previous

1. Career paths of women and men physicists - new emerging pathways and new challenges

Towards a new career model of a physicist: unpredictable, shattered and precarious pathways

The study reveals the transformation of the scientific pathways of the European physicists, similar to that experienced in other fields within academic world and even other professions - from the linear and predictable career model to one characterized by the shattered and precarious pathways of the labour market participation.

The linear and predictable career model in its ideal form is marked by stable employment usually in one institution (or few of them) on a full-time position for a prolonged period of time. This model implies the gradual advancement within an institutionalized framework, predictability of one's career path and an attachment to a university or a research institute. The entrance to the academia is difficult but once within it, there is a high probability of remaining. The linear model still persists in some of the studied countries (e.g. Poland, Italy), nevertheless with the new model also co-existing. The interviewed senior researchers often followed this model, but there were also some divergent pathways in their case.

Linear and predictable model	Shattered and precarious model
From the start of PhD studies my career was typical for the employees of the institute. 4 years of the PhD studies, then I waited for the review of the doctoral thesis. And more or less 8 years for habilitation. //74_F[1)]|Very linear, I had my children very early so my PhD took a little longer. I studied in [name of a country] then I moved abroad for 2 post-docs and then came back to [name of the same country] and got a permanent job within a few years. //01_F //I am 37 years old, I have done several post-doctorates and I still don't have a long-term contract. (...) I hope I won't have this [situation] in 3 or 4 years. //33_M	

Within **shattered and precarious pathways**, there are multiple entry moments to employment, as the need to apply for a position, re-appears almost after every step of the career. The pathways are less predictable and are characterized by the especially difficult period of precariousness at the early career stage. Once completed PhD, the recently graduated applies for the non-permanent positions usually of the period of 2-3 years (post-docs). The model implies heightened mobility, as work opportunities are often abroad and demand changing countries or continents. The advancement is non-predictable - the postdoctoral fellow may remain at the same level of the scientific ladder for an extended period of time.

- //I think this is a huge problem of the institute and an issue that the [institution] should solve. There are so few career upmove occasions, that researcher will stay for decades in the entry level, without any motivation to do better. //41_F
- //I know a couple of colleagues, who (..) now moved to England. (…) There the job market is completely different. So there you get a permanent position much earlier in your career. //06_F

The science labour market transformations are noticed both by young and senior researchers. The negative evaluation is especially voiced by the young generation. Due to the lack of permanent posts, some interviewed physicists were forced to participate in several post-docs in multiple countries (see chapter on “Mobility, migration…” on “Extensive burden of forced mobility”). Those interviewed who after one or two post-docs managed to obtain permanent positions usually evaluated positively their post-doc experiences, but those who did not manage to reach permanent employment after several post-docs remain frustrated with the lack of employment opportunities. They underline: high competitiveness, lack of career predictability, little stability, low attachment to institution that may hinder engagement, as well as difficulty to get engaged in some long term collaboration.

- *It's the classical problem: I'm sure they want to hire me, but //***we have to find the money**//// to open a permanent position and it's not so easy. It's //***sometimes difficult to feel involved***// and invested with its mission thoroughly, when we do not know if we will still be there in few years. A post-doc is very short, only 3 years on a research project. //***We don't have so much time***// and we don't know if we can continue our work after or not. Honestly, I have no idea where I'll be in 3 or 4 years, and //***it's pretty frustrating****. 37_F*
- *I am 37 years old, I have done //***several post-doctorates**//// and I still don't have a long-term contract. It's starting to be a bit //***difficult to cash in****; I sometimes ask myself if I've made a good choice of career guidance and if I should not change. At the same time I love my job, it's frustrating. I think the crazy number of precarious jobs is really a huge problem, and that is what makes many young people hesitate to choose this career. (…) //***I could work now in a company.**//// But I like so much what I'm doing, it compensates this issue. I hope I won't have this in 3 or 4 years. 33_M//
- *I don't //***have a sense of belonging**//// because I know that //***I'm precarious****, and it's not sure I'm going to stay here. 43_F*

The lack of permanent positions creates **a generation gap** in the research - this was especially stressed as a problem by senior scientists. The lack of young researchers in an institution is due to little investments and effects negatively whole community within in.

