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FORUM

No space for girliness in physics: understanding and overcoming the masculinity of physics

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Abstract Allison Gonsalves' article on "women doctoral students' positioning around discourses of gender and competence in physics" explores narratives of Canadian women physicists concerning their strategies to gain recognition as physicists. In my response to her rewarding and inspiring analysis I will reflect on her findings and arguments and put them into a broader context of research in gender and physics. In addition to her promising strategies to make physics attractive and welcoming to all genders I want to stress two more aspects of the tricky problem: diversity and contextuality of physics.

Keywords Physics · Girliness · Masculinity · Gendered knowledge

Allison Gonsalves' article on "women doctoral students' positioning around discourses of gender and competence in physics" explores narratives of Canadian women physicists concerning their strategies to gain recognition as physicists. In this sample of her doctoral dissertation on "Discourses and gender in doctoral physics" (Gonsalves 2010) the author analyses narratives demonstrating competence and performing stereotypical behaviour while struggling with the pretended gender neutrality of physics. In my response to her rewarding and inspiring analysis I, trained as physicist and working in gender studies, will reflect on her findings and arguments and put them into a broader context of research in gender and physics. The women physicists interviewed and observed by Gonsalves were not the first to experience tensions between femininity and physics. More than thirty years ago, physicists within the women's liberation movement explicitly articulated their uneasiness with the masculinity of physics (Keller 1977). Since then scholars of different disciplines have looked critically at the physical sciences and materials research from a

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Forum response to Allison Gonsalves' paper "Physics and the girly girl—There is a contradiction somewhere": Women doctoral students' positioning around discourses of gender and competence in physics.

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feminist and gender studies perspective. Meanwhile a flourishing literature explores the range of inter- and trans-disciplinary approaches, methods, and theories in the area of critical physics research (for an overview see Götschel 2011).

The masculine image and the unwelcoming culture of physics

Some of this scholarly work in gender and physics focuses on the masculine image of physics and the unwelcoming culture of physics across different geographic locations and times. Historians interested in everyday practices of science study local scientific cultures by looking at women in science and vice versa. Anthropological and ethno methodological studies in gender and physics describe research and technology as part of a cultural framework and observe how researchers negotiate the sub-cultural values, meanings, and practices of their research environments. Sharon Traweek—in her classical study on 'Beamtimes and Lifetimes'—noted how scientists in high energy physics constructed gender in male tales told during a life in physics. She analysed the informal stories told by physicists in the laboratory for statements of success and failure and for acceptable and unacceptable ways of expressing affect and gender to learn more about patterns of power and tradition in the physical world (Traweek 1988). Karin Knorr-Cetina compared gender practices in molecular biology laboratories and high energy physics communities, and noticed that physicists (with the exception of Italians) exhibited a kind of "mono-gender" that is closer to masculinity than to femininity (1999, pp. 232–233). Other scholars analysed the presentation of the history of physics as a male genealogy or a 'male master–male disciple' relationship that made clear which gender is the legitimate beneficiary of the cultural heritage (Traweek 1988, p. 77). In summary, these and other historical, sociological, and anthropological studies on physics in (Western) culture, as well as on physics as culture, highlight the deeply gendered culture of physics (Götschel 2011).

Compared to the scholarly work discussed in the last paragraph, Gonsalves in her study on "women doctoral students' positioning around discourses of gender and competence in physics" is interested how the participants are doing gender in the process of identity negotiation. In recent years a shift or extension in the research on the gendered culture and image of physics (education) can be noted that stretches from a more static picture of "having gender" to a more dynamic understanding of "doing gender" in physics (West and Zimmerman 1987). These dynamic processes can be analysed in micro sociological studies that are interested in everyday social interactions and agency on a micro level or small scale. In her paper Gonsalves explores how four women doctoral physics students at a Canadian university create narratives about their becoming a physicist and their experience in physics that enabled or constrained their career path. She analyses how these graduate scientists gain recognition as physicists by demonstrating competence on a technical, analytical, and communicative level as well as by performing stereotypical physicist's behaviour. Both male and female doctoral students use these citations of competence and stereotypes to demonstrate their physics' ability. But, as Gonsalves argues, women doctoral students position themselves in conflicting subject positions. They struggle with the contradictions of the pretended gender neutrality of physics and the potent gendered sociocultural discourses on questions such as who actually can be a physicist, what a physicist should look like, and how physicists should behave or act.

In Gonsalves' paper we get to know Lily, a doctoral student in experimental solid state physics, who stresses her technical competences while struggling with a device that gives easy access only to physicist of a large stature. We meet Laura, a doctoral student in

theoretical particle physics, who avoids paying attention to her appearance to demonstrate her strong commitment to her studies. We become acquainted with Ruby, a doctoral student in astrophysics, who is presenting herself stereotypical unfeminine in appearance and behaviour to distance herself from femininity and thereby stressing her competence in physics. Last but not least we get to know Alice, a doctoral student in astrophysics, who is recognized as competent by her physics department as well as by a broader scientific community. Despite her success she suffers from unfilled desires to express her femininity more in her professional life, but is hesitant as she knows that dressing in a more feminine way would make her feel out of place. Gonsalves reveals how these women physicists struggle to get recognition as physicists by demonstrating competence and by performing stereotypical physicists' behaviour. Girliness and stereotypical femininity, however, can not be performed in a playful way. Instead girliness and hegemonial femininity can only be used as a foil to define a position in sharp contrast to it.

