1); in particular, female temporary researchers in public research institutes are in an even weaker position, as they are denied not only pension rights, like their male colleagues, but also the right to maternity leave, and for this reason they are more subject to tacit coercion on the part of the Professor or manager, who has the power to renew their work contract.

It is interesting to note that the factors which in our study contribute to driving physicists away from research have already been considered by Molinari (2002) and Palomba (2000) to analyze the 'glass ceiling' effect in Italian public research institutes. These would seem to be, therefore, factors which have a greater impact on women, but a precise analysis of this aspect would require deeper investigation in further research.

The reflections of the Italian interviewees were confirmed by a group of physicists to whom we illustrated the results of our research during the UPGEM project seminar held in Rome from 15 to 25 November 2007[20]. Regarding the reasons for leaving, if on one hand it was emphasised that the Italian Ministry for Scientific Research has introduced some changes, such as the appointment of several temporary researchers, on the other the physicists from whom we received

[19] Universities and public research institutes.

[20] This confrontation was very important in that it permitted us to contribute to the physicists' knowledge of some real practices in the organization to which they belong. This knowledge may be useful for the organizations, which can use it for their development and innovation; for this, contributing to the acquisition of this knowledge is a criterion of external evaluation of the effectiveness of research on the communities of practices (Belardi, 2006).

comments on research data emphasised that in order to change the situation, radical and far-sighted political choices would be necessary.

Intellectual emigrants

In Italy the issue of leaving physics is connected to the mobility of those who stop doing research in their own country to go abroad. For some time this problem has been called "the brain drain" and in Italy it assumes worrying proportions, especially regarding the so-called "hard sciences", like physics. In this respect, in our report we considered as leavers not only those who have left research to work in other work contexts, but also those who have left Italy to do research abroad.

Our choice was motivated by the fact that from the reflections of the interviewees, besides what was revealed by several newspaper inquiries[21], it emerged that these researchers *flee abroad*, given the impossibility to obtain a permanent contract before they are 40 – in part due to the non-meritocratic mechanisms of selection – because of low salaries and the lack of responsibilities given to young researchers. Theirs is a choice forced by the conditions in which they have to do research in their native country: it is not only, a question of geographic mobility, but of '*intellectual emigration'*. What physicists of any country consider desirable for their career, that is, an experience of even several years abroad, for Italian researchers means the only opportunity to do research in satisfactory conditions in terms of funds available for carrying out projects (equipment, scholarships for young members of staff, etc.) and in terms of salary. As we pointed out in the report, many leavers who do research abroad hope to return to do research in Italy, and in this sense they share with emigrants the fantasy of a return, which makes it less difficult psychologically for them to leave their home country. Obviously the '*intellectual emigration'* which the interviewees speak about does not have the same dramatic characteristics of, for example, the emigration from Italy to the United States at the beginning of the twentieth century, or that of today from the poorest countries of the world to the richer ones. However, we feel that the term 'brain

[21] Such as, for example "W la ricerca" ("Long live research") of R.Icona, broadcast by the public television channel RAI 3 on 25 June, 2005; see also articles by Ichino 2007, Stella 2007 and Pappagallo 2007.

drain' ends up by "sweetening the pill" rather than highlighting the difficulties (if not the impossibility) involved in coming back to do research in Italian public institutes with the same contract and pay conditions they have abroad. Moreover, this is not only because of the shortage of research funds in Italy and the insufficient number of competitive examinations each year for researchers, but also because those who are abroad for many years are no longer part of the group of temporary researchers "waiting their turn" to be able to win a competitive examination. Once they have left the "queue of temporaries", once they have lost contact with their Professor, they risk not being able to return, except as temporaries with low salaries[22]. For researchers from other European nations, on the other hand, it is much easier for them to return to their home country. Besides, the concept of mobility confers equal importance on the idea of leaving one's place of origin and on that of being able to return if one desires to do so.

In concluding this point, it is important to underline that while the metaphors 'brain drain' and "leaky pipe-line" regard the loss of researchers as a social phenomenon, the metaphor 'brain drain' in Italian ("fuga di cervelli") tends to accentuate the choice of individuals to leave conditions which they consider worse for more advantageous ones, and that of the "intellectual emigrant", to conclude, underlines the nature of constraint which often characterizes the "flight" of Italian physicists in the last few years.

Women physicists

a) Gender asymmetry in families and careers

We have already emphasised how female physicists are the "weakest" elements in Italian public research institutes, where they experience situations of horizontal and vertical gender segregation. Our interviewees pointed out how it is above all after the birth of children that a woman's career slows down and the possibilities of segregation – especially

[22] The same law on the "rientro dei cervelli" which aims at favouring the entry of researchers to Italy from abroad, once the application has been accepted by the Ministry for Research, allows them to obtain a short-term contract renewable only after the approval of a further application to the Ministry.

vertical – increase. Our results confirm, therefore, the *"gender asymmetry in families"* factor which, according to Palomba (2000), can explain in part the 'glass ceiling' effect. In our research, however, this factor also helps to explain why some women leave physics when they decide to give priority to the family rather than to work.

In the report, we highlighted how in Italy it is expected that women, rather than men, will take care of the children, the home and often also ageing parents. Moreover, the lack of care facilities makes the burden of these responsibilities weigh even more on women's shoulders and makes it hard for them to combine a family and a career. In our sample it is above all the male stayers who do not share in the running of the home and children with their partner, whether she is a physicist or not. In fact, in this sense when male stayers speak about their professional life, they stress their enormous commitment to work in comparison to a poor involvement in their families' lives, and at the same time they are described in this way by the other interviewees, especially by female stayers. When the responsibility for running family life is not shared by their partner, this means that women physicists have a greater number of absences from work, less availability to travel and therefore greater difficulty to be part of international research networks. All this contributes to delaying the career of women physicists. Hardly any of the interviewees questioned either the fact that the women must take responsibility for the family or the way of organizing work, which is described by everyone as highly demanding. The management of family responsibilities and organization of work are considered unchangeable facts. The awareness of the difficulties of combining such a highly demanding job with the family is actually one of the factors which drive women away from research, particularly at the beginning of their career, during or immediately after their Doctorate. At the same time this awareness on the part of female physicists who decide to stay and do research could be one of those factors which prevents them from "perceiving the slow progression in their career as a result of gender discrimination" (Palomba, 2007:33).

If we had to put our interviewees in order according to the difficulties they have to face in order to advance their careers in research institutes, young female researchers on short-term contracts would be

the "weakest" elements in comparison with the other female researchers with permanent posts and with their temporary male colleagues. In fact, temporary female researchers have to face a further potential discriminatory factor along their career path: *maternity*. Just like their colleagues with permanent posts (Molinari, 2002), temporary female researchers see maternity as a risk for their jobs given that paid maternity leave is not provided for by the most common short-term contracts (short term concern) and so they fear that their contract will not be renewed and consequently their career will suffer (long term concern).

b) Identity

At this point we cannot help but touch on a fundamental issue in the lives of numerous women physicists: the question of identity. In Chapter 6 we revealed that the stereotype of the physicist is that of a male genius, creative and not understood, absent-minded and shabby in appearance. Most male interviewees said that they recognize themselves in this stereotype, whereas most female interviewees stated that they do not. Moreover, we emphasised that for both women and men the *role model* was a man. As pointed out elsewhere (Palomba 2007; Molinari 2000), women in the hard sciences, such as physics, have had very *few female role models*, that is, women achieving success in physics and having a 'normal' life, i.e. with friends, families and other interests in addition to physics. The absence of successful female role models in the sciences and the stereotype of the physicist as a male genius are issues connected with strong gendered cultural models, which can be read, as Geertz explains, "sitting on the shoulders" (1988, 436) of all those involved. If, however, besides wanting to give "a thick description" (Ibid., 14) of these cultural meanings, one intends to modify them, it is also necessary to plan targeted actions in this direction. In Italy, for example, in order to increase the presence of female role models and challenge the stereotype of the physicist as a male genius, it is essential to concentrate the vocational guidance of high school pupils and students in the early years of university not only on their studies, as has happened up to now, but also on the profession of scientist, which is what most arouses curiosity and interest in youngsters (Palomba, 2007).

To go back to women physicists, they call into doubt the traditional division of male and female roles, according to which men are the "breadwinners" and the women are the "nurturers", in as much as women devote themselves to research with just as much passion as their male colleagues. At the same time, however, physics is not a pervasive feature of their lives, seeing that many of them take on – not without sacrifices – a variety of roles (partner, mother, daughter, besides being a researcher, supervisor, etc.). Women physicists, therefore, also call into question the identity of the physicist devoted only to science. In this, though, they are not backed up by the research environment, which organizes work practices without considering the needs of those who have a double workload. Integrating one's identity as a researcher with that of a mother has been defined by one of our female interviewees as a "tricky question", to manage with "blood and tears". At this point it is not difficult to imagine a life of "female immigrants in the territories of science" – already emphasised by Seranis (1997) – which characterizes the presence of women in the world of physics.The result, the price to pay for this life, this existence, is a feeling of insecurity, a continual underrating oneself as a researcher, an aspect which often crops up in the interviews of the women in our research (see Chapter 6), as in the biographies of women scientists analyzed by Sesti (2005).

Recommendations

In the following paragraphs we have singled out some proposals for initiating policies to face the issues stressed by the UPGEM research carried out in Italy, well aware that these solutions are the result of a study, and that in order to initiate effective processes of change, the joint action of Italian and European policy and decision-makers is necessary.

Faced with such a complex scenario, in order that far-sighted strategies of change may be promoted, it is necessary not to describe the issues dealt with up to now in individual terms, but rather bear in mind the very close connection between the different factors which can drive people to abandon research and those which contribute to discriminating against women. When, for example, the reasons for the presence of very few women at the high levels of academic hierarchies are expressed in terms of "women's *incapacity* to construct their own

lobbies" (Gavetta, 2003:7) and in the "*incapacity* of women to make known and appreciate the results of their professional activity" (ISTAT, 2001: 104), one does end up by describing these issues in individual terms, losing sight of the complexity of the factors which contribute to determining them.

Measures which could affect the leaving factors and also discriminatory factors against women physicists in the short run involve providing the right to maternity and sick pay also for those women working on short-term contracts[23]. In the middle and long term, however, it is necessary to set in motion structural reforms in the organization of the universities and of research institutes which will then be translated into changes in the policies of research appraisal and selection of researchers from both a meritocratic and gender point of view. All this makes sense if inserted in policies of economic investment which bring to Italian research those funds for staff, infrastructures and instruments necessary for quality research, which contributes to making not only Italy but also Europe a highly competitive knowledge society (E.C., COM/2005/0125 and Recommendation 2005/251).

It is also necessary to develop strategies for facing the fundamental issues of gender we have emphasised. In order that gender discrimination may cease to be dealt with solely "by the experts" and that awareness of this problem may grow among male and female researchers, it is necessary to initiate procedures to favour a dialogue between the various levels of the hierarchies of research institutes[24]. A public discussion of these issues could favour the elaboration of new cultural meanings of gender and contribute to modifying the attitudes which are expressed in daily interaction between researchers.

[23] For example, various scholarships, research allowances, etc. This necessity has already been stressed by temporary researchers at various institutes as holders of research cheques at CNR and INFM. As we have already stressed in the report, INFM is one of the few Italian public research institutes to have provided maternity pay for holders of research allowances (Betti, 2002:65).

[24] In this respect our data confirmed those described in a project funded by EU that 'Young women believe that gender discrimination was "solved" in the previous generations and would not touch them' (Palomba, 2007, 33).

Changing those gendered cultural models which have a negative influence on women physicists' careers – that is, attributing to women the management of family responsibilities and the male identity of the physicist devoted only to science – requires, on the other hand, various complementary measures, such as an increase in the number of nurseries and the setting up of nurseries during conferences[25]; the insertion of correctives in the ways of organizing work practices and of the appraisal of researchers' work in order not to put at a disadvantage the men and women who optimize the time spent in the office or in the laboratory, because they have to combine work and other commitments and interests.

However, in order to avoid policies for combining family and work becoming gender traps (Gherardi & Poggio, 2003), it is also necessary to promote a change in the way of placing family responsibilities in that the women should no longer be held solely responsible and unsupported in issues that are effectively concerns for both members of a relationship. A drastic measure in this regard could be to oblige men to take paternity leave, which up to now in our country has been considered as a free choice allowed for those who have a permanent contract.

To use the words of Crawford and Chaffin (1987), improving the laws and organization of work with top-down approaches could constitute the first step towards initiating those changes at a socio-cultural level necessary in their turn to change these meanings and gendered cultural models, which in daily interaction force women to struggle with great effort to accomplish their choices freely.

[25] This has also been experimented successfully by INFM (Betti, 2002).

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Appendix

Table 1. Italian interviewees according to age and stayers/leavers groups

	Leavers		**Stayers**		**Total**
Age	*Female*	*Male*	*Female*	*Male*	
29–39	8	13	7	7	35
40–49	1	2	7	2	12
50–59	0	1	3	1	5
> 60	0	0	4	1	5
Total	**9**	**16**	**21**	**11**	**57**

Table 2. Italian stayers' present positions

Position	**Female**	**Male**	**Total**
Full Professors and research managers	6	3	9
Associate Professors and principal researchers	4	2	6
Permanent researchers	5	1	6
Researchers with fixed-term contracts[26]	5	3	8
Ph.D. students	1	2	3
Total	**21**	**11**	**32**

Table 3. Italian leavers' new jobs

	Female	**Male**	**Total**
High school teacher (physics and maths)	1	2	3
Technician at INFN	0	1	1
Member of association for divulgation of science in schools	0	1	1
Private companies	4	6	10
Air officer	0	1	1
High Finance Master student	1	0	1
Research abroad	4	4	8

[26] i.e. post-doctorate fellowships, Article 23 and other types of scholarships.

Total	**10**	**15**	**25**

Table 4. New positions for Italian interviewees who do research abroad

Position now	**Position when they left**	**Female**	**Male**	**Total**
Research Director 2nd class[27] – France	Ph.D. title	1	0	1
Teacher-researcher – France	Graduate student	1	0	1
Teacher-researcher – France	Ph.D. title	0	1	1
Researcher – France	Assistant Professor	1	0	1
Post-doctorate researcher – France	Graduate student	0	1	1
Post-doctorate researcher – France	Assistant Professor	1	2	3
Total		**4**	**4**	**8**

Table 5. Parental status of physicists

	Has children		**Has no children**		
	Female	*Male*	*Female*	*Male*	
Leavers	4	6	5	10	*25*
Stayers	12	5	9	6	*32*
Total	**16**	**11**	**14**	**16**	**57**

[27] 8 years research experience.

UPGEM National Report
Poland

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CONTENTS

INTRODUCTION

Poland seems to be one of the countries characterized by a relatively low interest in hard sciences, which is compatible with an all-European tendency reported nowadays. Not only do many potential scientists refrain themselves from starting studies and pursuing a career in this field, but furthermore, a significant number of them quits academia after several years of broadening their academic knowledge and competence. What are the internal and external causes and possible explanations of this trend, and hence how does the reality of working at the academia look like? UPGEM (Understanding Puzzles in the Gendered European Map) Project, funded by the European Commission's 6th Framework Programme "Structuring the European research area, Science and Society; Women and Science", seeks to present some answers to the above questions as its main objective is to investigate local and global cultural processes hidden behind the 'brain-drain' of scientists across Europe. The project concentrates on physics as an example of hard sciences.

The Polish National Report, written as an outcome of the 1,5 year long research, is based on 66 in-depth interviews conducted at seven universities and research institutes from all over the country with the use of semi-structured questionnaire. The research sample group consisted of 43 female and 23 male physicists, including 24 leavers[1] and 42 stayers[2], holding different

[1] For the purpose of the research, leavers are defined as persons who: left both academia and physics completely, left academia but not physics, remained in physics but only on a part-time basis. This group of informants was particularly difficult to approach as there is often no information available to the public on the former university employees or their current workplace. What is more, the former physicists were frequently not willing to be interviewed themselves or to provide contact details to other leavers.

academic degrees and administrative positions. Moreover, the research is complemented with participant observations, deep analysis of field notes and related literature.