- *We tried to support every person with hope that maybe they will get interested in physics, stays for longer and we will have someone, someone who could rejuvenate our institution staff. We have some generation gaps, this is a problem. 68_M_L*
- *It is not a pleasant workplace and it is not easy to work in our institute because there has not been invested on new people with new skills and then, after 10 years of abandon, the research quality is reduced. Workplace is not stimulating and there are not opportunities for growth. 39_F*

It is interesting to add that in the eyes of some interviewed senior scientists the situation today was evaluated as better than some decades ago when posts were more limited, and there were little opportunities to apply for external funding. In the biographical accounts of some senior scientists one notices as well some periods spent outside academia, or unemployment spells. There were also situations in the previous generations of precarious employment or even unpaid positions, e.g. some senior researchers said that due to lack of permanent position they were on short-term contracts for

even 10 years - but within one institution.

- *I've started in my Institute with a research grant and after I had 10 contracts for 12 years before being permanent. 42_M*
- *I had for six year a collaboration contract as student at my actual research institute without wage. Not asked I took a long time before having a proper contract, so I think my career was quite slow at the beginning. 41_F*
- *I'm not sure what the supply of job positions was, but I think it was smaller than now, because there was less money for academia, so the supply of job positions was smaller. Currently there are more job positions, not only academic, but also in grants. The positions in grants appeared in last ten years, previously the grants were not enough to have any post-doc or a doctoral student (...) One received PhD and one had to look for a job and either you had this position or you dropped out. 54_M_L*
- *I left with my husband who received a post-doc position, and I went without about promise that I will be employed. So when I arrived I sent application to many research organizations (...) I was even a volunteer as the University, I was not paid, but I had access and that's important. Scientific world is open, when a person comes and says that they are volunteering, institutions are happy to give them a space to do what they want. 58_F_L*

Precarious pathways - characteristics and processes

Today the internationalization of science requires from researchers **intensive engagement in mobility** - a lack of positions in one's country strengthens this tendency of searching for employment in other locations. Advantages of the mobility are underlined by most interviewees, nevertheless the extensive mobility model is not welcomed - while an experience of working abroad is valuable, becoming a vagabond scientist is seen as counterproductive. Mobility is attached to the early stages of the career and young age, and prolongation of this phase is negatively evaluated. The advantages and difficulties for female researchers are described in the chapter on “Mobility, migration and internationalization of science”: first, the family duties and partner work obligations constitute a barrier to mobility, secondly in dual career couples it is more often women that is expected to give priority to a male partner's career:

- //I was working 11 years abroad on nonpermanent or permanent positions. 79_M //
- *After the PhD, you will normally spend around 15 years with 2 or 3 year-contracts and moving all over the world. This is not a very attractive career prospect. 30_M*
- *I didn't used to find it difficult but you have to consider, I started moving around places already in January 2005. (...) And now of the several years [of moving around], I find it increasingly difficult to do this over a longer period of time, not really knowing when this state is going to come to an end. 15_F*

Second trait of today's employment patterns described in the interviews is a growing presence of the **grant-based positions**. The responsibility for securing funds for one's employment is placed on the candidate not on an institution. The need to find money to fund one's post is a lengthy and time consuming process, followed by administrative burdens in grant management, which distracts from scientific activities. Still, interviewed researchers stress that the moments when they received the grants constituted usually an important milestone in their careers (confirming excellence), and they were important turning points, as simply allowing them to continue their work as physicists:

- *Milestones in my career include getting a PhD grant, becoming part of the staff... 32_F*
- *The turning point has been the ERC [grant]. 48_F*
- *Quite recently, the financial situation and the support for researchers are really complicated. We have to spend most of our time to make applications and huge paperwork for almost nothing. The ratio between the effort and what you get for it is just a disaster. So if I had known this evolution early, I think I would have done something else. 35_M*

After the grant system is exploited, there should come a stage of obtaining a permanent position. The interviewed physicists observe that the grant-based employment is available only at some stages of a career - there are plenty of opportunities for PhD scholarships and quite many for Post-docs, while the funding opportunities at later stages of the career is not so available anymore in such extent. Getting a permanent post constitutes a critical point in the career - permanent positions are rare and those who obtain those are by some interviewees perceived as “lucky”. This contradicts with the meritocracy perspective of some other respondents, but on the other hand may indicate the belief that excellence in today's conditions may not be sufficient to remain within academia.

