

Women in Physics: Experiences of Professors and Students' in Higher Education *

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Abstract

This paper is based on research, funded by CNPq, which examines the perceptions and experiences of female professors and students about gender relations in academic life in traditionally masculine fields, with a focus on physics. The research field is a federal university in Brazil's Northeast and the methodological procedures involved interviews, after mapping the distribution of professors and students by sex. The results show women's difficulties, as professors and students, in being included in the field.

Keywords: Gender, Higher Education, Physics, Female Professors, Female Students.

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Introduction

This paper synthesizes the results of research about the perceptions and experiences of female professors and students concerning gender relations in academic life in traditionally masculine fields, funded by Brazil's National Council for Scientific and Technological Development (CNPq) (Carvalho, 2017; 2012)¹. It focuses on physics, one of the disciplines most dominated by men in the natural sciences, technology, engineering and mathematics (STEM), exploring the following questions: How do they describe the academic culture of their department or program, in terms of its practices and values, interpersonal and professional relationships, and the factors that facilitated or impeded inclusion? Is it possible to outline a profile of women professors and students in this field, and patterns of their inclusion or exclusion, based on the knowledge of individual characteristics, professional projects, educational background and career path, productivity standards and cultural/institutional practices?

The field of investigation is a public federal university in Brazil's Northeast, and the methodological procedure involved mapping the distribution of professors and students according to their sex, and in-person or video-call interviews. The approach used quantitative data to describe the problem, but was mainly qualitative, rooted in an interpretive paradigm and in the theoretical perspective of biographical-narrative research (Andrade, 2012; Kelchtermans, 1994), in the case of the professors.

Data collection faced difficulties. First, due to the unavailability of disaggregated data by sex for professors and students in the institution. Second, because the subjects' had little time available for the interviews. The interviews with the professors began in 2011 (Carvalho, 2012) and were complemented in 2015, as part of a PhD research project (Silva, 2017). The interviews with undergraduate and graduate students were conducted as part of a master's research project in 2016 (Amorim, 2017).

The data analysis sought to identify perceptions of gender inequality in their accounts about the meanings of events and situations that are part of their past and present experiences in education and professional practice. In the case of the professors, the interviews were inspired by Kelchtermans' (1994) model of a cycle of interviews, conducted at different moments, recorded, transcribed, organized into academic biographies and returned to each interviewee.

The resulting text is organized into two sections. The first describes the rare presence of women in physics at the university examined, either as professors or students. The second section presents some aspects of the academic culture of the department and program, according to the students and teachers interviewed: practices and values, interpersonal and professional relationships, factors that facilitate or impede inclusion. A pattern of exclusion of women in physics is traced by following their paths amid the cultural and institutional practices of the time, which lead to their limited presence and subalternity. The conclusion synthesizes the still problematic situation in Brazil today, and points to challenges to overcoming it.

So few!

The current numeric advantage of women in higher education enrollments in Brazil, and in American and European countries, among others, is not found in the STEM fields, where their presence is still very reduced. Moreover, as the literature indicates and local experience confirms, more women dropout and delay graduating in STEM fields. This phenomenon has been called the leaky pipeline or the gender filter (Blickenstaff, 2005) and is related to the tough culture and pedagogy found in the field. With few female students, there are few female professors and a lack of female models, which establishes a vicious circle.

In this context, physics is one of the academic disciplines where women are most under represented in Brazil and throughout the world (Skibba, 2016; Agrello; Garg, 2009). How has the

¹ The research has been authorized by the university's Ethics Committee, the Physics Department and individually by the participants, whose names are omitted.

distribution of women developed in a physics department (among faculty) and program (among students)?

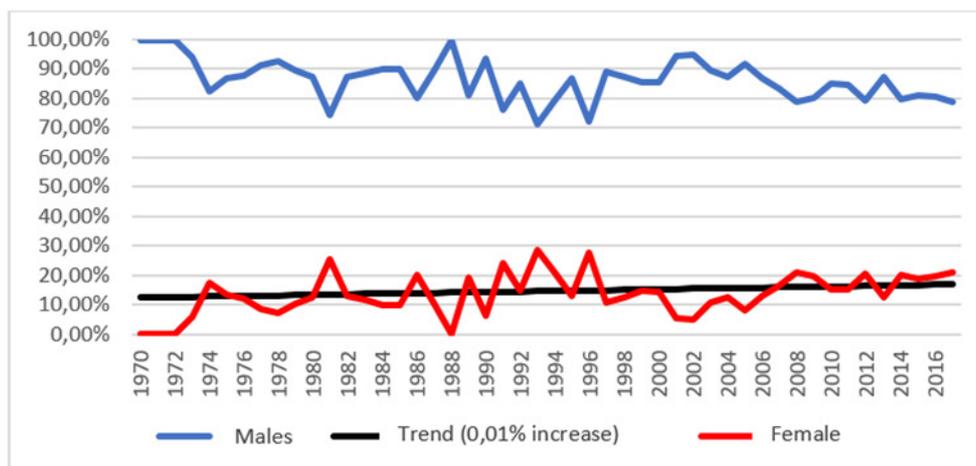
The physics department in the institution of higher education examined had two women on its faculty throughout its history. When one of the female professors retired, in the 1990's, another female professor joined the department. There were 27 male professors in 2009, 30 in 2012, and 32 in 2014. Therefore, the number of men on the faculty grew, while the number of women did not. Until 2016, the two female professors made up 5.88% of the department faculty. In early 2017, one of them retired and the other was transferred; and the department became all-male – with 33 professors in 2018².