The main assumption of UPGEM project is that the cultural-historical processes affect the academic working life as well as the selection processes in- or excluding males and females in their pursuit of professional careers as physicists. The Polish National Report will discuss this issue in six chapters, each of them focusing on a different aspect of physicists' life. For a better understanding of the problems elaborated, the first chapter will present some historical perspective as provided by the interviewees themselves. Thus, the two radically distinct political systems: communism and democracy, and their impact on the day-to-day working conditions at academia will be described. This part will also show how the prestige of physics and the perception of a scientist by the Polish society developed within the last decades.

The subsequent chapters of the Report will concentrate on the issues and factors that seem to have the greatest influence on the physicists' career paths and were often pointed as valid by the interviewees themselves. Thus, Chapter II will investigate the question of motivation in terms of becoming interested in physics and choosing physics as a field of studies. It will analyse to what extent family, teachers, literature or social norms contribute to the above-mentioned decisions.

The third Chapter will explore the problems of reconciliation of academic career and family life that physicists are often confronted with. The informants' statements on such topics as the significance of family in their lives or their approach

[2] Stayers interviewed were selected on the basis of their sex, age, academic degree and administrative function in order to present the full spectrum of standpoints resulting from different experiences of informants.

towards resigning from some professional obligations for the sake of family will be discussed here. Moreover, such issues as a demanding nature of physics, silent requirements of mobility, or challenges of parenthood perceived as factors having a great influence on both family and scientific life of scholars will be elaborated in detail. Adaptive strategies applied by physicists in order to cope with work/family conflict will also be covered in this chapter.

In order to provide an even clearer picture of problems scientists have to face at the university, the following two chapters will focus on academic working environment. In Chapter IV, the subtle issue of gender discrimination will be discussed; perspectives of both women and men will be presented. Even if not named as such by interviewees themselves, various examples of discriminatory practices will be brought to the surface. In case of discrimination against women, the questions of motherhood seen as an obstacle in pursuing one's academic career in physics, difficulties with acknowledgement of women's excellence, and gender stereotypical approach towards female scientists' skills and competence will be elaborated. The interviewees' opinions on such a controversial question as whether their career could have taken a different course if they had been of the opposite sex, will also be analysed in this chapter.

Chapter V, however, will continue discussing the problematics of working environment by analysing such factors as work organization, social atmosphere and employment conditions as the ones that may influence everyday work of an ordinary physicist. It will be demonstrated that the majority of scholars appreciate flexible working hour system as it allows them to organize their time and place of work according to their individual needs. On the other hand, many scientists point to the lack of employment stability, particularly visible in case of PhD students,

as a main drawback of working at academia and a potential factor for leaving it.

Finally, the last chapter will investigate the data material based on the interviews with those physicists who quitted academia. The emphasis will be put on their reasons for leaving the university as a workplace, which will be analysed according to three historic periods: communist times, the transitional period of the 1990s, and the beginning of the XXI century. The chapter will also look at the new places of work of the physicists who decided to leave academia at various stages of their research careers.

The main objective of the Polish National Report is to investigate the factors that lay behind 'brain-drain' in Polish physics. With this aim in view, the analysis will be centred round two major axes of comparison[3]. On the one hand, the study will juxtapose the way male and female physicists experience these processes—whether there appear any gender differences, and if so, which aspects play the most significant role for each gender (gender axis). On the other hand, the categories of stayers and leavers and reasons standing behind their choices of continuing or quitting academic career will be discussed ('brain-drain' axis).

[3] As the third axis of UPGEM project – 'culture axis' focuses on differences between partner countries, it will elaborated in detail in the Culture Catalogue.

CHAPTER I
PHYSICS AND ACADEMIA IN POLAND UNDER COMMUNISM AND DEMOCRACY

The insight into the phenomenon of physicists' 'brain-drain' at academia would hardly be possible without identifying local cultural-historical processes in a particular country as "the practices of scientific investigation, its products and its norms are historically variant" (Rouse 1962, 60). In practice, the assumption means that science and society not only influence but also co-construct each other; this mutual dependence can be clearly seen in the context of Poland, which, in its recent history, experienced two contradictory political systems, communism and democracy. Studying reflections of UPGEM respondents allows to analyse how the situation of Polish physics and academia has changed under the above-mentioned regimes in the last decades.

The period of communism is inseparably connected with the notion of the Cold War (from the mid 1940s until the beginning of 1990s), that is the time of conflict, tension and competition between the United States and the Soviet Union as well as their allies, with Poland on the side of the USSR. The rivalry was played out in a number of areas, such as ideological, military, industrial, or technological ones (Nowa encyklopedia powszechna PWN 1996, 1025). To win the battle the two superpowers involved many scientific fields placing particular emphasis on hard sciences. One of UPGEM respondents comments on that period in the following way: "[…] in the Soviet Union a lot of money was spent on research, especially in the field of physics, where new discoveries were expected to come up. For example, the fission of an atomic nucleus was used for the construction of the atomic bomb. [Also] in other cases the Russians expected to gain superiority over the Americans" (*09p, male). The trend of

promoting and investing money in hard sciences was also observable in Poland, which as an ally of the USSR, had to follow its line of policy: “A part of this research was done also in Poland […]. The research was supplied with a lot of money and the development of physics at that time in Poland was great” (*09p, male).

Due to substantial financial aid on the part of the governments, science at that time was brought to the fore of national consciousness and therefore began enjoying high prestige among the societies (Wade 2007, web page). Spectacular discoveries and exceptional development in physics not only made scientific literature and films become more popular but also caused the emergence of other forms of physics dissemination, such as special interests groups, trips, seminars, lectures and contests organised in youth palaces and cultural centres. An undeniable role was also played by media, which, according to Enwise Report, “succeeded in building a positive public image of science in society” (Blagojević et al. 2003, 43) at that time. The ‘golden age’ of physics, especially high energy and elementary particles physics, is often recalled by the physicists themselves: “It [physics] used to be more fashionable… There used to be more popular scientific programs and [even] ordinary people, laymen, were interested in science” (*03m, female).

The above mentioned description stands in a striking contrast to the recent situation of Polish science as the collapse of communist regime in 1989 caused the end of the Cold War and thus the “good years” (*17a, male) for physics. A sharp cut on military spending, paralleled with an economic crisis that resulted from the transition to democratic political system, brought about a significant reduction in expenditure on science. This phenomenon is best reflected in the poor financial conditions of scientific institutions, which, according to UPGEM research, often lack funds even for basic equipment. One of the male professors

illustrates the dramatic condition of Polish academia in the following way:

> […] a lot of money is needed and the state does not want to give any financial support. The state subsidies are sinking, they are one of the lowest ones not only in Europe. We do not compare ourselves to Europe, but to countries such as India. Only 0,5 per cent GNP is devoted to science in Poland. It is a ridiculous sum. In other countries the amount is 2 per cent, four times as high or even more. Richer countries give a lot more (*09p, male).

In the democratic reality, low investment in research has also contributed to the diminishing prestige of science and scientists. Enwise Expert Group explains the phenomenon with lack of a defined strategic goal— which in the communist time was both to win the Cold War and to create the rational socialist society—and the appearance of new career prospects outside the university. UPGEM analysis also proves this theory. Moreover, the contemporary media "lost any interest in building the public image of science and scientists in society, because they had also their new priorities and agendas" (Blagojević et al. 2003, 54). What is even more striking, the similar tendency can be found in 'post-transitional' educational system, which having downgraded physics as a school subject, is often blamed for contributing to the negative image of physics. The two below UPGEM quotes confirm the described trend:

> […] we have a completely different situation with students because they now come completely unprepared for studying physics. […] It is not their fault because they come here having had one hour of

> physics [per week in high school]. Some of them don't know anything (*02p, female).
>
> Young people are afraid to study physics, they are just scared. What we have are not the students who want to study physics, but the ones that have to study something and found themselves here (*09, male).

Another aspect symptomatic of democratic period has been the development of marginal so far scientific specialisations. The demands of market-oriented economy and democratic society have made also physics itself adjust to the new challenges of life. In response to these requirements, the focus has been put on such fields as biophysics, geophysics, nanotechnology or econophysics. In the interviews, the informants themselves point to the importance of those fields: "During the last years […] some majors have appeared, characteristic of current times, like econophysics. […] It is a combination of physics and economy. An application of some physical and mathematical methods in economy. So new majors appear" (*11a, female).

The above analysis shows explicitly that political and economical trends have always strongly influenced the development of both science and academia. Since the system of funding under the communist regime was focused more on financing working places rather than research itself, Polish scientists could feel absolutely secured in terms of their salaries as well as research funds; nevertheless, they lacked political and ideological independence. It was only after the fall of communism that the whole Polish society regained long-awaited freedom. For the scientists, including physicists, this meant the possibility of making their own research decisions. On the other hand, however, as it was already mentioned, they lost a substantial part of the

financial government's support (Blagojević et al. 2003, 48). Hence, in order to maintain an appropriate level of research and education, scientific institutions have been made to find additional sources of income. This, in turn, has imposed on physicists a necessity of constant applying for grants and scholarships, which not only constitutes for them an administrative burden but also considerably disturbs them in pure scientific work.

Applying for grants, however, seems to be particularly essential when it comes to trips abroad, which are an inseparable part of physicists' work. Though there are a lot of offers available and scholars are free to travel abroad without any political restrictions, the procedures of obtaining financial support are often very complicated and do not guarantee success. The only exception was the period just after 1989 when the governments of Western countries used to encouraged their own academics to invite and maintain close scientific contacts with researchers from the former Eastern block: "[…] at the beginning of the 90's, when all those political barriers disappeared, we were in this lucky situation that […] the other side wanted to see us there – they even used to get money from their governments or some foundations to invite these people from this part of Europe or the world" (*18p, male). In contrast to the present situation, in the communist times, scientific exchange as well as international cooperation were not only limited to the Soviet Block countries but also under the strict control of the party and government; "there were state contracts, which determined the exchange level. After such an establishment it was distributed" (*09p, male) among particular research institutions and so not every scientist was free to take part in this exchange. It was only in the 1970s when the departure procedures were alleviated and so not only the party members were allowed to leave for the Western countries but also ordinary scientists had such opportunities. One of UPGEM respondents recalls this period in the following way:

> I was – already by the end of the communism – abroad. And it made a huge impression on me, not only as far as physics was concerned, but [because] [...] then going to Berlin or Prague was something like going to the moon, for this iron curtain was so tight... For now it's enough for you to have some cash and you simply get on the train. And [...] this is really an unimaginable change – this feeling of freedom. [...] Well, just think, going to any congress, any convention, or visiting some laboratory was an incredibly difficult thing (*27p, female).

Another difference in the status of science and scientists under the communism and democracy is the stability of employment. The older generation of UPGEM researchers often stress the feeling of security academia provided them with during the time of communist regime. Interestingly, it strongly corresponds with the Enwise Report's finding which states that "as a rule once appointed to a position in the R&D [Research and Development] sector, the scientist could not be dismissed for reasons of poor performance" (Blagojević et al. 2003, 48), thus s/he was not afraid of being made redundant. This aspect of working conditions changed dramatically along with the dawn of democratic system; since then, long-term contracts have been no longer taken for granted and therefore scientists have had to compete not only for the project funding but also for academic positions and contracts. Additionally, their research progress started to be regularly evaluated by assessment commissions. The above change is best described by one of the astronomers:

> INTERVIEWEE: Has physics/astronomy and the university as a workplace changed in your opinion over the last 20 years?
> RESPONDENT: In Poland, it has. It is a totally different university and the world, different working conditions. Before, it actually used to be this way that if I wasn't openly against the [political] system I would be able to afford doing nothing here and live quietly until I retire. Now it's no longer possible. Now one has to compete very hard with the whole world, especially in astronomy and physics, I think in mathematics too. Briefly speaking, in science. There is big difference (*13p, male).

The following discussion confirms that changes in academic working conditions have negatively affected the researchers' feeling of workplace stability. Therefore, there is no wonder that many of them express their dissatisfaction with the fact that despite having a permanent employment "everything is in question […] [and thus] there is no stability" (*03p, female). The other problematic issue often mentioned by physicists in this context is a very restricted number of vacancies at the universities. Contrary to the communist period, during which Academia offered a wide range of positions to the university graduates, democratic system brought about a sharp limitation in the possibilities of employment. The group which seems to be the most affected by this change are PhD students who, despite having gained a degree of doctor, often have to leave Academia after completing their studies, as "there is no employment for them" (*25p, female). It seems that the situation has been strongly influenced by a relatively recent modification in the system of obtaining PhD degree. Previously, a postgraduate student of physics while doing his/her doctoral research was simultaneously

employed at the university; they had eight years for completing their thesis and then their contracts were automatically prolonged. Currently, such a person is admitted to four-year PhD studies which neither guarantee him/her employee rights nor the opportunity of being employed after doctoral defence. Hence, in the opinion of many scholars, doctoral students in Poland "don't have actually any prospects" (*18p, male) at academia.

Summing up, one can draw the conclusion that all the changes at academia discussed in this chapter stem from one source, that is the shift of Polish society from communist to democratic system. And indeed, this transition caused not only political and economical changes in the country but also strongly influenced the role of science in Polish society. As it was already mentioned, during the communist regime, due to military demands of that time, "science was on a pedestal" (*02p, female), both in terms of prestige and government's financial aid. Thus, also scientists themselves enjoyed high authority and a privileged position in the society. In democratic Poland, however, the profession of a physicist cannot be considered as prestigious any longer. Furthermore, it is sad to observe that, according to some academicians, the main "attractiveness of physics is the fact that […] when all the universities have finished recruiting, […] [they] still take people on" (*05p, male), which clearly shows the present lack of interest in physics among young people. Thus, one may conclude that the agendas and priorities of a particular political system condition the functioning of physics in the society. All in all, Polish findings do not comply with some scholars, such as Robert Merton (1942), who would like to perceive science as neutral and free from any cultural and social interferences.

CHAPTER II
TO BE OR NOT TO BE A PHYSICIST? ISSUES ON PHYSICISTS' MOTIVATION TO DO SCIENCE

In order to understand the nature of physicists' work at academia as well as reasons for their quitting science, one has to investigate the motives why they decide to take up physics at all. This chapter aims at analysing the issue of motivation both in terms of becoming interested in physics and choosing physics as a field of studies. Hence, the analysis covers a period from an early childhood of the respondents, throughout their school years, until they begin education at the university.

The majority of the informants admit their scientific interests started already in their childhood, as it was, for instance, in case of a male researcher who recalls that he "was interested in this before […] [he] even learned that it was called physics" (*4p, male). One of the explanations for this phenomenon may be the fact of having some family members whose professions were somehow related to science and who created "that kind of [scientific] atmosphere" (*6p, female) at home. Therefore, there is no wonder that among UPGEM interviewees one can even find some clans of physicists in which scientific traditions are handed down from generation to generation.

The relatives whom the respondents mention in this context are usually their fathers and siblings, however, only the first ones can be considered as the key figures in shaping children's interests in physics. It is particularly striking in the families where there were no sons and therefore fathers, having no male successors, tried to pass their scientific curiosity on their daughters. Not only did they help them with homework but also encouraged them to get some hand-on experience in science. Such parent's approach is described best by a young female physicist:

> My dad is an electrician. I have only an older sister so it was me who was this youngest child… a father's daughter, who always used to be a helper, used to hand some spanners to bolts, repaired different appliances, dismantled them. I think, that the credit of my being a physicist today goes a bit to my father, as he, for example he never shouted at me even if something was impossible to repair any more, although it was the most precious watch from a grandfather or someone else. I always had to – wanted to – know what was inside and I always had to touch everything. […] And I also remember that then I always solved problems in physics with my father, he used to sit for hours and think of a solution and so on (*07p, female).