- *You must have also a plenty, plenty, plenty of luck. And I have the feeling that //***in science you need just even more luck than in industry***//. And thus, that there is an end someday, so some day you will be a professor or you will be permanently employed. And from these few permanent positions there are even less for professorships. So, in this groups, someday there will be one professor and one or two scientists with permanent contracts. 22_F*
- *It is a very competitive field, and I feel... to be honest, when there is a position and 10 people would apply I think I will not get the permanent position. (...) Many PhDs, but no prospects to get a permanent job. 51_F*
- *I know what I have to do which is working hard and publishing a lot. But other things are not in my hands, such as the number of positions that will be offered in the future. 24_F*

In the new model, the unemployment periods can happen in between positions. In the senior researchers account, these appeared usually after obtaining PhD. As one respondent from Spain described, she “suffered the *threat* of being unemployed several times.” Similarly, in between positions may happen periods of atypical employment e.g. a young female researcher did internship to wait for the PhD position.

- *I was unemployed for a year and a half. (...) when I was defending my PhD thesis I was already in second pregnancy. (...) I had a plan to give birth and stay at home for 9 months, but later, after these 9 months actually it was that I had no employment for another 9 months. 56_F*
- *Just after my master, there was some issues, financial and administrative, to create a PhD position for me. My supervisor tried anything, but it didn't work. Finally they //*recruited me on a paid internship for a few months, to make a transition and allow me to work. 37_F//
- *I took one year of parental leave following the birth of my second child. [while searching for another position]. 03_M*
- *I was unemployed for a year. 27_F*

While the job positions in a given thematic area may be difficult to obtain, some researchers decide to undertake research **in a different subfield**. Such decisions are evaluated as having a slow-down effect for the career, but there were also opposite cases. The change of subfield is usually described as problematic as the more focused career model, when a person sticks to a theme of research,

seems the most expected.

- *[Interviewer: That means when you move together then it is likely that at least one of you is unemployed?] Yes, yes, in any case. Because of this and that was one of the reasons why I took the Post-doc here. Despite the fact that the topic was thematically quite far away. (...) I have a pretty general degree, also general education, and then I changed fields a few times and yes, I was told, yes, but they love people who have such a, such a [Interviewer: broad?] yes, exactly, such a broad education or something like that and now it turns out: no. (...) so at least in Xxx //[country of the interview]* it is the case that most people do their Bachelor thesis, their Master thesis, their PhD and their Post-doc in the same group and for that they are experts. And they get all the grants [proposal writing] and they get (.) probably a professorship eventually. 07_F//
- *It is difficult finding a senior position in Xxx //[one of the experiments run by an international collaboration]* if you have changed fields. They don't want to pick you, when they can find someone who has a lot of experience with that detector for most of their career. (...) I have progressed fairly fast through my career but not directly because I switched fields after my PhD. 03_M//

Pathways of physicists - differences between countries

The career pathways are changing between research generations - through our limited data we can say that the linear model with low tradition of mobility between institutions/countries still dominates in some countries - such as Poland, Italy and Romania, to some extent also Spain. The shattered model is more common in Germany, France, Switzerland or Netherlands. It is important though to stress that also in the first group of countries we observe a transformation of employment forms - while the system has not yet transformed as such, we see that one way to deal with a lack of regular positions is today realization of multiple grant-based positions one after another. From outside the person employed on multiple short term grant-based contracts within one institution appears embedded within the system, while in fact this person experiences consecutive periods of precariousness- this was already a case e.g. in previous generations in Italy.

Table 2. Most common pathways of physicists from different countries on the basis of interview data.