The graduate program in physics (with master's and PhD programs) had 23 professors in 2014, of which two were women, one from the department, and a visiting professor. In 2018, after the transfer of the last female professor, there were 28 male professors and one female collaborating professor. In 2014, 4 of the 26 master's students were female, and 7 out of 63 PhD students. In 2017, 3 of 16 master's students were female; and 10 out of 59 PhD students. In 2018, 6 of 19 master's students were women; and 10 of 57 PhD candidates.

In the second semester of 2017, there were 55 female undergraduate students in physics (including those working either towards bachelor's or teaching degrees), which was 17.5% of the student body. According to graph 1, over 47 years, an average of 85% of students were men and 15% were women. This suggests an insignificant increase in the rate of women's enrollment, of only 0.01% a year. If this trend continues, only in the year 2367 would the gender parity desired be attained in the physics undergraduate program.

In this scenario, the naturalization of the gendering of the field is such that a coordinator of the undergraduate program, interviewed in 2011, found it strange to refer to the physics program as masculine: "I was very surprised with that label as a *mainly male program*", he said. Seemingly feeling provoked, he mentioned another female professor who had been a member of the physics department: "It was not that few, there weren't just two, there's another one. Professor X was in our department and today is in the mathematics department". He recalled his days as a student and concluded that the rarity of women in physics has been decreasing. He attributed this to "that thing of promoting in high school that physics is difficult, Mathematics is difficult... I don't know if that keeps women away"; and to families "that keep steering their daughters to the humanities, literature, or even medicine".

Graph 1: Evolution of enrollment by sex in the undergraduate physics program (1970-2017)



Source: Developed from raw data provided by the university's Superintendency of Information Technology.

² All quantitative data were collected at the university's databases.

The department head, who was also interviewed at the time, minimized the issue and praised the rare women who enroll in physics:

No, I don't think there's prejudice against women. The environment is more masculine, but I've never seen anyone being discriminated for being a woman. Generally, when women do physics they have a quite high competence. So they compete shoulder to shoulder, and are at times better than men.

So today that rate has already increased, you find more girls in physics. Now in other fields, like chemistry, there already is a greater demand among women, mathematics... We often even discuss why physics has a lower demand [by women] and mathematics has a higher one, if you consider that math is something much more abstract than physics.

Why so few?

Feminist scholars from various countries have been asking this question. Hill, Corbett & St. Rose (2010) argue that social and environmental factors account for the low participation of women in STEM fields and not innate skills, which is evidenced by the rapid growth in the number of female students with high scores in standardized math tests in the United States in recent decades. In a recent study on women in engineering in Brazil, Lombardi (2016) also points to cultural and educational factors.

According to Pierre Bourdieu (1999), the old structures of the sexual division of labor still prevail – in spite of the school success of girls and women – guided by three practical principles that associate women with domestic roles (teaching, care, service), and subordinate ones (they may not have authority over men), while associating men with technical objects and machines. These principles lead to both the horizontal and vertical segregation of labor, that is, to the rarity of women in STEM in most industrialized countries, and to the glass ceiling effect, hindering their attainment of prestigious, powerful and high-paying positions, and thus leading them to subalternity.

Rarity

The factors that initially steer women away from careers in STEM are primary and secondary socialization: family and, above all, school experiences, that is teachers, curriculum and peer relations (Roger; Duffield, 2000). The coordinator of the physics undergraduate program, quoted above, attributed young women's orientation towards human and health sciences to family influence. However, the undergraduate physics program prepares high school teachers, who are mostly male, and gender issues are absent from the curriculum in teacher education.

It is in schools, in an apparent context of co-education, that curriculum experiences gender the identities and aspirations of male and female students: girls are not encouraged to pursue mathematics and some teachers have lower expectations for their performance (Warrington; Younger, 2000; Lima, 2013). This constructs their supposed incompetence in so-called male subjects (Stepulevage, 2001), based on belief in a preponderance of innate talent over the acquisition of mathematical and spatial skills (Hill; Corbett; St. Rose, 2010). This leads to the low self-esteem, self-confidence and self-efficacy that are characteristic of female gender socialization and lead women to exclude themselves from non-traditional careers (Donoso-Vázquez; Gazo; Moreno, 2013).

The first “gender filter” operates between high school and higher education, but the “leaking” continues throughout undergraduate and graduate studies and career placement (Blickenstaff, 2005), in such a way that women abandon scientific careers in a much greater number than men in all stages and especially after a PhD (Rees, 2001; Burger et al., 2010; Lacampagne et al., 2010). The reasons include: lack of access to resources; lack of connection to real life experiences, and emphasis on concrete applications and social contributions of curriculum contents; hostile academic environments; lack of a sense of belonging to a community of practice; exclusion from social networks; and the rarity of female professors in those fields, especially as researchers (Burger et al., 2010; Lacampagne et al., 2010).