Interestingly, this kind of encouragement to intellectual progress can be also noticed in some families where a father was "a simple man, not educated one" (*25p, female) and, yet, he made an effort to instil in his daughter or son the necessity of self-development, which resulted from his belief "that one has to learn, […] one has to develop, has to read books, has to be interested in the whole world" (*25p, female). Taking into consideration that this issue appears especially in the interviews with professors, one may assume that such attitude towards knowledge cultivated at home contributed to their success in physics.

Discussing the issue of forming physicists' motivation to do science in their childhood, one cannot ignore a possible negative aspect of a family's impact. This is strongly connected with the process of socialisation, which has been widely discussed by a number of studies (Firkowska-Mankiewicz 1995, Budrowska 2003). According to this concept, social norms impose certain stereotypical behaviours on both women and men; the main

determinant of a woman's position in the society is motherhood, whereas the basic source of a man's status is professional work (Budrowska 2003, 56). Furthermore, this role assignment seems to be also reflected in the field of sciences; women are mainly linked with humanities while men are primarily associated with hard sciences. The below quote illustrates this issue:

> […] there are fewer women in physics. I think it is also caused by the fact that already in their childhood, girls are brought up in a different way, boys are brought up in a different way – girls are treated like dolls, they sew clothes, and boys are those who help their fathers solder, repair something, use hand tools, etc. […] A girl must behave well and she must read poems, and then it would be best if, at a secondary school, she could write her own diary and so on – and so they are oriented more in the humanities, no matter if they show predisposition to it or not. Then, it works further like that (*07p, female).

The second stage in developing the respondents' passion for physics is a school period, during which the main role in shaping young people's interests seems to be played not by the family but rather by teachers. According to Women Physicists Speak report, educators "have the responsibility of teaching students about both the subject matter and excitement of the field. They also have the opportunity to affect students' confidence in their ability to succeed during the period when many students first make choices about eventual fields of study" (Women Physicists Speak 2001, 7). Indeed, UPGEM analysis also indicates deep teachers' involvement in the process of maintaining interests in physics in their pupils; more than 50 percent of the respondents point to a

positive role of their physics teachers in the development of their scientific curiosity; remarkably the majority of them are women. The informants often picture their physics teacher as an open person who "organized a physics interest group, […] put […] [pupils] up to the olympiads, some physics competitions […], suggested some books" (*15a, female). On the other hand, however, only six out of sixty-six interviewees admit that their choice of scientific field was exclusively affected by their teacher's approach while the rest describe them as guides and facilitators only. The following quote can serve as an example:

> RESPONDENT: […] I think, my teacher from the secondary school – just a physicist – made a big impression on me. He taught physics very well. And that was, I guess, what made me decide to choose such a studies faculty.
> INTERVIEWER: Did he encourage you to choose exactly this field of studies?
> RESPONDENT: No, not really. However, when I expressed such a will that I would like to study physics, I must say, that he devoted a lot of extra time to me, he even made some experiments in the laboratory after, you know, our normal classes or we just solved some issues. So surely, in this sense, he both helped me and he was a man who in some sense shaped my future (*25p, female).

Interesting to observe is the fact that in case of men, the role of teachers seems to be of minor importance; it is especially visible when it comes to discussing the prime source of inspiration for physics and can be proved by the fact that among the six interviewees mentioned earlier, whose interest was triggered by a

teacher, there was only one man. In contrast, men often stress that "the finding of the so called path to physics was […] [their] own initiative" (*9p, male). As many as 87 percent of male informants claim that there was no one in particular, except themselves, who motivated them to take up science.

A vital part, however, in creating both female and male physicists' passion was played by science-fiction literature, which not only introduced them into the world of physics but also made them consider this field as their future profession. Interestingly, an older generation praise the availability and variety of scientific literature especially in the communist period which was connected with the wide dissemination of physics at that time. (See: Chapter I) In the opinion of UPGEM informants the propagation of physics in Poland in 60-ties and 70-ties was connected with substantial investment in scientific research and discoveries as well as involvement on the part of physicists/astronomers themselves. Some interviewees stress the great impact of, popular at that time, youth palaces and cultural centres which encouraged children and teenagers to take up science by organising for them special interests groups, trips, seminars, lectures and contests. One of the respondents recalls the atmosphere that accompanied that period in the following way:

> But truly, in those times – I graduated in 69 – physics was present everywhere because there was plenty of popular scientific literature everywhere, there were films, scientific discoveries… The 60s, the 70s these were the years when physics was developing very dynamically. That is why such films as *Dziewięć dni jednego roku* came out then – they also decided [about the popularity of physics]. Then books about Marie Curie-Sklodowska were published... […] Besides, there was plenty of

> quotations, science was on a pedestal and I had the need to confirm authorities. I mean, those people were authorities for me – astrophysicists, physicists, chemists I just wanted to learn something from the mystical knowledge. […] Then there was this kind of scientific atmosphere... (*2p, female).

Following one's interests in a particular area of knowledge can be considered as an obvious reason for choosing this area as a field of study. However, while analysing UPGEM data, some interesting observations related to gender differences appear. In case of male interviewees, studying physics may be regarded as a natural continuation of developing their scientific curiosity, as it is expressed in words of a male researcher: "I knew it already in primary school, that I will be studying physics, only I didn't know what exactly. At high-school I crystallized my, so to speak, views, that [it would be] experimental physics and more in the nuclear physics sector" (*10p, male). For female physicists, on the other hand, the choice of studies was usually more complicated as their scope of interests in general seems to be much broader. Therefore, female decisions on selecting physics as their major were often a result of their resignations from studying other subjects, for example mathematics, architecture, biology, chemistry, psychology, fine arts, German or French philology. These resignations were, however, not fully dependent on them but, to a large extent, caused by low self-esteem or unfavourable external factors, such as failure in entrance exams, illness or mobility aspects. From this perspective, choosing physics studies by some female respondents may be treated as their 'second choice'. The following quotations serve as best illustration of this trend:

> I even wanted to study French philology in the beginning but my mum firmly said that I was not prepared well enough for the studies (*2p, female).

> I was taking entrance exam for psychology […] and I didn't get admitted. […] And so that I found myself studying physics" (*12m, female).

> After high-school, I actually chose mathematics, and I wanted to study it very much, but it turned out I passed the exam, but the number of points was too small to take up mathematical studies, and I thought 'Why not? We'll try and see if it works out.' And it did (*16p, female).

> I really wanted to be an architect. Well, but later they showed me there that I could not draw too well. […] I had some marks at secondary school and I got tempted that, 'Oh, at physics it will be easier and maybe somehow without an exam' (*24p, female).

To sum up the discussion on motivation, one may notice that the passion for physics in future physicists developed as early as in their childhood. Interestingly, girls seem to have been infected with scientific passion mostly through personal contacts, by contrast, boys developed their interests mainly on their own. No matter how this curiosity was aroused, in both cases it was strengthened by school teachers (though to a lesser degree in case of male pupils) who often acted for their pupils as advisors and helpers. Therefore, the choice of physics as a field of study seems to be in many cases a natural course of events. From the above observation, one may draw a general conclusion that both male and female physicists were strongly motivated to do science and, thus, this aspect seems to be of little importance in their decisions to leave academia.

CHAPTER III
IS IT POSSIBLE TO GET THE BEST OF BOTH WORLDS? ISSUES OF RECONCILIATION OF ACADEMIC CAREER AND FAMILY

Contrary to a stereotypical image of a scientist, who often tends to be associated with a 'lone wolf' buried in books, fully devoted to his studies, and not meant to deal with everyday problems, the majority of UPGEM project's interviewees had established family and declared that it is of a great value to them. As a consequence of the willingness to get the best of both worlds—academic career and family—they need to juggle efficiently between professional responsibilities and family chores. The narratives gathered reveal, however, that in terms of work/family reconciliation, the informants cannot be perceived as a homogenous group. Such factors as gender, parenthood as well as age and position in the academic hierarchy play a great role influencing the physicists' standpoints on the issue. Thus, in this chapter, the following axes of comparison will be taken into consideration: women vs. men, parents vs. the childless, beginner scientists on entry positions vs. experienced scientists at high academic posts.

While responding to the questions concerning family issues, the physicists interviewed covered a broad range of topics important to them. Among the most frequently and widely discussed, one could find such recurring motives as demands of scientific career, mobility, household work and sharing duties, children, working environment arrangements. As these issues seem to be especially symptomatic of a physicist's academic career, they will be elaborated in detail below and the three above-mentioned axes will be considered.

No matter if single or married, a woman or a man, with children or childless, a PhD student or a professor, a significant

majority of interviewees sees the family as of great value both to themselves as to their colleagues. These informants who gave an ambiguous response to the question on the importance of family in the scientists' lives, supported it by giving examples of people both fully focused on their professional work and thus not very much interested in family matters, and the ones who give priority to the family. The voices raising negative opinions in terms of this issue touched usually upon some more general problematization of physics as a very demanding profession not leaving time for family, which aspect will be further discussed in detail. All in all, however, an overwhelming majority of respondents perceives their family, understood as both spouses and children, but also parents, as a clearly significant element of their lives. Surprisingly enough, a couple of informants noticed that according to them younger generations of physicists are more family-oriented than the older ones. This observation was supported by their arguing that nowadays one cannot find that many unmarried persons among physicists as it used to be some time ago:

> My male colleagues with whom I studied, they almost all got married. My female colleagues got married too. It's sort of strange because when you meet the older generations of physicists, there are spinsters and confirmed bachelors, and it's not like that with younger generation. I guess, all in all, we're all attracted by family values (*5m, female).

Renata Siemieńska in her paper *Polish Universities as a Place of Study and Academic Careers: Class and Gender Considerations* mentions this issue as well, and referring to some older data notes that in the past there used to be proportionally more single and divorced women among Polish scientists and academics than the average in the society. However, more recent research, she draws

upon, demonstrates that women in academia seem to marry more frequently nowadays (Siemieńska 2003, 17). The other UPGEM interviewee had, moreover, the impression that for older academics family is often a burden, a "necessary evil" (*22p, female) as she describes it lacking any better comparison.

The informants further acknowledged the fact that they do prioritize family as a significant aspect of their lives by expressing their position on the question whether they would give up some important professional task or a project due to family reasons. With some minor exceptions, nearly all of the informants declared that they would resign from a work task for the sake of their family or assured of their willingness to negotiate and find a compromise solution that would allow to keep the balance between professional and family obligations. A group of respondents stated that they could not have imagined such a situation taking place or that their reaction would depend on the specificity of the case, but at the same time they did not distance themselves from the possibility of prioritizing family, if there occurred such a need. It seems that proportionally more men than women could be found among this group of interviewees not giving a clear-cut answer to the question. This could suggest that either thanks to their comfortable family situation, they had never had to confront themselves with such problems or that though perceiving family as important they are still more inclined to weigh pros and cons of such decision. On the other hand, women seemed slightly more prone to present unambiguous reactions or one could conclude from their statements that they once had to make such a choice.

The issue quite often brought up by informants of different age, gender and academic position was the requirements that the scientific career poses in front of a physicist. Physics was described as a highly demanding profession that needs full commitment. On the other hand, as one of the interviewees said

"It's interesting enough for one to forget sometimes that it's worth leaving it and going home" (*18a, male). Although a significant number of scientists interviewed thinks that reconciling scientific career and family is definitely not easy, some of them go even further arguing that being successful in one field excludes the possibility of reaching the top in the other:

> However, scientific work unfortunately requires sacrifices. It is absolutely out of discussion. I don't believe that people may be super in two areas – professional and domestic. Always, there is something at the cost of something else (*23p, female).

In case of women this work/family conflict seems to be even greater, which is more specifically described in Chapter IV. While discussing potential difficulties that are linked to the pursue of a career in physics, one of the female interviewees raised a very interesting issue of the clash between scientific career demands and socially constructed expectations towards women:

> Well, there is this cultural model in Poland that women should not chase after a professional career. And somebody who wants to work as a scientist has to chase after such things, be very ambitious and even ready to sacrifice family life a little bit, I guess. That's because this work is connected to various, longer stays abroad. Not everybody is happy with it (*3m, female).

This statement, however, not only points to the difficulties female scientists can face, but also brings to the front one of the biggest problems of many physicists and yet, at the same time, a

great opportunity for them, namely the issue of mobility. Being flexible, mobile and ready for various trips not only in the country but also abroad is a requirement each physicist thinking of having a career in science, has take into account.

The narratives of informants, regardless whether they already had some experiences of longer research trips or just consider it theoretically, clearly show that for a majority of interviewees mobility might be perceived as problematic. Both among women and men, there occurred a few voices declaring that one did not face any complications while going abroad for longer or that one has no opinion on the topic; they, however, constituted a visible minority. Surprisingly enough, in these cases, the fact that burden of family chores was simply shifted to spouses or other family members, who were just forced to manage the situation, or that these were not very long trips, or that the informants were able to take their families with, was given as explanation. While discussing their past or possible future travels many interviewees declared that the separation from family seemed the most disturbing. The situation was even more complicated in case of the informants with small children. Consequently, a number of physicists interviewed expressed their unwillingness to go abroad for longer without their families. Obviously, in case of those, who were single or did not have to take any special care of their elderly parents, the decision to do some research away from the country looked much easier. All in all, for both women and men, one of the frequently applied methods of dealing with job requirements in terms of mobility was choosing only shorter trips or going aboard with family.

Although, such factors as the length of the trip, distance from home, and what scientific or financial opportunities such travel would provide, could have a major influence on the informants' decision regardless of gender, one could, however, notice a difference in female and male scientists' narratives

concerning the mobility question. While not denying the fact that a longer trip abroad might be problematic, none of the male physicists interviewed and being given a chance to conduct some research abroad, actually referred to any experiences of resigning from such an opportunity due to family obligations. Although a number of male informants declared that if offered such a chance, they would rather not take it unless family can be taken with, these were still hypothetical assurances not proved in practice yet. As far as female physicists are concerned, some of them already made some actual sacrifices for the sake of their families; various examples of resignations, postponing, or shortening of trips abroad because of childcare or other family obligations were mentioned.

There is no doubt that reconciliation of professional and family responsibilities is an issue existing not only in relation to mobility possibilities but also, if not predominantly, in everyday life. The analysis of the interviewees' statements concerning juggling work obligations and family and household chores allows first to differentiate between two groups of respondents: these who perceive balancing family and work as problematic and those who do not find it especially difficult and/or do not have any opinion on that topic. What is worth mentioning is the fact that no direct question on the level of difficulty of combining work and family tasks was asked and the interviewees just referred to their feelings while describing how they actually reconcile these two spheres of life.

As to gender differences that can be assumed on the basis of narratives, one can notice that a significant majority of male interviewees either does not perceive reconciliation of work and family obligations as exceptionally hard or does not relate to this topic at all. Among women the proportion between those who find it problematic to pursue a scientific career and fulfil family obligations and those who manage without major complications is

more balanced. This can suggest that despite allegedly growing equality and greater involvement of men in family life, women are still more burdened with household chores and consequently their reconciling with professional career more often poses a trouble for them. One should also note that proportionally to male scientists, women talked more about their families and problems linked to them.

It is worth bearing in mind that in case of work/family balancing the factor of gender, though very important, is not the only one significantly affecting the informants' attitudes in this respect. The group of interviewees declaring no problems with juggling professional and home obligations consisted, to a large extent, of people who do not have any families, defined as partners or children. These were in majority single PhD students who have not yet established any stable relationships and often still live with their parents. The other sub-group were people who are married or have partners but are childless. The issue of children as contributing to a greater burdening of physicists with family responsibilities was frequently brought up by this segment of people. They argued that since they had no children, their family responsibilities were rather limited and thus their reconciliation with scientific career did not cause any substantial problems. Among those who had partners and children but still did not see any major complications with family/work juggling was a number of older scientists occupying higher academic positions. On the other hand, the group of respondents admitting that reconciliation was problematic for them was much more diversified.

No matter if successful in juggling scientific career and home responsibilities or desperately overwhelmed with numerous burdens resulting thereof, both female and male physicists referred to various adaptive strategies that help them to manage the work/family conflict. The methods listed could basically be

divided into two groups: these concerning cutting on work responsibilities and these linked to family chores.