France	Shattered pathways, new model of a career with intensive mobility and migration - having worked in few countries in each case. The career model is PhD-post-doc - post-doc... or finally permanent position.
Germany	New model with forced mobility at the early career stage - post-doc abroad after PhD, later trying to find a permanent post in Germany. Some mobility within Germany between institutions.
Italy	Linear pathways, staying in one institution, little mobility. Precariousness also in a linear model - a chain of short term contracts in one university for female senior researchers (or single father), finally leading to permanent post. For younger researchers, positions that are project funded (grants) after PhD grants.
Poland	The career model is: PhD-habilitation-permanent position. Linear pathways, usually an experience of working at one institution. Some senior researchers entered academy at the later stage after working outside for some time due to lack of positions in academia. Longer mobility periods integrated within employment, particularly at post-doc level. Emerging grant-based model: example of person whose positions are funded through grants still all located in the home institution but with integrated mobility, rather short term mobility.

Spain	Pathway is partially linear and partially shattered. The PhD grant is a first milestone, obtaining post doc position (often grant-based) is a second milestone, a third one - permanent position. Those can be made in one institute - no pressure of mobility. In the senior researcher accounts, permanent positions were obtained directly after PhD completion (no post-doc).
Romania (limited data)	The career rather experienced as linear, but some researchers who arrived to an institution from abroad had an experience of shattered pathways.
Switzerland (too few cases, limited data)	Indications for precarious model. The career model is: PhD-post-doc-permanent position.
Netherlands (too few cases)	Indications for precarious model.

More holes in a pipeline - challenging moments in the career for female researchers

The difficulties in finding a permanent position after the multiple short-term contracts are the most difficult aspect of nowadays career as a scientist, it is important to say that this is a problem for both men and women. Nonetheless, these transformations have different effects on women and men scientists and they both undertake different strategies to navigate these.

When considering the new model of a career path and reconsidering the popular leaky pipeline metaphor (Bennett 2011, Etzkowitz, Ranga 2011), it appears that the shattered pathways create new potential moments of the leakage, or in other words - drop out. In a linear model the most possible moment of drop out was during the PhD or after concluding PhD, or in case of not completing habilitation (even if in some institutions there were institutionalized ways to retain such researchers on some secondary posts). In a new model, **the pipeline has more potential holes**. After the completion of each post-doc, there is a need to reconsider one's career and also to go through recruitment procedures for a new position. When there are so many points of “re-entrance” this causes more risk of leaving science.

Matched with hesitation or self-doubts voiced often by the interviewed female physicists, unfavorable atmosphere, encounters with bias, preference for male career model and others - this creates potential moments of leaving.

- *Every time a contract was coming to end, I wondered: “**should I stay or should I leave the career?”** I have been lucky I did not give up. 28_F*

In their stories women were generally prone to voice doubts about their career, about their presence and contribution to science. They complained about the competitiveness, and precariousness, as well often voiced the doubts in their skills - some of them were aware that possibly those doubts can cause the situation that women leave science and were linked to the internalized stereotypes of science as a male profession. Female respondents were more open to critical position towards their choices and indicated moments of doubts, men rather presented linear pathways and concentrated on description of the career from the science perspective - nevertheless men as well complained about the new situation concerning employment. The moments when doubts or hesitation appears are linked to the career path (particularly the period of the university studies), physics as a field (e.g. masculinized culture, microagressions, discrimination), but also to private life (e.g. having children, relationships, dual career couples employment decisions).

Summarizing, similarly to other critiques of leaky pipeline metaphor (e.g. Bennett 2011), our study

shows that the career model is more and more often not similar to a pipe, but shattered and unpredictable with divergent pathways (see more in the last subsection of this chapter). Nevertheless, the results also point to the fact that while the linear and predictable career model is the one expected and rewarded, even if so difficult to realize or also unwanted, there appears a need to renegotiate the normative model of a physic career. The new model could be more embracing, allowing and recognizing divergent pathways, interdisciplinarity and cross-fertilization between fields/subfields, valuing contribution within teaching, administration, socially-oriented initiatives (e.g. promotion of science) and recognizing need for private life commitments (cf. Bennett 2011, Miller, Way 2015). Finally, in some cases, the pipeline may be just simply blocked for new entrances - of both women and men - due to lack of permanent positions offer.