Gender and the language policy of physics

There is no space for girliness and femininity in the physics department. Moreover, there is no space for girliness and femininity in the public discourses on physics either (Erlemann 2012). Furthermore, not only the culture and image of physics is linked to masculinity, there is no gender neutrality in the knowledge production in physics or in its consolidated knowledge. On the opposite, physical knowledge makes statements about gender, societal notions of gender feed into the description of the material world, and epistemological reflections on physics relate to gender (Götschel 2011). As a case in point I draw in the next two paragraphs on the language policy of elementary particle physics. In this subfield of physics different strategies exist for the nomenclature of particles and phenomena, instruments and institutions. A strategy widely spread in particle physics is the naming of research centres, accelerators, and detectors in playful abbreviations. CERN in Geneva comes from Centre Européenne pour la Recherche Nucléaire (European Centre for Nuclear Research), while DESY in Hamburg comes from Deutsches Elektronen Synchrotron (German electron synchrotron). Cern is homophon to the French word cerne (year ring) and the German word Kern (nucleus or core), DESY homophone to daisy (a flower or an attractive woman). Traweek (1992) deciphers the strategy of homophony as a typical strategy for the creation of names of research centres, accelerators, and detectors in particle physics. Abbreviations such as SLAC and SPEAR in Stanford, TRISTAN and VENUS in Tsukuba, or ZEUS and HERA in Hamburg indicate a joking ambiguity that is associated with an allusion to genital and sexual character. These ambiguities generally refer to heterosexual desire. Moreover, heterosexual language is used in particle physics to describe the "marriage" of machinery parts of the detector or the arrangement of the entities of material particles in a "family" structure (Götschel 2006).

Furthermore, many things in particle physics are named after outstanding physicists who discovered or conceptualized particles and theories. The Higgs particle—possibly responsible for the mass differences in the standard model of elementary particles—is called after British physicist Peter W. Higgs, while Bosons—representing the fundamental interactions in the standard model—are named after Indian physicist Satyendra Nath Bose. But so far none of the 2,400 women physicists active in particle physics are honoured in such a way (Götschel 2006). Nothing, for example, is named after Mary Katharine Gaillard, who predicted the charmed quark mass, the bottom quark mass, and three-jet events. Nothing is named after Sau Lan Wu, who discovered the J/Ψ particle that lead to

understanding of the fundamental structure of matter in terms of leptons and quarks and who discovered the gluon particle that is important to understand fundamental process of the strong interactions among quarks (Byers 2006). The only exception is the Randall-Sundrum-Model, a mathematical description of fundamental physical forces, which was named after Harvard theoretical physicist Lisa Randall and her colleague Raman Sundrum in 1999. Apart from that female names and citations of femininity in particle physics, such as Desy/Daisy and Venus, do not honour women physicists' scholarly work, but effect allusions and connotations of sexuality.

In Traweek's interpretation this can be read as a sign that women or femininity are emotionally and sexually threatening (masculine) physicists (Traweek 1988). Moreover, it can be misunderstood by students and the broader public as a sign that women physicists because of their femininity are neither geniuses, nor do they decisively contribute to the development of their profession (Götschel 2006).

Gendered strategies in the laws and concepts of physics

Astonishingly, not only language reveals the gendered entanglement of physical knowledge, but the physical laws and concepts used by physicists to argue for a hegemonic femininity in society. For example, around the year 1900 scientists inferred from laws of thermodynamics that women would only follow their 'nature' and give birth to healthy children, if they avoided intellectual work and did not waste their energy by working as professionals in academia. Thus, Max Planck and others used the concept of energy conservation of thermodynamics to prevent the rivalry between men and women in academia (Heinsohn 2000). Similarly, the natural philosopher Johann Wilhelm Ritter used concepts of indifference and polarisation of eighteenth century research on magnetism to explain woman's 'natural' longing for conception and pregnancy (Holland 2006). In doing so, physical laws were used to naturalize cultural ideas about femininity and gender. Furthermore, we can find scholarly work that examines how cultural ideas about femininity are inscribed into the concepts and laws of physics. Scheich (1985), for example, stated that the disregard for female reproduction work in the economic theory of Medieval Ages is reflected in the scholastic understanding of the impetus of motion; and this erasure is continued in Issac Newton's laws of motion. Potter (2001) argued that English notions of class and gender of the seventeenth century influenced Robert Boyle's choice between corpuscular and mechanical interpretation of the experiments with the air-pump, which were inscribed into Boyle's law of gases.