As far as the first group is concerned, changing scope of one's professional responsibilities, reducing limits on working time or choosing one-academic career, one-job marriage[4] or, in more radical cases, deciding about one partner's quitting academia were among the most frequently listed. The appearance of a child was in case of some female physicists mentioned as a trigger for changing the work profile from academic to technical or limiting oneself to didactics only. The efforts to cut down on time spent at work or to carry out professional tasks at home instead of academia in order to devote more time to family were, however, referred to by both women and men. Various examples of scientists resigning from a career in physics and leaving for less demanding professions or sacrificing their working life at all were also discussed as a work/family reconciliation method. Although in this respect examples of both women and men were given, one could risk the statement that a situation when a woman resigns for the sake of her family is still more common, unless a man quits in order to get a better-paid job and be able to support the family in a more satisfactory way. Subordinating one's own career and going abroad with a partner was not uncommon for female scientists either.

As to the reconciliation measures taken by physicists in relation to the family sphere, sharing household chores, shifting responsibilities to the partner, planning ahead, escaping responsibilities or reducing standards and making use of some outside support were brought up. Although there occurred examples of female scientists complaining that the whole of

[4] The notion of 'one-academic career, one-job marriage' is a more specific version of 'one-job, one-career strategy' of Becker and Moen used in relation to middle-class dual earner couples (Becker and Moen 1999).

family chores rests on their shoulders, in general the majority of informants referred to sharing household responsibilities. Even if not having actively participated in the family chores on a daily basis, many physicists had to take over some or the whole of family or childcare obligations when their partners or spouses needed more time for work (for instance were completing their PhD dissertation) or had to leave for a research trip. For some, reducing standards understood as doing less at home became a method to win more time for work. Both in a shorter and longer run, the issue of time management was also stressed by informants as of great significance in this respect. This applied not only to the efficient organization and planning of everyday tasks but also designing one's family life and career progress in relation to each other. Postponing having babies until after a PhD defence or giving birth while accompanying husband abroad at his research trip can serve as examples. Benefiting from outside assistance both from partners, children and extended family members as well as social support institutions (nurseries, kindergartens, etc.) or hiring baby-sitters or nannies cannot stay unmentioned either.

While reflecting on the issue of work/family reconciliation some interviewees referred to an interesting phenomenon symptomatic of the physicists' environment, namely the inter-physicists marriages. Having a spouse or a partner working in the same profession can, according to some interviewees, be very helpful in terms of juggling career and home as it often results in a better understanding of one's work demands, supporting each other and acknowledging the other person's professional achievements. Due to similar lifestyles and working arrangements, being married to another physicist can also make it possible to find work for both abroad, in case one of the partners goes for a longer research trip. On the other hand, some respondents reported the instances of female physicists significantly lagging in their pursuit of scientific career behind their husbands, precisely

because of family and childcare obligations. As to other factors conducive to better reconciliation, such specific characteristics of scientific work as flexible working hours and flexible working arrangements (e.g. working from home) were broadly discussed by the interviewees.

Undoubtedly, issues of reconciliation of work and family remain hot topics for the physicists interviewed. For those who do not plan having a family yet, they still remain only hypothetical. For those who have spouses and kids, it is an everyday reality. Those who already achieved success in science and brought up children also consider this question from a slightly different perspective. Looking at this topic through a gender-sensitive lens, one could ask: is it so much harder for women than for men to get the best of these two worlds? In the opinion of many female physicists, though some male also concede with the statement, most of the household and family chores still lie predominantly on women's shoulders. They tend to be more family-responsible and even in the inter-physicists marriages seem to have more family obligations than their husbands, who do not divide their time between work and family to such an extent. Such standpoint seems, however, to be particular only for a certain group of respondents, whereas the others stress that the women's burden of the double shift is not so troublesome and men get more and more actively involved in family obligations. This positive observation refers especially to younger generations. As one of the older female interviewees noticed:

> […] I actually see, with huge satisfaction, that the male colleagues, especially the young ones, who happen to be at home, obediently get home at this two-three o'clock, they also collect those little kids from the kindergarten, from school, they help. Here, there is really, in my opinion, a huge progress. And

> they are able to get organised, and actually they have quite good scientific results in all this. (*22p, female).

In the light of the above, one can hope for a greater gender equality in terms of juggling family and work responsibilities at Polish academia and consequently elimination of one of the factors discouraging women from continuing their careers in science, namely difficulty in getting the best from scientific career and family at the same time.

Summing up, while analysing how physicists deal with various aspects of reconciliation of their scientific careers and family, one has to keep in mind that this sphere is influenced not only by such factors as gender but also age, academic position, parenthood, etc. Only a meticulous analysis of interviewees' narratives in the light of these intertwining factors and relating more to individual histories of informants than creating categories and as a result false generalisations, allows to understand the whole complexity of the work/family conflict.

CHAPTER IV
DO YOU HAVE TO BE A MAN TO BECOME A SUCCESSFUL PHYSICIST?
PROBLEMS OF GENDER DISCRIMINATION

Taking into account that being a physicist or generally working in hard sciences has for a long time been perceived rather as a men's domain, one would assume that women could feel rather discriminated against in this traditionally male environment. The analysis of the informants' narratives concerning the issue of discrimination indicates that this phenomenon is very multidimensional and thus should be looked upon from many various perspectives. The understanding of discrimination functioning in the consciousness of both female and male interviewees cannot be undervalued here either.

Generally, the problem of gender discrimination named as such by the informants themselves did not emerge too often in the interview data. This, however, is not unanimous with the fact that such a phenomenon is not present at Polish academia. To the contrary, both female and male physicists' statements on their working life revealed a substantial number of discriminatory practices that, however, often remain stay unnoticed even by their victims.

As far as female physicists are concerned, they rarely mentioned the issue of gender discrimination classifying it as such on their own. Often, they tended to avoid underlining their gender and usually identified themselves just as physicists and not necessarily female scientists. This observation is to some extent consistent with the finding of Joanna Pinińska, who noticed in her "Women and science: a review of the situation in Poland" that Polish female scientists are inclined to see the efforts to promote women at academia as potential indicative of their unreliability

(Pinińska, 2). Among the UPGEM respondents, there was also a couple of female informants interviewed, one of whom presented a very strong opposition towards any affirmative actions favouring women, such as grants for female scientists exclusively or openings for women only, whereas the other one even questioned the legitimacy of such research as UPGEM. They perceived it as of discriminatory and sexist nature since, according to them, it implied that women must be either better or worse, or in any case different and in that way it contributed to the strengthening of gender differences and stigmatization of female physicists as 'the others' in academic environment.

While asked more specifically about the cases that can be indicative of discrimination, which they had personally experienced, for a number of female scientists it was easier to give the examples of their colleagues who had to face some inequalities, than reflect upon the episodes from their own lives. A statement coming from a female PhD student can serve as an example of such tendency.

> Personally I didn't [experience any obstacles in my academic career pursuit] but... I can talk only about myself. I had such a situation, my friend told me about it, that once they had the exam... A person who was examining told her that a female shouldn't study physics. So those experiences may differ (*4m, female).

The interviewee stressed that as she herself was a good student, this could not have happened to her. Although in this case the reference was made to the student times, the trend to describe others' struggling with inequalities rather than one's own experience was also present in regard to further stages of academic career. The other informant gave the example of a

female colleague, who left academia and explained her decision saying: “The male ‘patriarchal’ atmosphere had a bad influence on her. The Institute is almost 100 percent male, women are not treated well here […] they aren't treated as serious partners for conversation, discussion” (*13a, female). Both of the above-mentioned instances illustrate not only the lack of willingness to talk about one’s own experiences but also bring up the issue of the acknowledgement of women as physicists at academia, which will be further elaborated in detail.

On the other hand, the very own life narratives of female physicists often abounded in recollections that could successfully be categorized as ‘stories of discrimination’. Consequently, the pattern of refusing the existence of gender discrimination or convincing of the inability to recall any such incidents in one part of the interview and contradicting oneself by demonstrating clear examples of gender inequality in the other, was not uncommon. The below-quoted statement can illustrate it:

> So I was pregnant last year, I have had my child now, and I believe that this year will be easier. I will have to come back to work next year for sure, and I personally have the impression that, in a way, it ruins my chances for scientific career later on here. Because having a gap year cut out of my scientific curriculum vitae, I won’t be able to have so many publications and studies to get admitted to a position of a senior lecturer (*16m, female).

> I don’t feel discriminated at all. I don’t have such feeling at all. I am surely more appreciated here than in other fields, because women are discriminated there and I believe that here, knowledge is what counts and not gender. On the other hand, I believe

> that it would be easier for me if I were a man, because, for example, I might not feel that attached to my child. Even in biological terms, because my husband works, even though he would like to spend his time at home, but it is a mother who is most of all necessary for such a small child. But a woman is, even as far as psyche is concerned, more family-oriented and that hinders her scientific career. It is not that they [women] have to resign completely or partly from their career in order to devote themselves to their families, but very often they want to. And this is such a biological conditioning which hinders their career, because spending time with children results in the fact that there is less time for professional work (*16m, female).

What is of great significance here is the fact that even such blunt instances were often not defined as gender discrimination by the female informants. Although they noted their weaker position as compared to their male colleagues, they were inclined to explain the problems they experienced in relation to reconciliation of work and family either as resulting from biological preconditions, and thus natural and normal, or as their free choice linked to the will to establish family and prioritize it. The issue of the structure of academic career as adjusted to the male standard was hardly ever mentioned by women.

Certainly, there were some female scientists who overtly expressed their awareness of the discrimination against women at academia by saying for instance: “There is something like discrimination, of course. Generally, women are considered to be worse physicists. Simply – because they are women” (*8p, female). However, such views were in the minority. While trying to list the episodes of unequal treatment pointed by female

informants, the issue of motherhood as an obstacle in the academic career came to the front. Although women are usually able to successfully reconcile an academic job with family when their children are already a little older, the time of pregnancy and months just after the child is born seem to be especially difficult for them. Lack of any female friendly policy at the university level does not help in this regard either. That is how a female scientist illustrated the above, while recalling one of her research progress assessments done by the commission of nine male physicists:

> The dean said to me: 'Well, we congratulate you on your baby. We know that you have a baby, that you have a family. We congratulate you on that wholeheartedly. We are really pleased. But you know, it has nothing to do with your research nor with our assessment of your person. Nothing whatsoever.' So a woman who is several months pregnant, then gives birth to a child or children – she has as much time for her *habilitation* work as a man, who will not be pregnant, will not give birth to his babies, will not take a maternity leave, or anything of that sort. A woman has exactly the same 9 years to complete her research and is evaluated in the same way. According to the same criteria. She needs to have the same number of publications. It would be good if she could demonstrate some co-operation with foreign institutions _ if she could demonstrate before her *habilitation* that she participated in some 6-month or one-year research project abroad. How am I supposed to do it? [...] You are not in the position to do it all _ unless you sacrifice your family, but I won't do that. And I think it's simply

> not fair, because men do not have to sacrifice their families. They can go abroad for several months. They go and their families stay in the country. And this way they develop scientifically – they will do what they have to do without scarifying anything, you know. Well, of course, if there are small children in the family, they miss their daddy and suffer too. But they would suffer more if it was the mother who left. Much more (*15p, female).

What is worth pointing out is that a few sentences further in the interview the same women declared that she has never experienced any distinct discrimination just because she was a woman (!), although she clearly perceived what happened to her as an unfair treatment.

Another hot issue for women was the difficulty of obtaining their excellence acknowledged. More than one female physicist underlined that women have to work harder than men to prove themselves and still they do not get such appreciation as men do nearly effortlessly:

> […] a woman has to work twice as much for the same position which a man [has]. Simply, it requires more effort of her; […] when a woman says something and presents some project, […] they [men] take it more sceptically than men's ideas. And only to convince the circle of the colleagues, or men, then you have to have real achievements already, you have to have it in the form of a publication, and it's best to have it in quotations. First, you have to convince the world, and only then [you may] convince your colleagues, that's how it is (*21p, female).

> It seems to me that a woman – in physics, or anywhere else, has to distinguish herself first, prove that the fact that she is a woman doesn't make her worse than a man. And only when she manages to achieve this, then she may begin going this path, which a man is following from the beginning (*l6a, female).

There were also some cases of discriminatory practices mentioned that were linked to the alleged skills women are stereotypically attributed:

> So, when I came at the university, one of my colleagues brought a tablecloth and put it on the table, and the head said straight away: 'Here we are, the feminine touch! I17 came and she brought a tablecloth'. And I said: 'I am sorry, but it was not me'. And then it was obvious for everyone that as I am the sole woman in the team, I will make tea. Frankly speaking, I didn't like it (*17m, female).

> I hate, frankly speaking, I hate till now – and luckily I no longer have to do it – such kind of work, which women are usually selected to do. I mean, such precise yet silly job (*17m, female).

Some informants referred to the feeling of being treated as "a wife at home" (*9a, female) by the boss. A case of suspending a female's scientist application for an assistant professor post for the reason of her having two kids and not being able to fulfil all professional duties, was brought up. Comments such as "It will be

all over when the baby comes to the world!" (*17m, female) were also recollected.

Despite the fact that a great number of female informants was far from pointing to gender discrimination at academia or at least calling the unequal treatment that they experience liked this, when asked if their scientific career would at some point take a different course if they were a man, the significant majority of female physicists gave a positive answer. As a result, similarly as in case of the question about discriminatory practices faced by one's colleagues, this question served as a 'skeleton key' and while potentially taking some stigmatization of the 'gender discrimination' notion away, helped to discover what women and men really think about the advantages and disadvantages of being a female or a male physicist. The two following issues seemed to be listed by women most often: the question of being burdened with family responsibilities and that of personality traits, which substantially differ women from men.

The issue of women's greater involvement in the family life seen as an obstacle for pursuing an academic career was mentioned by both women and men. One of the women nicely put into words what other females' concerns were: "I think that [if I had been a man] I would have a little bit more time for scientific career, and I would improve myself faster, for I wouldn't feel so much responsible for my house and my family. I wouldn't have to waste so much time with the household. I think I would develop my career faster – that's certain!" (*11p, female). Subsequently, biological preconditions linked to giving birth as well as socially constructed requirement of child rearing, lying predominantly on women's shoulders, were often brought up as well. Such statements as:

> Let me put it this way: you want to have children, that's natural. It's easier for a man because he won't have these breaks for maternity leaves, pregnancy

> periods… and he doesn't have to discontinue his research. And a woman does. There's no other way out – she's got to go through her pregnancy. And you know, when you are pregnant, it's not that easy to carry on… there are problems, complications and the like. Then, when the baby is born, you have to devote a lot of time to take care of it. Here, at home, as you have just noticed, it's hard to do anything, especially during the first few months. And when you go back to work… those first months are really… And you still breastfeed your child, for instance (*15p, female).

were often heard from women and thus prove how difficult it is for female scientists to continue with their academic career and keep up with their male colleagues while having one or even more career breaks on the way.

What is worth pointing out in this respect is the reaction of male supervisors and bosses to such problems. In many cases, but not always, women felt abandoned with their concerns. While expecting some support from their superiors, they happened to meet with either lack of interest or suggestions to consider quitting. Some female scientists assumed that if they had had a female boss, the situation could have been different.

In order to present a slightly broader perspective and avoid any implications that all women pointed exclusively to the disadvantages of being a female scientist, one very interesting standpoint concerning the question of women's identity as physicists should be mentioned. The informant put forward the hypothesis that being a nerd, as she was, but at the same time a man would probably be more difficult for her since "A woman who is a little bit tougher than an average one, is always considered to be tough and manages somehow. And a tough

woman is treated in a better way than a nerd-like man" (*7p, female).

Although the women themselves did not usually try to undermine their own professional skills, they quite often raised the issue of personality traits that significantly differ female from male scientists. Such features as the ability to focus better on a given goal, being more go-ahead or less attached to children (sometimes seen even in biological terms) were listed among these factors that could make a female scientist's career different, if she had been a man.