Family formation decisions and precarious career paths

The female respondents indicate the moment of family formation as impacting on their career path. For many of them, having children causes a slowdown in the career (confirmed by quantitative survey: Ivie, White 2015), and results in several limitations which include: impossibility to be as mobile as before having children, limited time for work because of care obligations or tiredness. Even those who did not have children, notice that needing to consider partner's career choices can have also limiting impact e.g. when it comes to choosing a location.

- *If you look at the career of female physics professors that are now 50 or 60, both often they don't have children as the male colleagues almost always have. 18_M_L*
- *Children were influent in the sense that they limited the options I could consider (…) Of course it impacts your career if you get a maternity leave once and again, you travel less, go to few conferences and publish less, just because you are exhausted. 27_F*
- *The most problematic is international mobility, especially when having small children that require constant care and support from other family members. 56_F*

In the interviews, it is remarked that there exists an image of a scientist being an elderly bachelor and a pressure of women to remain childless. Other studies as well notices that in STEM family is perceived as hindering success in research (e.g. Godfroy-Genin 2009). One respondent is even describing how her PhD supervisor required from her declaration on resignation from childbearing before completing doctorate:

- *It is shocking how female researcher profile is oriented towards single or married with another researcher. 30_M*
- *If you decide to have children, you stop publishing. You cannot keep this pace of work with family. You have to slow down. Career breaks are not valued in science. If you stop to form a family, you have expelled yourself from the system. 31_F*
- *When I searched for PhD supervisor (…), he said something like that: no child, you need to promise me or a child or a doctorate. And then, I of course said, fine. I thought what will be, will be, but from the perspective of a 44 years old without children, I see that this was binding. (…) I have it coded in my head that having children does not fit with work. (…) only later I started to meet women physicist with four children, active in civic society, heads of departments, and are doing well. 65_F*

It is important to say that family is not only seen through the lenses of limitations. The family is also given value and many remark that both spheres of life have for them great value. Some of the

respondents having children try to abolish the vision of a scientist as a person who does not have children, bringing forward the vision of balance between those two spheres of life. There are also those who tell that family or children can be seen as auxiliary to career and notice that engagement in family life and contact with their children gives them a certain distance to their work or that a break due to pregnancy allowed her to overcome work crisis as she had more time to reflect better on her career plans (cf. Godfroy, Genin 2009).

- *We did measurements and then it appeared that what was supposed to be basis for my habilitation is not appropriate. And then, came my second pregnancy and second break, thanks God! I needed it. And when I came back I realized I need to give on basic research and do something which is easier, where you do not need so much time to get a result, but few months. (...) second pregnancy - when I it was needed and I reorganized my future plans. 61_F*

The interviewed parents underline that with determination, good organization, institutional and personal support it is possible to realise a scientific career and have children. Having a partner who is an engaged parent with the additional support from institutions and extended family is mentioned as critical.

- *Well, I..., so-called dedication to science, I think it is very controversial to say that you can devote yourself to science (laughter), because I know people who have scientific achievements and family and so they devote to both. It is a certain compromise, a person tries to feel comfortable, but surely there is also the issue of choosing to go abroad and [to establish] international cooperation. (...) I believe that sacrificing family life for science is not a proper definition, because if the family is organized well, there is a lot of support, family support. 60_F*
- *Yes, yes, he supports my career, for instance he has taken parental leave. That means **we shared the parental leave** and each of us took 7 months (...) he stays at home when our son is sick or something. So there he does support me. 06_F*
- ***My husband is very supportive** in my career, helping with the child, adapting his schedule after mine when it's necessary and others. 75_F*
- *For me it has been very simple: I knew two weeks before my delivery that the city gave us a place for the baby in September in the **kindergarten.** As my daughter is born in June, September was exactly the end of my maternity leave. I was so lucky it's nearly outrageous for all the other families who have sometimes to wait months for a place! 34_F*
- *(...) thanks to the fact that the husband could stay with children and the **grandmothers **could take leave from time to time, because both of the grandmothers are employed, and help us, I could go often abroad. 53_F_L*

