Dynamics in the entanglements of gender cultures and disciplinary cultures in science as a key for gender equality: the case of the physical sciences

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Abstract:

Although the decrease of women among the academic personnel with each career step holds for all disciplines in higher education institutions, the underlying processes within the institutions which lead to this problem are closely related to the particular disciplinary culture. Thus when problematizing gender equality and asking for the gendering of academic careers in scientific research and higher education, it is indispensable to take into account that the gendering of the sciences differs between different disciplines.

The physical sciences are among those science disciplines with the lowest percentage of women in research and higher education. Whereas in Germany the vertical segregation within physics seems to mitigate slowly, the effects of the horizontal segregation still persists obstinately.

Academic careers in science are influenced by the gender cultures in the respective research institution and its working place cultures. Last not least they are also related to the organizational type of the research institution, e.g. universities or non-university research institutes. Drawing on an ongoing ethnography in four physical research institutions in Germany I want to discuss recent dynamics in the entanglements of gender cultures and working place cultures for the case of the physical sciences and consider the role of the different institutional settings for these dynamics.

In the course of the fieldwork there emerged different levels on which gender cultures become relevant: Firstly, the day-to-day explicit talk about „gender“, mostly in the context of gender equality, secondly, the *doing gender* in the interactions of physicists and, thirdly, the performings of gender through research practices of doing physics. The entanglements of the observed gender cultures, working place cultures and their institutional settings will be revised with regard to the recent policy-governed developments concerning gender equality in these research institutions.

Introduction

Though in the past two decades the participation of women in science has constantly increased, the so-called ‘glass ceiling’ still impedes the professional advancement and the participation of women in the higher ranks of academia across all scientific disciplines. This phenomenon has been thoroughly studied within Higher Education Research. It has been documented how the decreasing percentage of women’s participation with each step on the

academic career ladder is entangled with the structures and cultures of the academic disciplines. One crucial factor is, among others, that students and young researchers have to adapt their educational and professional career paths to institutionalized requirements and the dominating norms which still seem to match predominantly to stereotypical male career paths (c.f. for a more recent publication Beaufaÿs, Engels & Kahlert 2012). Furthermore the organizational requirements of many female scientists' private lifes are still in conflict with the normative expectation of being constantly present and available in research laboratories and offices, even though these norms are more and more criticized also by young male researchers. Moreover women have less access to and are less strongly integrated in formal and informal networks of funding and support (Dautzenberg, Fay & Graf 2011).

Although this vertical segregation holds for all disciplines, the underlying processes that lead to this problem are closely related to the particular disciplinary culture. Thus when asking for the gendering of academic careers in scientific research and higher education, it is indispensable to take into account that the gendering of sciences differs between different disciplines (c.f. Beaufaÿs 2003; Heintz, Merz & Schumacher 2004) – and moreover also within an academic discipline, depending on the particular subfield.

Due to horizontal segregation processes some STEM-fields suffer from a low participation of women at all ranks of the academic career, among them physics. At the level of first-year-students the percentage of women in physics increased over the past 20 years from 15% to 25%. Since 2000 this rate fluctuates between 18% and 25% and have recently levelled out at 25% (c.f. GWK 2011). Contrary to the percentage of female students the percentage of female professors has increased more continually, from 2,7% in 2000 to 9,4% in 2012 (c.f.. Statistisches Bundesamt), as well the percentage of PhD's from 9,1% (Kassing 2000, 35) to 20% (Matzdorf & Düchs 2013, 33). Thus the vertical segregation in physics seems to mitigate, whereas the horizontal segregation still leads to the low percentage of women among study-beginners.

Physics being gendered due to the underrepresentation of women means a domination of men concerning social and also research practices in the laboratory. Relevant factors are institutional structures, temporal and organisational conditions, social practices of daily laboratory life, styles of communication and interactions as well as professional self-conceptions and value systems. A Europe-wide comparison of different national cultures of physics has demonstrated for the case of physics inasmuch gendered academic careers are influenced by the gender cultures in the respective research institution and its working place

cultures (c.f. Hasse & Trentemøller 2008). Gender turned out to be inscribed in scientific practices, in habitual styles and disciplinary cultures (c.f.. Traweek 1988; Münst 2002; Erlemann 2004; Lucht 2004).

Also for the case of physics the project "genderDynamics"[1] examines the entanglement of three interrelated dimensions. It relates different disciplinary cultures within physics with different forms of organizing science and ask for their entanglement with gender cultures. Empirically three institutional settings are investigated: universities, non-university research institutions and excellence clusters.