It is not surprising that the conviction that there exists a difference within the career paths of women and men was shared by the majority of scientists irrespective of gender. Whereas women often declared that their scientific life would have been easier, if they had been a man, male scientists rather tended to point to the negative sides of being a female scientist.

The male informants put the question mark saying they were not completely sure whether they could have been able to get the posts they finally obtained if they had been a woman. One of the male interviewees, for instance, reported a case when he had been offered a position that he eventually rejected but suggested an equally well-qualified female colleague in his place and heard that the supervisor simply preferred it to be a man. The references to women's obligations towards family and children were also mentioned and although female scientists' skills and qualifications were usually not expressly undervalued by men, such statements as "... if one creates a family, all the time they have to do what's best for the family and the children. And here, a woman has to devote time to it" (*13p, male) gave a quite clear picture of women's position at academia in men's eyes. The demanding nature of science was also stressed and the potential problems with juggling professional and home responsibilities raised: "Generally, it is harder for women, especially when physics is

concerned. It is more difficult, because physics demands a lot of time [...] And for a woman there is really this time barrier, most of all" (*9p, male). Listing possible problems that could make a woman's career in science more difficult while not reflecting on the drawbacks of being a male scientist was fully consistent with the fact that none of the male physicists reported that they had ever felt discriminated against. The only two male voices stating that it could be favourable to be a female scientist, referred to the fact that while being a woman one could rely financially on one's husband and just have fun doing physics or benefit from the affirmative actions targeted at women exclusively. All in all, the conclusion can be drawn that being a female scientist requires much more determination, planning and organization than on the part of male scientists and this is quite clear for both genders of physicists.

It is important to keep in mind that those informants who were positive that their career path would not have looked any different, if they had been of the other gender– interestingly enough, the difference between the numbers of interviewees who supported and who rejected this statement was smaller in case of female scientists—were usually successful women on the top positions in the academic hierarchy, very young women not having any family obligations yet or men referring to the examples of careers of their female colleagues doing exceptionally well in physics. Women, however, who were of such opinion, were still stressing that "[…] a woman, in spite of all, has to put twice the effort to be noticed than a man has, but if she eventually does something, it [gender] has no great meaning" (*22p, female). Men, on the other hand, made a point out of objective criteria that in their view resulted in science being an area of equality: "But if somebody has had the same achievements as a man, then the fact that she is a woman doesn't matter. […] there are some standards which a person must meet, irrespective

of sex. So, it seems to me that… I haven't encountered such discrimination because of the sex in physics" (*30p, male).

Although the male scientists did not refer to any cases of gender discrimination against themselves, many of them were able to notice some unfair practices towards their female colleagues or heard some rumours about it. They recognized various incidents of discriminative nature directed at female physics students, such as lowering their grades or jeering at their skills as well as efforts to pretend that "women do not exist at all"(*1p, male) in physics. What is more, they also happened to stress the discrimination female scientists suffered not only from their male co-workers or supervisors but also other women. As one of the interviewees stated, women seemed to expect other women to do more (at least more than men). An explanation standing behind this observation, which some informants referred to, was that the already well-established female scientists might know how much one could demand from a woman in physics and purposefully pushed the young female scientists to work harder and prove that they were capable of achieving a real successes in this field. Others explained it, however, as pure gender discrimination.

The issue of women discriminating women opens up a whole new space for discussion on the position of token females in science, who could do much in order to ease other women's lives at academia, as well as enhance female students first to start a scientific career in hard sciences and then to continue with it.

Coming back to men's statements on discrimination, some of the male scientists put much emphasis on the symptoms of equality at academia. One of such issues mentioned was the alleged lack of gender pay gap at academia. In this case, however, the men referred rather to the 'equal pay for equal work' principle that is indeed applied at universities and research institutes, but did not consider horizontal sex segregation that prevents women from advancing to higher and at the same time better-paid

positions and results in the total gender pay gap covering whole economy and estimated by Eurostat at the level of 10% in 2004 (European Commission 2006, 74).

As far as sexual harassment being an extreme example of gender discrimination is concerned, with minor exceptions, both female and male scientists stated that they would have been very surprised, if something like that had happened in their environment. Such standpoint suggesting that Polish academia is free from sexual harassment, could be, however, explained by very different perceptions of this phenomenon among people (Miazek 2005). On the other hand, while predicting their astonishment in case of such occurrence, the informants did not refute the possibility of such instances' existence supporting this claim by the fact that 'humans are only humans' or 'such is world', but stressed their potential shock if such conduct would concern their closest co-workers. The actual reference to the real case of sexual harassment experienced and named as such by the informant happened only once.

While trying to address the question posed in the title of this chapter: *Do you have to be a man to become a successful physicist?,* it is impossible to disregard the voices that were also present in the interview data, coming again from both men and women (!), which sustained the stereotypical belief that hard science is not for women. The following quotes may well exemplify this issue:

> They [women] get lost as there are many cables to connect, and I do not think ill of women, but, unfortunately, they are not fit to do everything, they are just not made to do it. Don't take it wrong, it's the same with me – if I get a handkerchief to embroider, then I will come up with something horrible. But a woman will do it nicely because she has a natural flair for it. In the case when we have

some experiment and four cassettes and about six thousands wires, then even the best women fail to do it. It is a rule that, unfortunately, not all women are fit for it (*5p, male).

or

As I have said at the beginning, unfortunately you can't overcome biology. I also think that, excuse me, but the women's mentality is differently shaped than this of a man, and I think much more effort is needed, much more self-discipline sometimes, in case of a woman, to go that scientific path so decidedly (*12p, male).

They [women] have a differently constructed brain. In physics, building models for oneself is crucial. These models, or the equipment, or the phenomena, very often require a very good spatial intuition, And women very seldom have the spatial imagination so well developed as men have. They are at times incredibly good at calculations. And in some fields they may compete with us quite well. But not in this. There is no way, there are hardly any, [but] there are exceptions (*18a, male). being cautious bunt having spatial imagination

or

INFORMANT: […] I think that men are always better […] I think, that if on the same post there is a woman and a man, then it's 90% possibility a man is better.

> INTERVIEWEE: Mhm. But he is a better scientist, or a better, I don't know, manager?
> INFORMANT: Well, everything. Both the former and the latter.
> […]
> I think that other professions are better for a girl. Some connected with language teaching, or something like that (*10m, female).

Fortunately, such beliefs were in the minority though, interestingly enough, they were still more common among men.

The more general conclusion, which could be drawn on the basis of the informants' narratives is that, indeed, being a female physicist is very different from being a male physicist. Although, it cannot be argued that a 'universal' scientist is still perceived rather as a man, it does not mean that a woman cannot succeed in this profession. As one of the female professors interviewed said:

> […] it's not true that it's much harder for women in hard sciences. It's harder for women in general and in hard sciences the situation is the way you see, but that's it, you have to live with that [...] It's not true that they can't reach the top of their professional career. But it's true that they've been able to do so only in recent times, isn't it? […] hard sciences and universities had been closed for women not very long ago. Women weren't allowed to study. So I think that this factor_ the factor of gender is important, but in science it's less important than in other jobs (*13m, female).

On the other hand, for some of the female informants the reality of academic life still looks like as following:

> Maybe they are not discriminated against but they are subject to very severe assessment. And where does it come from? Well, it comes from a popular belief – that I have to repeat here with regret – that a woman physicist is no physicist. And I have to tell you that men – when they carry out some classes or are responsible for employment of new staff members – do their best to prove that this statement actually holds true, that a woman physicist is no physicist. Which implies that men are more talented, more ambitious, they have more drive. And for us it's more important whether our kid's pants are clean or _ (*1a, female).

Undoubtedly, a woman can become a successful physicist, it requires, however, much effort on her part and the willingness and courage to overcome the gendered nature of the academic career path. Thus, such facilities as adjusting academic requirements and criteria to the demands resulting from pregnancy, giving birth and rearing a child or increasing the number of women in assessment committees would be of great help.

CHAPTER V
SHOULD I STAY…?
ISSUES ON STAYERS AND WORKING ENVIRONMENT

It is a common knowledge that working environment may strongly influence people's approach towards their profession, either in a positive or negative way. This is also clearly visible among physicists at academia, whose work is strongly conditioned by such elements as access to literature, equipment and trips abroad. Apart from these basic factors, other ones, such as work organization, atmosphere and employment conditions seem to be equally, if not more, important and may either stimulate or discourage employees from deeper involvement in their academic duties. Therefore, the aim of this chapter is to analyse how the above mentioned aspects of working environment affect physicists' everyday work.

One of the greatest benefits of work organization at academia is undoubtedly its flexibility, both in terms of place and working hours. Though, it is appreciated by men and women equally, the explanation for this is different for each sex; female physicists prize the system because it enables them to "take and adjust […] work time to some household duties" (*27p, female) while men stress it gives them freedom "for one has their time in their hands" (*13p, male). The gender difference can be also found in a practical use of flexibility provided by academic work. Male respondents tend to work at home where they can find peace and quiet, are not disturbed by students or colleagues and are able to concentrate better; they "simply […] have good conditions there" (*9p, male). The majority of women, on the other hand, favour staying at the institute as it is easier for them to detach themselves from their domestic problems and focus better on

work. This opinion is shared by female respondents irrespective of having children and can be best illustrated by the below quote:

> And where, in fact, is it best for me to work? If I were to mention any of these places [*i.e. institute and home*], [*these are*] first of all the ones where I don't have to divide my attention between other things happening around. It's true, we don't have children yet, so they do not absorb our attention, or mine, so theoretically it would seem, home is the place where one may sit and work in peace, especially that it's quiet. But it's not quite so – home is the place where something always needs to be done, there are many distracting factors, so generally at home it's much worse for me to work than, for instance, here. Here it's peace and quiet, my attention isn't absorbed with anything, so I can devote myself to my job (*16p, female).

The only exceptions to this unwritten rule seem to be female physicists holding high administrative positions in their units, who consequently divide their academic activities into research and organizational ones. The female administrators often complain about inability to focus on their research work at the institute because "somebody comes all the time and wants something" (*21p, female), and thus they prefer taking their scientific work home.

It is worth stressing that the organization of academic work (though brings the flexibility in terms of place and time of work), contrary to the typical 8-hour system, entails also "duties which very often must be done more than at such normal work" (*25p, female) and which demand total devotion on the part of scientists. They include periods of finalizing some projects, trips connected

with astronomical observations or conducting experiments outside the institute, conferences, but also long-term post-doctoral programs. Theoretical fields in this context seem to be more relaxed than experimental ones, where the longer research stays outside mother institutes are usually obligatory. That is why, it is especially important for women, who have been always culturally burdened with child raising and household duties (Oleksy 2005), to have family's support and understanding of their job nature.

Another problematic aspect, which female physicists tend to be more sensitive to than their male colleagues, is workplace climate. Women try to create interpersonal relations with their co-workers and are not indifferent to their problems, both with regard to work and (though, to a lesser degree) private life. Moreover, good relationships at workplace mean not only nice atmosphere of work but they also may influence female scientists' decisions to stay at academia, as it was in the case of a female PhD student:

> INTERVIEWER: You mentioned before about nice people at your department. Did it have a big influence on your choice?
> RESPONDENT: A very important one. That is, on the choice of the department?
> INTERVIEWER: Yes.
> RESPONDENT: Well, of course it is nice doing what you like doing, but people you are working with are also important. And if one goes hand in hand with the other, I mean, with people with whom you can easily cooperate – it's very important (*7p, female).

> RESPONDENT: […] Our department, and generally that field is very friendly towards people, and there are, well, I won't say family-like, because

> that would be exaggeration, but there are friendly relations.
> INTERVIEWER: So there is hierarchy as far as structure is concerned, but not necessarily in terms of…
> RESPONDENT: No, not in terms of social life. It is very nice there, and I knew it from the start. I knew already when I was joining that group and that department that it is a very nice and friendly department and it turned out to be just right.
> INTERVIEWER: And the fact that you knew it, did it have any influence on your decision to choose this particular department?
> RESPONDENT: I guess so. Because, for example, I didn't want to join a department in which there are unpleasant people and where people preparing for the master's exam are treated badly (*16m, female).

As for male respondents, it appears that social relations in the department are not that significant, which can be proved by the fact that when asked about their colleagues' family situation, most of them were not able to give any information. On the contrary, they are inclined to separate their private life from work and thus show no interest in maintaining social contacts at work. Such approach is expressed both by younger and older generation of male physicists:

> To tell you the truth, when it comes to the relationships with my, let's say, colleagues from the institute, we don't have any relationships of this kind. We don't even see each other everyday,

> only sporadically. We somehow don't talk about personal things (*4p, male, ca. 30).
>
> INTERVIEWER: Do you think that family is an important issue in your colleagues' lives?
> RESPONDENT: Yes. Oh, you mean colleagues? No, we don't really talk about it. I'm not really interested, let's put it this way, in my colleagues' family lives (*4a, male, ca. 50).

The above described male physicists' attitude makes one put them within the frames of 'an ivory tower' concept, in which a (male) scientist is portrayed as a devoted intellectual who is not interested in what is happening around him (Benschop and Brouns 2003). Female physicists, one the other hand, as mentioned above, do not fit this metaphoric image at all.

Discussing the aspect of workplace atmosphere, one should mention unit managers, who often play a key role in creating—so important for female employees as cited above— workplace climate. UPGEM study shows that a manager's attitude can either negatively or positively influence not only boss-subordinates bonds but also work dynamics and relations in a group. If the boss happens to be autocratic, unpleasant, or the one who lacks understanding of their employees' needs, then it is usually reflected in the behaviour of group members; they become unmotivated, distant, passive and uncooperative, which deteriorates their research work as well as social contacts. As a result "everyone sits silently, they don't like a lot of things but […] but nobody speaks out. There is lack of common basis" (*3p, female). On the other hand, a supportive and open manager not only encourages people to a more efficient work but may even become their mentor as it was in case of a female interviewee who very warmly recalls her supervisor:

> He was indeed… a very good boss, very fair, looking after his people. He was a great physicist and he could take care in a great way. Because it often happens that there is a great physicist but s/he doesn't think about others. And he simply… created that group and really cared about the development of people, about doing those degrees. […] He encouraged people to write doctoral dissertations, post-doctoral dissertations. He really supported it, was interested in it. And it was a big help (*15m, female).

The analysis of subordinate-boss relations would be incomplete if one did not mention a strong pyramidal social structure that is so characteristic of Polish universities. Although the significant majority of respondents describe their bonds with their supervisors as satisfactory (they may be stayers therefore), they point to the clear structure of scientific hierarchy and the significance of formalities which often create a gap between a group and its boss; respondents often describe these relations as "Byzantine" (*18a, male) or "feudal system" (*3m, female). In this pyramidal structure, institute and department chairs, whose positions are occupied almost always by professors, seem to be quite isolated and unapproachable as they "sit closed in their own offices, and nobody talks with them, they just quietly do something, but nobody knows what exactly" (*5a, male). Interestingly, these observations overlap with the feeling of separation expressed by a male institute manager himself: "[…] if one has any managerial function, especially for a longer period of time, information doesn't reach them. People don't want to talk. […] you fall a bit into a kind of isolation" (*12p, male). Furthermore, the findings correspond with Geert Hofstede's conception of large power distance, according to which

subordinates do not consult their superiors and have no possibility to raise an objection to a superior's decision in a direct way (2000); the phenomenon seems to be typical of the Polish society in general.

No matter how big the power distance index is and what atmosphere is created by a group leader, in the opinion of respondents, the boss also plays a crucial role in shaping their subordinates' academic career paths, including such aspects as employment and promotion opportunities. These two issues seem to be of great importance for both female and male physicists at Polish universities as they are related with their stay at academia. This, in turn, is inseparably connected with obtaining scientific degrees; all the respondents are fully aware of this requirement. Thus, a continuous research development is a necessary condition for stable employment, which means that "when one begins one's academic career, there is no possibility to end it on a particular stage" (* 9p, male), otherwise one has to resign.