The flexibility of the working time in scientific work is also underlined by parents as an important element of reconciliation work and family duties. Self-regulation of working hours in a competitive labour market though can create a pressure of a constant work and result in a total colonisation of private life by work (read more in “Work conditions and environment”). Those scientists who are mothers try to regulate the hours spent in work but the limited amount of hours that could be devoted to work make them often frustrated or disadvantaged in comparison to those who do not have children and can stay endless time in laboratories or offices. On the other hand, parents underline the advantages of the flexible working time and indicate that it helps them in balancing duties in work and in family:

- *As I try to devote to my child when I'm home, I don't open my computer before she sleeps. It means I have fewer hours to work, even if I have still the same workload. It's frustrating from*

this point of view: I'm very happy to be a mother, but it obviously hurt my worktime. 34_F

- *I had the chance to balance my work and my duties as I preferred, thanks to the flexibility of my work. 41_F*
- *It is always hard [to reconcile work and family life] but it is easier for sure when having flexible working hours, for sure it is easier. 56_F*

In the context of precarious and unpredictable pathways, the decision to form a family and have children becomes difficult. Young female scientists postpone decision of having children or resign from childbearing because of their unsecure employment situation - this decision is hard especially when both of potential parents have precarious work contracts. The period of precariousness at the early career stage (post-doc period after PhD) coincides with the time of having children (usually women are about 27-30 when completing their doctorate). As described also in the chapter of mobility, the post-doc period includes usually international mobility - the expectations towards post-docs are high and demand full-engagement. This particular pressure on high engagement in early career is noticed by other studies: “individuals facing tenure review must demonstrate high levels of competence and research productivity in the earliest years of their academic career to avoid losing their jobs” (O'Laughlin, Bischoff 2005:83). The post-doc period being intensive, some suggest that the best time for women scientist to have children is during their PhD - this shows for the actual belief that the physicist career path choice demands the adjustment of a private life to work expectations.

- *My impression is that now when it takes so long to have a permanent post, for women the best moment [to have children] would be during a PhD. Afterwards during post-docs if you are missing half a year of a post-doc that's very difficult. Then you are really behind in your CV compared to others... If you are in such a competitive field as becoming a scientist it is never easy to have half a year off. If you wait until everything is perfect as a woman you are too old. 01_F*
- *Precariousness influenced my life in terms that I and my boyfriend couldn't go live together. Now I've been wondering about being a mother and, even if I know that earlier is better I also know that it is not going to be possible in several years unless I decide using my saved money. 43_F*
- *Women at the end of the PhD are concerned about how to realize something concrete, such as to make a family. I like doing research, but if the stability perspective is in ten years from now, it is a problem. (...) it is a problem to be both non-permanent researchers to hypothesize the building up of a family. 46_F*
- *[Interviewer: does your professional life impact or hinders realization of family duties?] Yes. [Interviewer: some conflicts emerge?] Yes, yes, yes. It is what we were talking about earlier - the employment policy - and my unstable situation at the university. It was hard for me to intentionally decide to enlarge a family when I had a contract signed for 3 years and after these 3 years no one knows what, for 3 years after 6 hard years fighting for doctoral results - I claim that yes [it has impact]. 57_F*

Divergent pathways of female physicists

Emerging fields and interdisciplinary approach

Research indicates for wider presence of women in the emerging fields linked to physics such as

physical medicine, biological physics as well as physics education research (Hasse, Trentemøller 2011; Barthelemy, Van Dusen Henderson 2015; McPhee 2016). Thus, the interviewees are asked about their opinion about this issue and about reasons for such processes. It is important to stress that a share of respondents did not confirm such a trend. But in some countries (for example, in Poland and Romania) this trend is observed by the interviewed physicists - they indicated mostly subfields such as medical physics and biophysics as adequate examples. Those subdisciplines according to interviewees are represented in some cases mostly by female scientists.