As a case in point I draw on my gender analysis of static electricity (Götschel 2012). William Gilbert of Colchester—a medical doctor trained at Cambridge University—published his twenty years of research on magnetism and electricity in London in 1600. In this weighty tome, called "De Magnete", he described his theories on natural philosophy as well as his laborious experimental practice. I noted three different gendered strategies that Gilbert used to propagate his understanding of electricity. He employed Greek mythology, antique and medieval authorities, and contemporary medical theories. Gilbert's main motivation for his research on magnetism and electricity was the proper application of the mariner's compass. To support the use of the compass in overseas navigation for discovery, conquest, and trade, Gilbert studied magnetism and tried to establish a new cosmology of the magnet. Therefore he differentiated between the interesting and applicable phenomenon of magnetism and the similar, but useless, phenomenon of electricity. He argued that his experiments proved that electric bodies needed to be rubbed to emanate an effluvium or

subtle liquid, while magnets had an immaterial, durable character. Furthermore, Gilbert used the Aristotelian dichotomy of matter and form that was entangled with a cultural dichotomy of masculinity and femininity to stress on the difference of magnetism and electricity and to highlight superiority and uniqueness of the magnetic force. Within the cultural framework of Renaissance academic thinking linking magnetic force to virtue and potency meant a subtle—although not outspoken—connection to masculinity; while conceptualizing electricity as material, passive, secondary, insignificant, and unusable meant a subtle link to femininity. Cultural gender dichotomy was used by Gilbert as a strategy to devalue electricity. His theoretical concept of material effluvia not only dominated the discourse of his Renaissance contemporaries but influenced the development of theories in modern physics until the early nineteenth century.

Gaining competence as physicist in a masculine profession

Women physicists have to deal with such subtle masculine and feminine content in the knowledge of physics. Moreover, they have to gain competence as physicists in a masculine profession. They ascertain their competence not only through assumed objective grades and publication records, but by becoming recognized as physicists. Gonsalves indicates in her article that technical, analytical, and academic competencies are symbolically linked to masculinity. Women physicists, therefore, need to develop and use additional strategies to gain acceptance. They rework discourses of competence, practice gendered passing, or position themselves as stereotyped physicists. These strategies, as Gonsalves indicates, do not overcome the tricky, curtailing situation. Lily defined herself as technically skilled because she prepared probes with her small hands. But her redefinition of technical skills does not change her masculine devices and therefore does not lead to a transformation of the physical culture. Alice accepted a gender neutral subject position and adopted androgynous dress in the physics laboratory. A similar choice was made by Laura who 'dressed down' at work and in everyday life. Their strategies to "pass" enable these women physicists to avoid marginalisation, but it requires downplaying a desire for expressing a more feminine style. This passing forced Alice to fragmentize her gender identity in an inauthentic way. Ruby placed herself in the subject position of the stereotyped physicist. In doing so she had to reify the woman/physicist dichotomy, putting femininity outside physics. In this position Ruby is different from both, being a (masculine) physicist and being a non-physicist woman. There is no subject position that did not make her "different". How can these women physicists escape that restricting dilemma?

How can we create more space for girly girls, Betties (attractive women), Sissies (feminine boys), and other "others" in physics? Or, in a more serious formulation: How can we make physics attractive and welcoming to everybody? Gonsalves draws the conclusion that it is necessary to dismantle the story that gender is not a problem in physics in order to understand the complexity of the situation and to find new subject positions for women physicists. Furthermore, she indicates not to reify discourses of femininity that put normative pressure on women in physics. In addition to her promising strategy I want to stress two more aspects of the tricky problem: diversity and contextuality. Gonsalves in her paper presents micro sociological scholarly work from North America, Europe, and Asia. These studies suggest a globally uniform situation. But this might not be the case. Studies from Knorr-Cetina (1999) indicate that Italian women physicists at an international research laboratory dressed in a quite feminine style. And what do researchers know about femininity in the physics laboratories in India, Nigeria, or Brazil? Moreover, class is the

crucial category for women mechanical engineers in Greece (Molvaer and Stein 1994) and race the determining category for women computer engineers in Malaysia (Mellström 2003). So, gender in some regions of the world might not even be the most influential category to prevent recognition in physics. Comparative studies and meta-analyses might reveal slight differences and disruptions and open up perspectives for more creative subject positions.

Second, Gonsalves stresses on the point that we have to lay open how gender is woven into the cultural narratives of physics. Furthermore, we have to become aware of the different ways of thinking about gender diversity in physics and physics education. This enables us to create more subject positions that are not in contradiction to all kinds of femininity and that give feminine persons competences and recognition in physics. Gonsalves' way of discussing the problem as a question of wearing make-up, sexy skirts, and heels in the laboratory, reproduces physics as an objective, non-gendered body of knowledge. Physics, similar to mathematics, seems to be universal and therefore cultural free. But it is not. It carries along Western cultural values such as rationality, decontextualisation, and aspects of power and control (Bishop 1995). Moreover, as I have shown, it carries along the devaluation of femininity in its knowledge. Therefore I suggest examining the cultural narratives that are woven into the solidified physical knowledge, too. I doubt that ethno methodological research on a micro level will be sufficient to open up that perspective. Nevertheless, Gonsalves' excellent findings broaden the horizon of gender and physics (education) research and will inspire further investigations.

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