UPGEM research revealed that the stability of employment constitutes a crucial factor, as far as working conditions are concerned, for two groups of interviewees; PhD students of both sexes and female physicists (excluding female professors). These two groups express openly their constant fear of job instability at academia. The feeling of being "suspended in the void" (*6a, male) can be easily explained in the case of PhD students, who are enrolled on four-year doctoral studies with no assurance of further employment. The phenomenon, however, appears to be more complex in case of female physicists; they tend to have low self-esteem and in general underestimate their academic achievements, which results in their underrating chances of getting or prolonging the job contracts, as it is in the case of a female professor's assistant describing her employment situation:

> […] after earning doctoral degree, there's a three years long post of professor's assistant. And next there's a possibility of applying for the position of senior lecturer. It's hard to say what it will be like. It's impossible here to feel secure. There're just no posts here. Well, there's a number of people, who will be fighting and applying, and they will present their CV. […] They're all very good. […] And how to select from the equal ones? Everyone meets the highest standards. […] I'm not sure what it will be like […] (*6m, female).

This is in striking contrast to the way male interviewees perceive themselves and their scientific abilities; they strongly believe in their own potential and – what seems to be characteristic of Polish academic environment – connections and academic networks. In the opinion of some of them, at academia there even exists an unwritten rule which says: "It is all connections. [...] If you 'keep your finger on the boss's neck properly, so that it wouldn't pinch him, then you're good, but not when you have your own opinion, personality" (*10a, male). The facts that a physicist's environment is dominated by males and that the above-quoted words were uttered by a man, might give an impression that the notion of connections can be understood in the academic context as 'male solidarity' where most of the procedures are based on networks and contacts. Furthermore, if one takes into consideration the fact that the overwhelming majority of decision-makers at academia consists of men, it is fully comprehensible that none of the full-time male researchers interviewed express any doubts concerning their job security. In fact, the only group of academics entitled formally to feel permanent job security are full professors, both male and female ones, as "if one obtains the position of a full

professor […], then one has an unlimited kind of employment contract" (*12p, male).

Despite the fact that female researchers pay attention to stable work positions much more than their male colleagues, it is interesting to observe that they express little interest in obtaining scientific degrees as such, but treat them rather as means to achieve stability at academia. The following statement coming from a female professor can serve as an example:

> INTERVIEWER: You're not at all interested in scientific degrees?
> RESPONDENT: Well, I can't say I'm not, because – you know – what I've said, it's that… I don't go for it, to speak colloquially. While I have to… I had to have a proof to obtain a certain degree of safety for doing what I really like. For otherwise they would throw you out and think you were not doing anything. And I needed it for this (*27p, female).

> […] this is not most important for me, I won't cry if I don't have this title and if I stay on the position I am now. Unless they would push me back to a research associate, then I will get nervous a little, for there is less money by a 600 PLN. And now, they have changed some bill, that now one has to apply for the title to secure safety of work [for themselves], as if, until retirement, but I have some time till retirement yet (*22p, female).

Moreover, this attitude can be further proved by the fact that seven out of eleven female professors confess they submitted their applications for habilitation or professorship not on their own

initiative but under their supervisors' or even university authorities' pressure.

The research analysis shows that a similar tendency is present when it comes to administrative functions; female physicists try to avoid holding such positions as they distract them too much from their research work and influence their scientific careers in a negative way. Men, on the other hand, appear not to have any problems in combining administrative workload with their research; quite opposite, they often declare being successful in reconciling these two kinds of academic duties. In case of women, even if they assume managerial positions, their decisions do not stem from their ambitions but are conditioned by staff situation and their feeling of obligation as well as responsibility for a group. The example of such a case is provided by a female professor who, after the death of her supervisor, turned out to be the only candidate in her unit meeting all the necessary requirements to take up the post: "[…] he died 10 years ago. And then I started to head the chair because, accidentally, I was the only person with a habilitation degree here" (*6p, female). However, even though female managers are much involved and successful in their administrative obligations, there can be found some cases when they relinquish their functions to a suitable candidate if only possible:

> I have never had ambitions to be a manager. However, at the moment I took over this function, you can say so in some way, that I was forced because the professor who was just here a manager was going to retire and there was nobody else with habilitation. So, there was just as if no choice. So if I hadn't taken up this function, a superintendent from outside would have just come, you know – either someone from among

> physics professors, just from our university here, or someone from outside would have come. So, well… I obviously took on this function. I must say that it gave me, in some way, a lot of satisfaction. I managed, I think, to do a few things. Well, however, later there was an occasion not to be this manager and I resigned from this function (*25p, female).

Another key issue connected with the working environment at the university, and widely discussed by the informants, is didactics as it constitutes an obligatory part of academic workload irrespective of a scientific degree. The interviewees often point in this respect to disagreement between what is formally required from them and becomes the basis for their performance assessment (i.e. high quality research and publications) and what they are expected (i.e. top standards of teaching). Therefore, in the opinion of some of the physicists didactics is perceived as an additional 'burden' or even 'a pain in the neck' which causes dilemmas:

> Well, let's say, the dean requires publications and scientific work. However, if you take a closer look, look at requirements, there are completely no didactics and education quality, and on the other hand, they say that these students must be prepared better and better. There are more and more these students and time is needed for it, so there is such a discrepancy: on the one hand, we should basically state clearly that there is no time because publications take the first place, and students – well, a pity, there is no time, and on the

> other hand, there is this awareness of the fact that we cannot do so (*20p, male).

The necessity of teaching and research work reconciliation is most often mentioned by female academics which might imply a problematic aspect for them. They claim that "if somebody wants to teach properly, reliably, they haven't got enough time for research" (*3p, female). As a solution to this problem they suggest one should "differentiate between posts, so that there were strictly research posts" (* 3p, female) and teaching ones.

In spite of the perplexity the 'didactic versus research work conflict' causes, the analysis of UPGEM material reveals that, on the whole, female scholars enjoy teaching more than their male counterparts. This may be explained by their broader teaching experience as many of them taught or still teach physics outside the university, working additionally at schools or giving private lessons. One of them states even that: "you really know you understand something if you are able to pass it on to someone in a relatively simple way" (*27p, female).

Contrary to what one could expect in the Polish context, salary is not the main concern for the researchers participating in the study. Though, the respondents admit their earnings are relatively low, as many as 70 percent depict them as satisfactory, stressing that "this issue has never been an obstacle" (*4a, male) when it comes to their careers at academia. Interestingly, both male and female physicists often describe their salaries as "minor things" (*24p, female) or "of secondary importance" (*29p, male).

Rather than individual earnings, what appears to be of greater relevance for them are poor financial conditions of their universities, which are reflected in the lack of necessary equipment and unsatisfactory access to trips abroad. Again, one can find a significant difference between theoretical physics and

experimental one, the latter demanding more financial investment. The limited amount of money institutes administer makes, therefore, the majority of the respondents apply for grants. Though, money provided by such grants may compensate the shortages of university funds, the complicated application procedures are very time-consuming and distract physicists from genuine science. One of the female professors describes it in a following way:

> Well, there are different grants for which one applies, there are certain possibilities to obtain them, but actually my life has recently been narrowed down to writing grants only […] You write grants, and some part of them is successful. So one then can't occupy themselves exclusively with writing grants, of which some will be approved, […] for then it starts to be, you know, vicious circle (*21p, female).

In conclusion, what is worth stressing in the physicists' approach towards their working environment is their enormous optimism and understanding for academia reality. It is really surprising that although they point to a number of drawbacks and obstacles, yet physicists' inner drive and will to do science is so strong that all these impediments recede into the background. This view is best reflected in the words of a male PhD student: "It depends what you think is most important in life. That is because if I had wanted to earn money after finishing my studies, then I wouldn't have chosen physics and I wouldn't have stayed here, I would have looked for something else" (*5p, male).

CHAPTER VI
…OR SHOULD I LEAVE?
ISSUES ON LEAVERS

Academia has been always perceived by the society as home for superior knowledge, excellent scientists, aspiring inventors and outstanding talents. Thus, the scholars who decide to stay at the university have been regarded as enthusiasts, men of passions, total devotees to theirs fields and yet indifferent to everyday down-to-earth worries; Yvonne Benschop and Margo Brouns describe them as "lonely hero[es] at the top, far distanced from everyday practices" (2003, 194). UPGEM analysis reveals, however, how strongly these everyday concerns interfere with physicists' work, often making them leave science (totally or partially); which in Benschop and Brouns' rhetoric might mean 'descending the ivory tower'. The following chapter investigates the causes for physicists' decisions to quit physics, that is the sphere which constituted for many the only essence of life. A deeper material examination reveals three leading groups of reasons for leaving academia by Polish physicists which overlap with three different stages in the recent history of Poland; communist times, the transitional period of the 1990s, and the beginning of the XXI century.

In the recollections of the older respondents, before the year 1989 academia as a place of work appears to be safe and stable. As there were more vacancies than nowadays, the interviewees stress they were often offered and encouraged to take up assistant posts or traineeships at universities. Hence, once a physicist decided to stay at academia, their career path was quite clear and easily predictable as it was in the case of a male professor: "[…] when I finally became an assistant, I knew that if I completed PhD, I would become a lecturer. When I completed habilitation, I

would stay, and so it went on. And it was clear from the very beginning" (*18p, male). Due to this fact, resignations from academic work at that time seem to have been a rare phenomenon.

Among those few resignations, described in UPGEM interviews, the most intriguing ones seem to be those connected with a political situation of that time. Some respondents reminisce they were rejected the possibility of doing doctoral research because of ideological issues. Interestingly, these cases concern only male physicists:

> […] I defended my MSc thesis on the basis of the work done in X. Well, and later I got employed there, only one thing occurred… Well, you know, for this was the year 1980-1981, when there were those fights about 'Solidarity'. At some point, it turned out I couldn't do the PhD. And I was told, explicitly: 'A doctorate in X is a political matter. You don't have the moral qualifications, so to speak, to do this' (*18m, male).

The analysis shows that if any women left academia during communism period, it was mainly due to personal issues; either "because of [bad] interpersonal relationships in the department [...] [and] the unhealthy atmosphere at work" (*9a, female) or family commitments e.g. following their husbands who moved to other cities in search for a better job.

Another group of explanations for leaving academia is deeply connected with the transitional period of 1990s. On the basis of the interview material, one may presume that it was during this particular decade when the vast majority of present leavers resigned from working at universities. The assumption can be proved by a relatively big number of leavers from that time among UPGEM informants as well as frequent references made

by all interviewees to that period. The process of leaving academia was conditioned by at least two factors, which were strictly combined with the political and economical changes in Poland. On the one hand, the financial crisis of 1990 (Toporek 1999, 123-125), had a strong impact on earnings at academia; as one of the interviewees states, "The beginning of the 1990s, then the salaries were hopeless […]" (*11p, female). On the other hand, the rebuilding of a democratic political system connected with the transition to market-driven economy brought about new perspectives in terms of employment. The market was affluent in job offers and physicists were also in demand. In the recollections of some informants, the oversees companies, especially banks, insurance or consulting companies looked for intelligent, bright, analytically thinking people and it seems that physicists fitted just perfectly their profile. Hence, "[…] banks absorbed a great number of people who knew how to operate computers, to operate data basis, they knew how to program such things or to provide maintenance of, for instance, bank servers net" (*25p, female). In return, they offered a couple of times better salary than university as well as tempting fringe benefits in a form of "an apartment, a company car, and whatsoever" (*15p, female).

The above discussion may lead to the conclusion that the main reason for physicists' resignation from academic work during the transitional period of 1990s is money aspect. This statement holds truth as for male leavers and is confirmed by both university stayers and leavers. A deeper analysis, though, reveals some additional issues underlying financial motives; men usually made their decisions to quit science and look for a better paid job in order to support their household. As the heads of families, they felt responsible for maintaining and providing decent conditions for their wives and children; this agrees with the prevailing in the Polish society image of a breadwinner (Arcimowicz 2004). The

below quote provides some examples of sacrificing science for the sake of a family by male astronomers:

> INTERVIEWEE: Do you know anyone who gave up research work in the institute of physics?
> RESPONDENT: Yes, they were young people. Probably their wives had found out that – since they were very good at computers – and probably, in the beginning of the 90s their wives found out that for the same job in a bank they would get four times more. And since they had no flats or anything, their wives quickly explained to them that astronomy – well, all right, but family first. And they did very right. The family is most important – there's no sense to pretend otherwise (*13p, male).

Bearing in mind the social and economic context of the 1990s, one may presume that, similarly to male leavers, financial aspects should also constitute one of the main reasons for leaving academia by female physicists. Indeed, several women point to money as a factor playing some role in making their decision to resign, but it has never been mentioned as the prime cause. The issues that, in turn, determined females' resignation from work are more diversified and can be generally gathered under the 'umbrella notion' of working environment. The most striking of them are unsatisfactory relations with their supervisors, who, in the memories of some interviewees, were not only centred on their own research line but also took advantage of their employees in order to achieve intended goals. Thus, independent researchers complain about having been burdened with a number of additional tasks not connected with their own scientific work while PhD students admit having experienced lack of interest and help in their doctoral dissertations on the part of their supervisors. The

latter case is best illustrated in the words of a physicist who describes the situation of her female colleague:

> Another friend of mine also gave up her career. […] Let me put it this way: her research supervisor didn't show much interest in her […] and she was left on her own. […] And finally she resigned after some two years. Her work just dragged on and nothing was coming out of it. She didn't manage to find any topic for her project, no-one took any interest in her work… […] her university career was finished (*15p, female).

The next evident reason women left academia in the 1990s is inability of reconciling academic obligations with family life. UPGEM analysis proves that female scientists are very dedicated to their work and "if they do something, they try to take it very seriously and with their whole self" (*17a, female). Simultaneously, when it comes to academic career and family, some respondents claim it is not feasible to devote oneself equally to both of these domains; as no matter how much one tries, either will always suffer. Thus, the research reveals that having been faced with the need of combining family or professional life, instead of trying to reconcile them by force, women gave up their scientific ambitions. This choice is particularly visible among physicists who left academia for their children's good, as it was in the case of a female assistant:

> I assume that once you're doing something, it needs to be done well, and since I gave birth to a child […] I didn't have enough time. I was carrying out observations, worked on the night shift. […] It was the first, in a way, and the most important [reason],

> that I was not able to devote all my free time to reading, profound study, to going, let's say, to the library" (*17p, female).

The issue which turns out to be equally problematic for many UPGEM respondents and forced some of them to resign from work at universities, is the necessity of making trips abroad. Scientists themselves admit that "the thing about science is that one is not tied to one place […] [and] one must change the environment in order to develop" (*7a, female); this indicates that, for example, post-doctoral stays abroad are unavoidable. It seems, however, that only women respondents realize how much sacrifice such stays abroad entail. Therefore, it comes as no surprise that the only cases of resignations in this respect are found among women. According to them, the bleak prospect of being separated from their children and family for a longer period of time and leading "such life of a nomad" (*17a, female) was unacceptable and became a decisive factor in making their decision to quit their university job.

At last, there are also those women leavers who gave up work at academia due to lack of permanent employment, which would have guaranteed them stability and security, so important especially in case of female physicists.

There is no doubt that working environment significantly influences physicists' attitude towards their work (as it was described in Chapter V) and, as the above analysis indicates, often plays a crucial role in making women's choice between staying or leaving academia. Nevertheless, UPGEM study reveals that unfriendly academic conditions were not the only causes of female physicists' resignation in the 1990s. The data analysis shows that women physicists at that time quite often left academia to support their husbands who carried on their own academic careers. This phenomenon is present among so-called 'double

stars' where both spouses were physicists working at universities. Surprisingly, it seems quite natural for scholars that it is a woman who gives up: "There comes a moment when one of them has to make a sacrifice […] it is still the woman" (*15p, female). In this context, it is even more interesting to observe, how female leavers managed after their resignation; some of them stayed at home taking care of their households, the other ones assumed the role of a breadwinner: "[…] she had to go to work, so that her husband could develop his scientific career, while she would provide for the family" (*7a, female).