- *Um, yes, so, I believe you are more like to find women when, in astronomy, so at least in larger proportions, um, or as well, I believe more like in biophysics (...). 08_F*
- *I had a meeting with a delegation from biophysics field. There were only women and only one man. 77_F*
- *We also have biophysics which seems to be more for women, there is evidently more women than men, both in doctoral studies and under- and postgraduate studies"; "biophysics is more feminized, that's for sure. 53_F_L*
- *I have thought of the department of statistical physics, where part of work is related to biophysics (...), this is relatively new research direction. 54_M_L*

When asked for the reasons behind such processes, the physicists indicated that new subfields are potentially an alternative to a masculinalised field of physics allowing more career opportunities to women (cf. Götschel 2010). They as well point to their interdisciplinary character and lack of stereotypes attached to it. One of the reasons mentioned behind the wider presence of women in emerging fields was a more applied character of the conducted research, which - according to respondents - is preferred by women (cf. Hasse, Trentemøller 2011; Barthelemy, Van Dusen, Henderson 2015). It is important to say that in such explanation respondents relate to "innate" characteristics of women, thus also reproducing certain stereotypes. Finally, researchers also indicate that stereotypically some fields are assigned to women - e.g. biology, so in effect attracting more female students. All those explanations were rather hypotheses, as interviewees usually have difficulty to find adequate explanation for this process.

1. **Not dominated by men thus perceived as more welcoming to women**
   At the junction of physics and medicine there is medical physics, where perhaps there are more women (...) while physics is this kind of science that is filled with men, when a new subfield emerges it is not laden with the firstborn sin, that it is assigned to this or another sex. And additionally if this subfield is interdisciplinary with one of the disciplines better populated with women, this might affect positively even in spite of negative image of physics? That's how I can explain this. 59_M_L
2. **Women more willing to do interdisciplinary research**
   Women can work across different disciplines, men stick to one, narrow, just physics. So When I look around, [women] they link... they have cooperation, competences they gained here are being matched with other competences... (...) [Where does it come from?] I have no idea. 64_F
3. **Less limitation in the careers ****
   I didn't hear about that before but I can understand this choice. I know about female colleagues who feel limited in their career, so they try to look in an alternative. Emerging fields could be one. 33_M -Looking for discipline of applied character**
   I noticed at a conference, if there is a biophysics section, or medical physics, there is a lot of young women presenting. I do not want to say it is easier, but this is, also why I have chosen experimental physics, this is concrete, something that can be applied, that can serve other people. Maybe it comes from our nature that we do not want to do something that is all abstract (...) When I deal with nanomaterials that can serve for treatment of cancer, this is much more

telling and maybe more attractive. 70_F
(…) women started being engaged in physics which can be applied and goes beyond abstract reflections, (…). Although I can't say that running an experiment, revision and data analysis is not complicated, it requires as well specific skills, intellectual too, planning, anticipation and surely more women are here, especially in biophysics (…).57_F

4. **Women choose less technical field**
   [Interviewer: Ah okay and the subfields which combine for instance biology and physics are probably not as respected? Or how is that?] Yes, it is a little difficult. But there is of course either more technology or more biology. That always depends (…). [Interviewer: and the more technology, the more (.)] More men (.). Exactly. [Interviewer: Because biology is no real science.] Yes, exactly. So for instance I remember, when I was still studying, the women, who studied biology, complained that there was not a single man in their program. Not a single one. In that engineering school as well. And then it was said, I do not know where that is coming from." 07_F
5. **Stereotypes at the level of school education that guide students choices**
   Family/school induce the idea that maybe it is more proper/functional for a girl/woman to work in a less technical field. 82_M

Noteworthy, some respondents notice that emerging fields, as well as physics didactics are not perceived as a "true science", thereof they are evaluated as less important by physicists. As Whitten (1996) suggests, physicists believe their field stand at the top of the hierarchy of sciences, with biophysics, and physics education at the bottom.

- *"[Interviewer: You said that, um, biology is more feminine and nanotechnology is more masculine. Do you have an explanation for why that is? So for you personally, based on your experience. Both are natural sciences.] Yes, whereby in physics it is said that biology is not a really science, but it doesn't matter (laughing). No science. No true science. 07_F*

Didactics

While many of research participants work at university, teaching is a part of their work engagement (see "Teaching" in Work conditions and environment). The teaching vocation is not being recognized (cf. Whitten 1996), and there is rarely an institutionalized mode to engage exclusively with this part of the academic work:

- *In some research institutions there are such positions dedicated to physicists who become experts but don't want to get higher academic degrees, but there is practically no such thing here. There is no such thing in this department. There are no such posts as the senior lecturer, who does little research and focuses on didactics. Practically no such people are employed any more. The career path is only one. 61_F*

In our sample, one researcher engaged in physics didactics underlines the difficulty to receive recognition for physics education, both personal but also institutional. The publications in physics education receive much lower impact factor than those in physics as such, what creates difficulty in progressing in career due to impossibility of habilitation. Interestingly, she as well has founded an organization promoting education of natural sciences to children in elementary schools.