Drawing on the ongoing ethnography in non-university research institutions within the frame of "genderDynamics", in this short paper, I will sketch entanglements of gender cultures and disciplinary cultures for the case of different physical sciences in Germany, among them solar energy research and astro-particle physics.[2]

Apart from the university research, non-university research institutions form an important part of state-funded research in Germany. Each of these research institutions is member of one of four umbrella organizations: The Helmholtz Association of German Research Centers, the Max-Planck Society, the Fraunhofer Society and the Leibniz-Association. Three of these umbrella organizations are represented in the project "genderDynamics": one Fraunhofer-Institute, two Helmholtz-Institutes and one Max-Planck-Institute. Two institutes are dedicated to rather applied research, as renewable energies and photovoltaics, a third one does experimental astro-particle physics and the fourth field institute deals with theoretical astrophysics.

Gender in discursive and material practices of physics

In the course of the fieldwork as part of the ethnography it became apparent that one can differentiate heuristically three levels on which gender cultures become relevant:

Firstly, there is the day-to-day explicit talk about „gender", mostly in the context of gender equality. As from the moment I am entering the field, it pops up in the first instance and becomes a topic for the institute's researchers when the people in the institute get to know me as a social scientist whose project is named "genderDynamics".

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[1] genderDynamics is a collaboration between the Freie Universität Berlin and the Technical University Berlin. It is funded by the German Ministry for Education and Research (BMBF) and the European Social Fund (ESF) by the European Union (Project Number: 01FP121235-38).

[2] For the notion of disciplinary cultures see Arnold & Fischer (2004) as well as Huber (1991).

In addition to this, a recent policy trend towards more, though relatively soft, regulation of gender policies in science aims at increasing the percentage of women in STEM-fields. This has repercussions on the actual day-to-day research culture, e.g. when equality measures like special fellowships dedicated exclusively for women to apply for, are discussed in informal communication. Some male researchers feel excluded by such initiatives supporting women and are problematized. In these debates some male informants see their gender even as a hindrance for a career in physics.

On a second level it is crucial how social interactions between the actors in the field are gendered in the sense of their 'doing science as doing gender' (c.f. West & Zimmerman 1987). It becomes particularly relevant for the physicists' career in interactive settings among the team members when it comes to be judged as being excellent or not, as being able to 'make it' in physics or not, as being the one who gets a position, further support or being offered career opportunities. For the processes of being ascribed a good performance, a reward-worthy reputation or strong achievements, Ridgeway and Correll argue that expectations of who might be acknowledged with these appraisals, are biased by gender beliefs and, in the result, lead to supporting predominantly men (Ridgeway & Correll 2004).

In order to examine how these processes are entangled with disciplinary cultures it makes sense to explore inasmuch research contents co-constitute communication and interaction settings and thus may construct gender cultures.[3] The different fields of physics under examination in the project are solar energy research, astro-particle physics and theoretical astrophysics. They differ concerning their research interests, methods and argumentation strategies as well as, partly, their epistemological groundings that co-construct daily research practices, epistemic, material as well as communication practices. While in solar energy research laboratory work is central, it is computing and programming which is dominant in astro-particle physics, whereas calculating with pencil on paper or on the blackboard constitute daily practices in theoretical physics. This leads to different forms and meanings of teamwork. In the observed solar energy research groups the single working steps are small-scaled – i.e. concrete, short-term, quickly emerging and completable – and are processed by different people. For instance, in manufacturing procedures of solar cells or fuel cells, probes are handed over from one person to the other. These procedures lead to strong dependencies

[3] Apart from communication settings of formal interaction settings like colloquia, group meetings, there is a lot of informal communication in coffee breaks, leisure time or 'shop talk' which is part of the gender cultures. This is not to be ignored but does not stand in the center of this argumentation of the entanglement of disciplinary differences and its dominating formal institutionalized communication patterns.

between the people in the group and on the group leader who is in charge of directing the procedures.

By contrast, in the observed astro-particle physics groups most of the researchers work alone at their desktops in their office. They get into contact with each other when they have problems to discuss, but their particular research tasks are rather independent from each other, compared to the solar energy groups. These differences in the distribution of research-work entails a different organization of communication settings: In astro-particle physics disciplinary discussions within the team are incited via group meetings in which participants are invited to present their work to each other or based on informal relationships. By contrast, in solar energy research, due to their strong dependencies from each other, communication about research contents is activated by the daily work in the laboratory and does not need to be incited through group meetings.

This snapshot of disciplinary differences concerning the social and epistemic function of team meetings point to differences in the day-to-day interaction patterns at the working place and thus can lead to different gender cultures as will be further explored in the project.