On the one hand, the finding can indicate that women felt more responsible for their relatives, on the other hand, however, their decision may suggest that they rated their chances of success at academia as much lower in comparison with their husbands. No matter what the motives were, the fact remains that it was a woman who made up her mind about leaving academia first and enabled thus her spouse to continue his scientific career.

The last span of time that can be distinguished in UPGEM analysis is the period after the year 2000. Contrary to the previous decade of the 90-ties, one can notice here the so-called 'turn-away' tendency as people very seldom make their own decisions to leave academia. Instead they try hard to stay at the university and continue their research work, even if it means the necessity of taking up an additional job in order to maintain their families. Thus, leaving academia of one's own free will seems a very rare phenomenon. The statement can be proved by the following respondent's opinion:

> I really don't suppose one would think about quitting connected, well, with what, that they would find some better job, right? Or something like that? Not really. […] If someone was to leave then I think

> it would be due to the fact that they are in the period when they get retired (2a, female).

In the situation of high unemployment rate and low earnings on the Polish labour market in general, academia, again, similarly to the period before the year 1989, appears as a safe and quite well-paid workplace. However, as mentioned in the previous chapter, the group that is, to a large extent, subject to the necessity of leaving academia are PhD students; their potential stay at university is first and foremost dependent on existing vacancies. In practice, it means waiting until "someone retires or something else happens to him" (*7p, female). According to some of UPGEM respondents, PhD students "don't have actually any prospects, so brutally speaking" (*10p, male) and, thus, they have to leave.

Yet, there remains one more interesting reason for quitting science by physicists after the year 2000; that is a physicist's burnout which seems to be common for both sexes. The scientists who left academia due to this phenomenon often complain about being bored with digging endlessly in and out the same problem, dealing with things that are not tangible or "visible to the eye" (*7a, female) or seeing no challenge and stimuli for self-development. Moreover, they describe academia as a place of "an unstable environment, changing but little" (*7a, female) where "fossilized atmosphere" (*7a, female) dominates. This all makes many physicists feel void and apathetic and paradoxically becomes an incentive for them to leave universities in search of ways to realize their wasted potential.

The issue that is widely discussed in the context of Poland, and already mentioned in Enwise Report, is a phenomenon of double/triple employment. Also UPGEM analysis reveals a number of cases when physicists or astronomers decide to take up additional job, or even a few ones, outside the university. The

reason for that are low earnings as "it is a public secret that even the lowest salary within the private sector and state administration exceeds the highest one within the HE [Higher Education] and R&D [Research & Development] sectors" (Blagojevic et al. 2003, 61). In this context, taking up extra side work seems to be an alternative for a scientist to leaving academia. This phenomenon appears to be popular among all scholars and became possible due to a large number of universities, equivalent higher institutes and private corporations which entered the Polish market especially in the transitional period and have been on the rise until present.

> Very many people, it was later, started to work on several posts [at the same time]. It was very difficult for them to part with astronomy – I don't know if [they couldn't part] with physics, but I suspect that it's the same way at physics – and they were trying to work double time: either, for instance, they were working in private schools, now [they do] at private universities, and they were getting another salary there, much higher than this one here, at the university, or they were trying to administer, for instance some computer networks, but all this due to the financial reasons. It was caused just and only by the financial aspects, and it was hard for them just to say goodbye to their favourite job – for it's obvious that when someone is studying astronomy or physics, they don't do it to abandon it later (*11p, female).

> […] colleagues who are at didactic positions, see that they can develop, they are interested in it and they have problems only of a financial type, they just somehow manage, working extra in their free

> time. So I guess, you know, that there are these two elements: a development prospect and a financial situation. If it's only one, that is this financial situation is poor, most people try to keep this job here because it interests them, it suits them. Nonetheless, they work extra just using their knowledge – it's not difficult nowadays (*20p, male).

Summing up the discussion on leaving academia, one should also examine places where the respondents found their new jobs after resigning from work at university. UPGEM analysis reveals that both female and male leavers are equally represented in private and public sectors. However, some differences can be found in the nature of their new professions; men are hired as software engineers or programmers in IT companies, as actuaries in consulting firms or as electric engineers in textile enterprises, whereas women are employed as project managers in IT or consulting companies and banks or as statisticians. In case of public sector, both men and women work as teachers in schools and other educational institutions e.g. planetarium. Furthermore, some of the informants decided to set up their own businesses, e.g. a company producing shoes or a printing firm. Interestingly, the only group of leavers who did not take up any work constitutes of women, who stay at home taking care of their children.

The above presented study on reasons for leaving academia by physicists demonstrates how a stereotypical image of a scientist, described by Benschop and Brouns (2003), differs from the realities of the contemporary life. A physicist is not able to afford doing science any more "at the top of the Olympus, far distanced from everyday down-to-earth worries" (Benschop and Brouns 2003, 207), as both working conditions and economic

incentives interfere with their academic work so much, that they often make scholars resign from physics. It is sad to observe how gifted and promising scientists abandon their passions and waste their talents for mundane things such as providing basic needs for their families. What is even more striking, is that academia does not appear to recognize its loss and, instead of making every effort to attract and keep physicists, lets them leave. The only positive side of the phenomenon for the leavers themselves is that, though many regret having resigned from work at university, they not only express their satisfaction with conditions in their new workplaces but also prove to be successful and fulfilled.

CONCLUSIONS

The specificity of academia and, thus, the problems physicists have to face in their everyday work at the university are undoubtedly influenced by many factors of various nature. All of them are, however, deeply rooted in the cultural context of a particular country, hence, its history and social norms; this finds its reflection also in UPGEM research results.

When it comes to political and economic background, the turning point for Polish science appears to be the year 1989 as it marks the transformation from the communist system to the democratic one. This huge political shift resulted in a significant change in the working conditions of scientists at academia. On the one hand, it brought about long-awaited political and ideological independence as well as freedom in terms of travelling and scientific cooperation. On the other hand, however, it reduced drastically funding for science, lowered its prestige in the society, and thereby imposed on the scholars the necessity of applying for grants and additional funding. Moreover, due to many social changes, academia not only lost its status of a stable and secure workplace but also turned out to be incapable of providing its employees with the same financial work package as newly established private companies. In consequence, the number of physicists who left academia seemed to have considerably increased after the year 1989. What is worth stressing here is the fact that no major gender differences in the perception of historical changes were found in UPGEM research data. The age of interviewees did, however, matter; the older generation happen to have fond memories of the communist past as the time of job and earnings stability while the younger generation tend to perceive this period quite negatively.

Following the timeline of an average physicist's career path, one could assume that various socio-cultural factors come to the front and shape decisions concerning scientific work at different stages of academic life. The impact of some of them can be perceived as gendered, whereas in other cases such aspects as age, academic degree and position play a more visible role.

Ones of the first gender differences can be noted as early as in the informants' childhood when the motivation to take up physics was formed. According to UPGEM study, boys tended to pursue their interest in science on their own—mainly through literature—whereas girls were usually inspired by family members or teachers. It was also interesting to observe how the process of socialisation influenced young people's decisions to choose physics, either in a positive or negative way; while in case of boys their scientific interests were frequently taken for granted, girls' choices were often considered as weird, or even inappropriate. Nevertheless, the data gathered among the physicists who have already started their academic careers prove strong motivation to do physics on the part of both female and male researchers. Consequently, it rules out the issue of weak motivation as a factor contributing to the decision of leaving academia.

In the subsequent stage of the academic work life, when the decision to pursue one's career in physics is already made, the issues connected to reconciliation of scientific work and family responsibilities come visibly to the front. UPGEM research shows that family as such is highly valued by physicists. Furthermore, they are also quite willing to resign from some professional tasks for the sake of the family. What is interesting, however, is the fact that these are especially women interviewed who seemed more prone to declare their immediate readiness to make sacrifices, whereas men more often tended to weigh possible advantages and disadvantages of such a decision and take additional aspects into

account. A significant number of interviewees, regardless of their sex, age or academic position, listed such factors as the demanding nature of physics, mobility requirement and the influence of parenthood as having a significant impact on the pursuit of their careers. Certainly, the interviewees' feelings in regard to these issues varied to a large extent; to exemplify, although for the majority of informants the mobility might be seen as problematic, it was women who already had some experiences with resigning from a research trip or longer stay abroad in order not to be separated from their relatives. Men, though declaring that in such a case they would prioritize family, more seldom referred to actual situations from their own lives and their considerations remained rather hypothetical. As far as the perception of reconciliation of academic work and family is concerned, one can notice that a great majority of male interviewees either does not perceive it as exceptionally difficult or does not refer to this topic at all; whereas among women the proportion between those who find it problematic and those who do not report any major complications is more even. In this case, however, such factors as parenthood, age and position in the academic hierarchy played a great role in shaping physicists' standpoints on the issue. Various adaptive strategies helping to cope with work/family conflict seem also to be applied by diversified groups of informants. Although the assumption that it is mostly women who suffer negative consequences of the necessity to balance professional and family chores—which can be a potential reason of women leaving academia—was reflected in the narratives of many informants, both female and male ones, one could also find some positive testimonials on greater equality in this field, especially among younger generation of physicists.

The life of scientists at academia can be conditioned by various aspects of working environment, including discriminatory practices, which might also influence one's decision to leave.

Gendering of discrimination is highly visible in this case. Although women sometimes did not realize that what they had experienced could well be classified as a 'story of discrimination', they often provided narratives that revealed incidents in which either they themselves or their female colleagues had been subject to unequal treatment. On the other hand, men did not perceive themselves as discriminated against but were able to point to discriminatory practices directed against women. The issues most frequently discussed by female scientists in regard to unequal treatment encompassed questions of motherhood seen as hindering their further academic career, problems with approving their excellence, and gender stereotypical attitude towards female scientists' skills and competence. When asked the question whether one's career could have looked any different if one had been of a different sex, the majority of respondents tended to be positive. Women often declared that their scientific life would have been easier, if they had been a man and pointed to the problem of being burdened with family responsibilities as well as to some personality traits that they found useful for this particular profession but which according to them were more characteristic of their male colleagues. Male scientists, on the other hand, were rather inclined to concentrate on the negative sides of being a female scientist. With respect to sexual harassment—an extreme form of gender discrimination, only one case of such incident was mentioned and generally physicists, irrespective of sex, stated that they would be highly surprised if something like that took place in their work environment.

As for the other aspects of working environment, UPGEM research clearly shows that the organisation and social atmosphere of work, contrary to what one could assume, strongly affect physicists' everyday work. The most frequently mentioned negative factor is undoubtedly limited financing of academia, both in terms of employees' earnings and general expenditure on

research. Surprisingly, Polish scientists tend to recognize the financial problems of their universities—often resulting in restricted access to literature, equipment and trips abroad—as more troublesome then their own ones, which, if necessary, they try to compensate for by taking up additional jobs outside the university. The poor financial situation of the university makes them, however, apply for grants and look for other sources which significantly distracts them from their scientific activities. The other factor that disturbs interviewees in their research is teaching; interestingly enough, it seems to be more problematic for women than for men. A similar tendency can be noticed in case of job stability as these are mostly female researchers—irrespective of their academic position—who confess to feel insecure about their long-term employment at the university.

It might seem then that the constant feeling of job instability could be one of the main factors in physicists' decision to leave academia. However, UPGEM study points to some other reasons as more crucial ones. Surprisingly to what stayers declare, and to what has already been mentioned, namely that the money is not of major importance for them, the analysis shows that indeed financial factor plays a decisive role in the interviewed leavers' decisions to quit academia. Interestingly, this issue concerns almost always men, which in turn clearly acknowledges the presence of a breadwinner stereotype in the Polish society. In case of women, the problem of resignation appears to be more complex; unsatisfactory relationships with the supervisors, inability of reconciling academic obligations with family life, the necessity of long research trips and lack of permanent employment significantly contributed to their resigning from academic work. However, discussing the issue of 'brain-drain' at the university, one should bear in mind the change of political system, which was followed by many important—though not always beneficial for the employees—modifications in academic

working conditions. Additionally, there appeared new well-paid job offers on the market which attracted a wide group of physicists making them to resign from research work.

To sum up, UPGEM research shows that the problem of scientists leaving the research system prematurely is present in Poland, and following the Western pattern, one may presume that this situation will continue to deteriorate. Consequently, both the problematic issues discussed by stayers and actual causes of leavers' decisions to quit, should be put in the centre of attention at the national as well as university level. In order to ensure the best possible adjustment of measures to be taken to the real-life conditions of Polish academia, further and more specific research also on other fields of science is recommended.

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Publishing, (forthcoming); 'Che Genere di Tecnologie?' (Gender and Technology) in *Le tecnologie tra lavoro e apprendimento* (Technology at work and in everydaylife), Gherardi S. (ed.), Il Mulino, Bologna, 2008; 'Making non-formal and informal learning visible through digital portfolios', in Lynne Chisholm and Bryony Hoskins (eds.) *Trading Up: Potential and Performance in non-formal learning*, Council of Europe publishing, Strasbourg, 2005; Economy and knowledge acquisition: how to make easier, how to face obstacles, in Hutchings M., Fulop M. and Van der dries, Young A. M. *People's Understanding of Economic Issues in Europe*, Stoke-on-Trent: Trentham, 2001.

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Her major interests are: cultural psychology, formal and informal learning processes, portfolio as a tool for authentic assessment, identity and gender. She authored and co-authored articles and books about the topics specified above, such as 'Family-related issues in shaping career paths of physicists: a comparison between Italy and Poland', to be published in *Gender and Citizenship in a Multicultural Context* edited by Oleksy E., Peto A.,Waaldijk B. (Peter Lang Verlag Publishing) and 'Making non-formal and informal learning visible through digital portfolios', in *Trading Up: Potential and Performance in non-formal learning*, edited by Chisholm L.and Hoskins B. (Council of Europe Publishing, Strasbourg, 2005).

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Appendix A. Partnerships and assistants

Consortium partners:

The Consortium consists of six project partner institutions in five different European countries. The partners appear in the order that has been used in project forms:

1) Danish School of Education (DPU), Aarhus University – represented by Dr. Cathrine Hasse, Learning Lab Denmark, Denmark

2) University of Lódz (UL) – represented by Elzbieta H. Oleksy, Professor, Director Of Women's Studies Center (WSC), Poland (secession November 2007).

3) University of La Sapienza – (LS) represented by Anna Maria Ajello, Professor, Director of the Social Institute of Psychology, Italy

4) Helsinki School of Economics – (HSE) represented by Dr. Kristina Rolin, Department of Social and Moral Philosophy, Finland

5) University of Tartu – (UT) represented by Dr. Endla Lõhkivi, Philosophy of Science, Estonia

6) Center for Activity Theory and Developmental Work Research, University of Helsinki (CAW) – represented by Yrjö Engeström and Merja Helle, Finland

The partners are selected according to two criteria:

1) *Criterion of geography:* to cover university physics departments distributed along the north/south and the east/west axes of the European map.
2) *Criterion of expertise:* to combine different scientific competences needed to make this kind of in-depth qualitative study which demands knowledge of the fields of psychology, anthropology,

qualitative methods, philosophy, gender studies, science studies and workplace research.

For each of the participating institutions, a senior researcher coordinates activities and contributes specific expertise to one of the above-mentioned fields which matches and complements the expertise of the other senior researchers in the project. The expertise needed to obtain project results is: expertise in culture studies of physics (to ensure the best approach and analysis of differences in physics along the geographic axis), expertise in gender studies (to ensure the best possible approach and analysis of differences along the gender axis), expertise in psychology (to ensure the best possible methodological approach and analysis of competence), philosophy and science & technology studies (to ensure the best possible approach and analysis to studies of tacit knowledge and physics laboratories) and expertise in developmental work research (to ensure knowledge of work place research and change).