- *(…) the position [I was holding] was with indication for didactics so I started going to didactics conferences. In 2006 I went for my first conference of physics didactics and it opened my eyes to the fact that (…) people do research on physics didactics, because I had not known that earlier and then I thought "let's do this too" (…) Lack of awareness [that there are different*

research paths in physics than in one's home department] results in stereotyping and reluctance and a lot of things that kind which are, in consequence, nasty for us. As it is with [my] habilitation and this impossibility [to defend it here]. 56_F

Switching to industry as an option

Industry is mentioned by the interviewees as a potential option for employment - there are respondents who already plan to switch to industry, while some others still consider this as an option. Working for industry is described a bit as a pragmatic decision (linked to financial or logistic argumentation), in contrast to being a scientist which is seen as a passion or a vocation. The arguments for working in commercial companies include on one hand work conditions - respondents mention that the employment is more stable, it does not demand mobility, and the salaries are much higher. Also way of working is described as more satisfying - working in teams, having more immediate results. For dual career couples, industry is a way to find work for both of them in one location (usually one remains in science and another one works for a commercial company). On the other hand, industry is also seen as an interesting sector when a person can achieve success or engage in challenges utilizing their scientific knowledge which potentially have wider impact.

- *Comparing my salary with my husband, yesterday we did our taxes clearing - my husband has also PhD in physics but he works for the industry - so //***my salary is three times smaller than his**////, so there is this disappointment. 61_F //
- *You earn more in economy (...) I will go into the economy anyway. (...) science only, it is just not me. //***I would prefer to really work together with several people.**//// Well, here you work alone almost the whole time. 23_F//
- *And this is really a big issue why many people change into industry, into a less interesting job. The money is not the issue in general, but rather //***the secureness which you get in industry**//*. And this is the most obscure: That our industry is more secure ... 20_M_L*
- *"[I: Is he supportive of your career?] Yes. I would say so. We are having important discussions at the moment, because we are both looking for post-docs or maybe I want an industry job and one of us is going to have to compromise more than the other. And at the moment I feel like somehow socially it should be me. The stigma is there. I don't want to feel it, but I think it's just part of society still is this "women follows". (...) [I: How likely is it that you both find something that you want to do at the same location?] //***Both of us doing academia is almost impossible. Going into industry is possibly more likely**//, but that really depends on the cities. And the country. 10_F*
- *But now however when I have this grant, I strongly consider working for the industry, because right now (...) there is this need for scientists and for people who do data analysis, who collect data by using artificial intelligence. It's //***very interesting [topic], and what's more it has a great influence on what is going on in the world**//// and it's very well paid. And finally I think that moment when people need it, will pass. 62_M//

Industry appears also an escape option in case of negative experience in physics - in a quote below, the respondent tells about a situation of a female student who left science to industry due to experienced discrimination.

- *[I: Have you personally, have you personally experienced discrimination? So either yourself or seen it happen to someone else that they are discriminated against during your career?] Yes, well, so there, there, right, I had a PhD student here at the institute who reported that she was*

bullied (uncertain chuckle), basically by her male colleagues, that she was not included and discussions and conversations were abruptly ended as soon as she entered to the room and so, it was quite obvious, that there was no good working atmosphere. [I: Was that resolved?] No, that was not resolved. The PhD dropped out and, yes, now she has another position, so she is not doing a PhD anymore, but she is working in the industry in the private industry. [I: So basically physics has lost a scientist?] Mhm (affirming) Exactly. [I: Because of this discrimination experience.] Mhm (affirming). 06_F

[1)]

Quotations used in this report have been fully anonymised. For each quotation we only indicate the number of the interview (01-83), interviewee's gender (F, M) and leadership position (L).

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