On a third level it is an issue if and how epistemic practices are gendered, if they can bear a gendered meaning for the individual or for a social group. What does it mean for physicists doing the actual research practices, e.g. standing at the workbench in the laboratory or sitting in front of the computer and calculating or programming or analysing data? Can these practices constitute a form of gendering that can be performed through doing physics? How, then, is gender inscribed in physical practices, by whom and for whom?

It was feminist authors who asked for gender in the contents and knowledge of science for the first time. Starting with the bio-sciences as the first disciplines under scrutiny, there can be found nowadays numerous studies that focus on the gendering of knowledge of the biological sciences. This focus may not be surprising since the biological sciences produce knowledge on gender, e.g. in biological reproduction theories. Since in physics gender is no explicit part of research contents, there are less accounts so far that deal with the gendering of the material sciences such as physics (for an overview see Götschel 2011). But also scientific findings in which gender or gender differences are not an explicit object of inquiry are in no way gender neutral. Feminist science studies scholars have drawn their attention towards the gendering of epistemic knowledge-producing practices in physics (Traweek 1988; Lucht 2004; Pettersson 2011). From these studies is can be concluded that forms of masculinity can be performed via many physical practices like calculating, handling with machines, designing and constructing

experimental devices. Thus physical practices allow practitioners to perform a sort of masculinity via doing research in physics. For the notion of masculinity resp masculinities I refer to Raewyn Connell (Connell 1995; Connell & Messerschmidt 2005). In her approach, masculinity is not an inherent property of the person that would be shared by all men in the same way, rather there are multiple forms of masculinities that are historically variable and that emerge in practices underpinned through institutionalisation and cultural orientation patterns.

Other forms of possible gender performings in physics beyond the male-female binary were found in a study by Anna Danielsson (2012). She concluded that some women in physics may perform a 'female masculinity' when doing physics, as a kind of constructively positioning themselves in a community that is dominated by a masculine research culture, while rejecting expectations to perform a traditional femininity (Danielsson 2012, 37). Her findings demonstrate that the options for gender performings of masculinities through the doing of physical practices are not restricted to men.

But beyond these (constructive) genderings in physics, also discontinuities, instabilities and tensions in the genderings of doing physical sciences play an important role.[4] For example contradictions between the traditionally masculinized intimacy of men and machines and the traditionally feminized concept of care that could be performed just in the same vein within practices of handling of machines and experimental devices, point to genderings of epistemic practices that are much more heterogeneous, fluid and changeable as for a long time has been supposed.

Borrowing the notion of 'resonance' from physics, which is meant metaphorically here, the studies show inasmuch doing gender and doing physics can resonate with each other and under which circumstances resonance cannot occur. Resonance in a physical sense describes the phenomenon when even small driving forces of the particular resonance frequencies produce large amplitude oscillations of waves.

The retelling of the narratives of becoming a physicist as Traweek (1988) has carved out or the handling of big machines as Pettersson (2011) has observed, resonate in 'resonance frequency' with a masculine gendering of heroism or craftsmanship which is associated with physical strength for many of the men in Pettersson's and Traweek's study. Via some other genderings that are performed through practicing physics, this kind of mutual amplification

[4] Conceiving gender as a situated assemblage with particular sedimented histories Dagmar Lorenz-Meyer (2014) explores the discontinuities, instabilities and tension within and between different gendering apparatuses of bodily production in an ethnography of mass spectroscopy.

might not be experienced. These persons rather have to reject the normative framework of a ‘traditional femininity’ or to resist heteronormativity, as in the example of a woman physicist in Danielsson (2011, 36) who rejects a ‘traditional femininity’ on the one hand and resists heteronormativity on the other hand when she constructs her concept of being a physicist through ‘laddishness’ and playfulness. Within the metaphoric frame of ‘resonance’ her doing physics as doing gender can be conceived as being ‘damped’ by normative frameworks of gender.

In the project “genderDynamics” the investigation of gender performings and their relations to practices of doing physics is still to be further explored. Within the fieldwork it might be approached by the exploration of the informants’ affects that emerge in the doings of physics and the role for their self-understandings, self-conceptions as a physicist and the negotiations with perceived normative frameworks in the gender cultures and disciplinary cultures of the respective field.

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Biosketch

Martina Erlemann holds a PhD in sociology and a Master physics. Currently she has a position as a social scientist at the physics department of the Freie Universität Berlin. Before, she held research positions at the universities of Vienna, Klagenfurt and Augsburg, at the Center for Interdisciplinary Women's and Gender Research, Technical University Berlin and at the Center for Gender Research, Uppsala University. Her main fields of expertise are science and technology studies (STS) and feminist studies of science. She worked extensively on the co-construction of gender and physics in public discourses and on risk discourses of nanotechnologies and their governance. Her current research projects are ethnographies of gender cultures in physical research institutions.