UPGEM assistants working on 'Draw the Line'-publication:

Fulltime assistants[1]

Estonia:
Katrin Velbaum (2 years and 1 month)
Mari-Liis Tina (1 month)
In all approx. 2 years and 2 months

Italy:
Christina Belardi (2 years and 1 month)
Giulia Calafiore (1 year)
Piera Gabola (trainee)
Cristina Cimino (trainee)
In all approx. 3 years and 1 month

[1] Part-time assistance has been converted into fulltime and covers only the period up to the finalisation of this publication in February 2008.

Denmark:
Stine Trentemøller[*] (1 year and 10 months)
Anne Bjerregaard Sinding[**] (9 months)
Maja Hojer (3 months)
Lena Dannow (3 months)
Ane Bentzen (2 weeks)
Stine Adrian (3 months)
In all approx. 3 years, 3 months and 2 weeks

Finland:
Jenny Vaino (2 years)
In all approx. 2 years

Poland:
Patrycja Chudzicka (1 year and 11 months)
Anna Diekmann (10.5 months)
Malgorzata Miazek (10.5 months)
Bartek Zwardon (2.5 months)
In all approx. 3 years, 8 months and 3 weeks

Apart from working on the publication *Draw the Line* all assistants have contributed with two other tasks in the UPGEM project: 1) A quantitative headcount of male and female physicists at 20 universities in the five partner countries to be published in a subsequent publication in 2008 2) Information boxes published on the homepage www.upgem.dk.

[*] In addition to the Draw the Line publication, the employment also covered the following tasks: minutes from consortium meetings and monthly Skype meetings, Atlas.ti development, development of homepage, co-ordination of assistants' work with coding interviews in Atlas.ti, assisting with work plans, State of the Art (SOA)-letters, instructions for Atlas.ti and Share point etc.

[**] Work tasks also include coordination of assistants' work with coding interviews in Atlas.ti and development of homepage etc.

Appendix B. UPGEM Interview guide (End version)[1]

Guidelines for interviews:
Interviews can last up till 2 hours. When finished check all questions have been answered, even if not in the "right" order.
End all interviews with asking concrete information on leavers.
Use interviews to get access to Shadow or participant observation.
Take extensive notes on "settings"

UPGEM-Interview guide

Theme 1: Career Path

1. Could you explain to me what your position is in the physics institute and briefly what you work with? (Follow up: To leavers: What was your position when you left and what did you work with?)
2. Could you describe your career path until now (draw it as a timeline)?
   - 2a Did somebody in your family or a personal relationship inspire you to become a physicist? (Follow up: Father, mother, grandparents or a teacher. Or was it rather a particular event, science fiction books – or other inspiration)
   - 2b. What or who made you decide to study physics at university? (Follow up: Did particular persons encourage your decision?)
   - 2c Why did you decide to do a PhD? (Follow up: (Did particular persons encourage your decision?)
   - 2d How did you come to work within the field of research you are in now? (Follow up: Did you choose it because of the people in the field, or the field itself?)

[1] The interview guide has been translated into the local languages in the project. The translated guides will be accessible at www.upgem.dk from July 2008.

2e Have you changed your interests in your field of research along this timeline – and why? (Follow up: Because of people you met, or because of scientific reasons?)

2f What kind of difference do/did you hope to do in the science of physics? (Follow up: Have your expectations of your own contribution to physics been fulfilled so far?)

3. Was there any moment that you thought that maybe physics is not what you wanted to do? (Follow up: If you have considered other work possibilities, what did they have to offer, that physics does not have?)
4. How do you think your field in physics and academia as a workplace has changed over the past 20 years?
   4a. How do other people in your institute (or former institute) talk about these changes?
   4b. If you have experienced these changes yourself, what has affected you the most (positive and/or negative)?
5. Do you think it can influence physics that you live in a catholic/ protestant country? (Follow up: Either in relation to conceptions of physics or in relation to conceptions of family)

Questions for Stayers:

1. Do you know anyone who left physics – either as a field or this institute?
2. Do you have any idea why?
3. Would you think these reasons for leaving are typical?
4. Will other of your colleagues talk about leaving for the same or other reasons?

Questions for Leavers:

5. What were the reasons that you left academia?
6. What do you do now?
7. Would you have liked to stay within academia? (Follow up: Do you regret leaving?)

8. Can you describe the differences between your current work and your work in academia? (Follow up: What is the most important gain or loss following your decision to leave?)

Theme 2: Family

1. Are you in a stable relationship?
2. If yes, could you describe your partner's education and his/her profession?
3. Do you have any children? (Follow up: How many? What age? If you do not have your own family yet, do you plan to start one in the nearest future?)
4. Do you think the other physicists (in your present or former workplace) prioritize their families (partner/children/parents/ relatives) enough? (Follow up: What about you?)
5. Would you sacrifice important work not to let down your family?
6. How do you combine your family and work responsibilities? (Follow up: What's the division of your household chores? To leavers: was this connected with decisions on leaving?)
7. Do (or did) your male and female colleagues talk about how they manage these responsibilities differently?
8. Have you ever gone abroad in order to do your research? (Follow up: If yes, did your family go with you? What impact did your stay there have on your family life? If not, do you take such possibility into account?)
9. Has your family supported you during your academic career (Follow up: Both financially and emotionally)?
10. Do you know any people who left physics because of family obligations? (Follow up: If yes, do you think it's symptomatic for the field of physics?)
11. Would you be surprised if any of your colleagues ever mentioned sexual harassment or other kinds of harassment as a problem at the workplace?

Theme 3: Working Environment

1. Where are (or were) your closest colleagues situated – next door or in another country?
2. Do (or did) you consider your work in physics mostly an individual or a group work?
3. Where do you prefer to work – at home or in the office – and why?
4. Do you consider doing physics a fun work? Why/why not?
5. Would you describe your present working conditions at satisfying when it comes to:
   - 5a. Security in the job contract (Follow up: for example possibilities of a permanent position)
   - 5b. Payment
   - 5c. Travelling/mobility
   - 5d. Balance between work time and free time
   - 5e. Promotion

   (Follow up: To leavers: were any of these issues important for decisions on leaving physics?)
6. Do (did) you have easy access to all the tools and meetings important for your work? (Follow up: Computers, databases, experimental equipment, participation in conferences, meetings abroad with colleagues ...)
7. Who do (did) you negotiate with to gain access to equipment and how did the last negotiation go?
8. How would you describe the hierarchy/leadership at your (former) working place?
9. Do you have, or have had, some kind of mentor at work, who has/is helping with your career? (Follow up: Male or female? Did the gender matter?)
10. What is the best thing you can say about your (former) colleagues at work? (Follow up: support, help, understanding, having lunch together, joking)
11. What is the worst? (Follow up: lack of support, help, understanding, loneliness, power play)
12. With whom did you author your last article? Was this typical?

13. Could you show me the article you are most proud of and explain to me why you are proud?
14. If you had the possibility to change your working environment (incl. promotion to a higher level in the hierarchy at the work-place, resources, people, hierarchy, building, rules etc.) what would you change? Why?
15. Have you already tried to change these or other things – and what happened?
16. Do you feel that there is (was) a strong competition in your working place?
17. Do you think that the competition at work might (have had an) affect your career path? How?
18. Explain how you think the prestige of your (former) work is estimated in relation to other colleagues (or lack of prestige)?
19. How do you perceive the prestige of:
    a) your own group
    b) department
    c) field of research
20. DILEMMA: Everybody has had the experience of being in situations at work where they had to make a decision but were not sure what was the right thing to do. Could you describe a situation where you were not sure what was the right thing to do? (Follow up: If no Dilemma turns up – use prefabricated)

Theme 4: Identity

1. Think about the physicist you have ever met, you admire the most? Could you describe his/her qualities and explain why you value these?
2. What do you have in common with this person?
3. Do you have a role model of your same sex – and if not why not?
4. What qualities do the other physicists in your community have that you think you lack yourself?

5. Almost every profession has some stereotypes ascribed. Could you tell me if you know what the image of the physicist is in society?
6. How do you relate yourself to this stereotypical image?
7. Has this stereotypical image changed in the last 20 years – and if so how?
8. How would you think your career would be different if you were a man/woman?

Theme 5: Future

1. What are you doing ten years from now?
2. How do you think you would describe your present workplace and field in ten years from now?
3. What determines if these future expectations come true?
4. What should happen so that you would stay in academia/return to academia?
5. Do you have good ideas for how to make physics in academia a more attractive career path?

Theme 6: Open Questions

Appendix C. Interviews and www.upgem.dk

It has only been possible to print four of the five National Reports in *Draw the Line*, but all five reports will be available at the project homepage www.upgem.dk in June 2008. The homepage is administered by The Danish School of Education, University of Aarhus. As part of the research, a number of information boxes have been produced. They present findings on contextual matters and relevant issues such as the history of women's emancipation and the gendered labour market in the partner countries. These information boxes can also be found at the homepage www.upgem.dk.

The National Reports (NR) presented in this publication are based on local interviews, which were originally decided to be 36 in Estonia, Denmark and Finland because these three countries have fewer physicists than the two 'big' countries, Italy and Poland, in the survey. Thus the Italian and Polish teams were decided to make 50 interviews. In some countries more interviews have been made than originally planned (up to 16 more in the case of Poland, nine more in Italy and five more in Denmark) for reasons given in the local reports.

All of the interviews have been conducted with physicists who have either begun or finished a PhD or who are employed as associate professor and up. We have aimed at having representatives from all levels of position – from professor and down. However, the local factors have also influenced the actual distribution. As for the complexity of the diversity of university titles we refer to the information box on contracts www.upgem.dk.

The interviews vary in length from 1–2.5 hours. The assistants have in each country had to follow the UPGEM Interview guide (see Appendix B), but have otherwise rested their interviews on their local skills and techniques, just as ethical aspects have been dealt with locally. To secure anonymity, though, the assistants have developed local intrinsic coding systems (with codenames from movies, zoological gardens and symphony orchestras, the military, flowers and nations and city names). As background for the national analyses the assistants have delivered reports with overviews of the research findings in the form of analytical coding in the software Atlas.ti. The codings relate to so-called

'families' such as 'country', 'stayer, 'female' and 'position'. The analytical codes spring from 34 hypotheses (see Appendix D).

In the National Reports, all informants have been given neutral 'p-numbers' and an indication of whether they referred to a male or a female, a stayer or a leaver.

In each of the partner countries, the informants have been randomly chosen from groups that were accessible through e.g. websites from physics institutions. The leaver group has been a particular challenge as they are not defined in any publicly available data source according as previous physics researchers, but rather listed according to their present job. They were typically found by obtaining access to university databases of former PhD-students, and the physics institutes have also been used as a point of departure in order to track leavers through the internet etc. However, many of the interviewees have been found through the contact of present employees at the universities. This method was particularly useful when it came to identify people who had begun a PhD but found had opted out before earning the degree. Throughout the analysis, we have discriminated on three parameters: sex (male-female), current position in or outside academia (stayers and leavers) and national culture.[1] Some might criticize that we operate with 'leavers' as it somehow implies that they are a lost case. This is not at all our intention. We have chosen 'academia' – state financed universities – as our point of departure, and it is from this perspective we, as researchers, have chosen to make an analytical boundary between those who stay in academia and those who leave to (in most cases more satisfying) jobs outside academia.

All through this publication, we quote stayers from a variety of fields in physics and leavers who have left for a variety of new positions. For the sake of anonymity we shall not list the present position of each of the stayers and leavers; instead we present a general list of which fields the stayers and leavers are primarily occupied in.

[1] The parameter of diversity found between physics institutes embedded in national cultures is not discussed in this publication, but the subsequent UPGEM-publication, 2008.

Stayers fields: Geophysics, theoretical physics, nanophysics, solid state physics, particle physics, nuclear physics, X-ray physics, aerosol physics, astrophysics, astronomy, meteorology, material physics etc.
Positions held by leavers: Designers, Public Researcher, Industrial researcher, Patent Consultants, Academic administration, Website administrators, Well site engineers, College teachers, Record managers, Medical and hospital work, Research & development in high technology companies, Energy industry, Specialist positions in public sector, HR management, Polytechnics and high school, Investment companies, Dissemination of Didactics, Retired and Unemployed

Appendix D. Hypotheses and Codes

Hypotheses and codes for the software Atlas.ti

1)
Code: Change
Hypothesis: Since the 1960s, huge changes in academia and the political system have taken place in all the partner countries. We assume these changes have affected the career paths of male and female physicists differently.

2)
Code: Competition
Hypothesis: We find more female physicists in universities that are less competitive compared to the more competitive universities.

3)
Code: Discrimination
Hypothesis: Female physicists in academia are discriminated against more than their male colleagues.

4)
Code: Maternity leave
Hypothesis: Female physicists take more and longer maternity leave than the males, and that impedes their career advancement.

5)
Code: Harassment
Hypothesis: More female physicists, than male physicists, leave academia due to personal harassment.

6)
Code: Chilly
Hypothesis: Chilly working climate affects female physicists more negatively than male physicists.

7)
Code: Sexual Harassment
Hypothesis: Women in physics are exposed more to sexual harassment than men are.

8)
Code: Class Mobility
Hypothesis: Parents' societal background and class society affect the career paths of physicists differently in each country.

9)
Code: Identity
Hypothesis: We find cultural differences in how men and women identify themselves as physicists.

10)
Code: Stereotypes
Hypothesis: Female physicists are connected to different stereotypes than male physicists.

11)
Code: Self-esteem
Hypothesis: Female physicists downgrade themselves more often than male physicists do.

12)
Code: Teamwork
Hypothesis: Female physicists prefer more than male physicists to work in teams. Different national attitudes towards teamwork in physics affect females more than males.

13)
Code: Academic Structure
Hypothesis: The academic structure differs nationally, and these differences affect the career paths of male and female physicists differently.

14)
Code: Happy Stayer
Hypothesis: Male physicists generally stay (in academia?) because they are happy while female physicists typically stays because they have no other possibility.

15)
Code: Pay
Hypothesis: Low pay drives more male than female physicists to leave academia.

16)
Code: Professor
Hypothesis: Staying on good terms with your professor is a prerequisite for staying in academia. This affects women especially because they are poorer at making and maintaining professor bonding.

17)
Code: Mentor
Hypothesis: Having a mentor facilitates your career advancement in physics academia.

18)
Code: Turning Point
Hypothesis: Personal turning points often cause dramatic changes in physicists' career paths.

19)
Code: Family Responsibilities
Hypothesis: More women than men leave physics/academia because of a double workload.

20)
Code: Abroad
Hypothesis: Male and female physicists are affected differently by demands of leaving their home department/going abroad.

21)
Code: Future – Past
Hypothesis: Female and male physicists envision their personal/professional future and past differently.

22)
Code: Double Star

Hypothesis: Women in ‘double star’ relationships in physics remain in a lower position compared to their spouse.

23)
Code: Teaching
Hypothesis: Female physicists teach more than male physicists do. Teaching and didactics are generally low prestige.

24)
Code: Administrators
Hypothesis: Women do more administrative work than men, which affects their career path negatively.

25)
Code: Dissemination
Hypothesis: Women do more popular dissemination than men, which impedes their scientific career advancement.

26)
Code: Diversity Interest
Hypothesis: Male and female physicists work, or would like to work, within different fields of physics. Fields with a majority of female physicists are low prestige.

27)
Code: Family Member
Hypothesis: Women more often than men have physicists in their family.

28)
Code: Motivation
Hypothesis: Females are more often than males encouraged to study and do career in physics by personal relations such as a teacher, family member or mentor.

29)
Code: Artefacts
Hypothesis: Lack of wanted and modern equipment drives physicists to leave academia.

30)
Code: Working Environment
Hypothesis: The female physicists are more sensitive than the male physicists to the physical working environment.

31)
Code: Children
Hypothesis: Having children hinders physicists' career advancement.

32)
Code: Male Snatchers
Hypothesis: More male than female physicists leave academia to work for private enterprises either because they consider themselves to be breadwinners or because they have the skills in demand.

33)
Code: Publications
Hypothesis: Male physicists prioritize publishing in academic journals over doing popular dissemination.

34)
Code: High school
Hypothesis: It is easier for women to do career in physics in countries where the educational requirements are broader.