At the same university studied, in 2016, Amorim (2017) interviewed seven female undergraduate and graduate physics students, between 22 and 37 years old, about their experiences.

When asked about the rarity of women in physics, they mentioned internal/personal and external/cultural factors associated with gender inequality. One student attributed their near absence to “the prejudice of the female population itself. Many women think they are unable to do a program that involves a lot of calculations and logical thinking.” Others mentioned “sexism” (*machismo*).

Feelings of exclusion, segregation and isolation are experienced by the few women who enter the field of physics. International literature points to a **chilly or hostile climate**, the lack of empathy and receptivity met by women in their attempts to socialize among colleagues and professors (Burger et al., 2010). One student recalled with dismay: “In the beginning it was me and a crowd of male assholes, one or two were exceptions [...] they are segregators to the extreme [...] I had few classmates who treated me as an equal”. It is worth emphasizing that an environment that is hostile to an individual or group because of their gender, race or other traits, is not only unfavorable to their continued presence at the institution, but also to everyone’s education.

The image of the male physicist persists, therefore women are seen as inadequate, and are constantly questioned, confronted and evaluated during their coursework (Barthelemy; McCormick; Henderson, 2016; Danielsson, 2012) as well as socially. One student confirmed that: “Most of the people who know me say: ‘You’re a physicist!? You don’t seem like a physicist’”. She admitted associating physics to the image of Einstein and considered herself distant from that representation.

According to Sandler (2005), women’s success is attributed either to luck or to affirmative action, whereas male success is attributed to talent. Especially in masculine fields, **women lack credibility**: they have their aptitudes continuously tested and need to prove their capacity, which threatens their self-confidence and generates doubts and anxiety about their performance (Skibba, 2016; Rosa, 2013). One student revealed she felt that: “I am expected to be highly efficient whereas that guy over there isn’t.”

In a male environment, a woman’s presence causes estrangement, and she can suffer manifestations of symbolic violence, such as **sexist jokes and moral and sexual harassment** (Barthelemy; McCormick; Henderson, 2016). One of the students said: “I entered the classroom in shorts and the professor said: ‘Wow, eh?’ Then I was all embarrassed and said: ‘You’re here to teach, sir, not to notice anyone’s body’”. That kind of situation, discriminatory and hostile to women, still usually goes unnoticed.

In general, the female students interviewed by Amorim (2017) revealed embarrassing, debilitating and challenging experiences in their educational paths. In fact they experienced sexist barriers that are naturalized in both the academic and broader cultures, which exclude them even in the context of their inclusion, and that can only be understood from a gender perspective. To remain in the physics program, these young women must confront, overcome or minimize such experiences. There was one student who said she needed psychotherapy to continue and complete her coursework.

Although victorious, not all of them are aware of the importance of a feminist consciousness for challenging prejudices, such as the idea of an incompatibility between women and physics. Some of the female students resented their situation and reacted by confronting professors and classmates. One of them, who was considered to be pretty, was able to fit in with the men. Another was object of estrangement and suspected of being a lesbian. Thus, to remain in the physics program, female students must overcome gender stereotypes, prejudice, discrimination and harassment, barriers that are frequently invisible and naturalized.

Subalternity

As for vertical segregation, in professional development and advancement, the “glass ceiling” constitutes both an external barrier – socially imposed – and an internal one, given that it is internalized by women, who do not aspire (and, when they do, are prevented from achieving)

positions with greater prestige and responsibility, and higher pay (Sarrió et al., 2002). In this context, the fear of a negative assessment stands out as an important psychological barrier, as well as the absence of successful models and mentors who could offer inspiration, shared learning opportunities, support and protection, and also teach them the rules of the game (Donoso-Vazquez; Gazo; Moreno, 2013; Cooper, Eddy et al., 2010). In fields where they are in very reduced numbers, such as physics, the possibility of having models and mentors is almost inexistent.

Thus, due to the interaction of external and internal factors, women's academic careers tend to be discontinuous (Shakeshaft et al., 2010), more timid and less brilliant. In any case, their working conditions are less advantageous and, moreover, their daily lives are affected by the effort to accommodate children and career, the anxiety about evaluation, stress and exhaustion (Acker; Armentib, 2004).

According to Leonard (2001), the enlightenment concept of science and the academic forms of professionalism, including its new managerial trend, are gendered. Academic culture is homosocial, rooted in a model of heteronormative masculinity. Science emphasizes super rationality, scientificism, independence and antagonism, as well as competitive and self-promoting behavior, while denying or excluding elements associated with femininity (the body, emotions, personal relations and the acceptance of human diversity). Meanwhile, practices considered "professional" provide advantages and privileges to men by excluding women from male social networks, friendships and formal organizations, and/or by framing them within heterosociability: as wives of faculty, docile, diligent colleagues in auxiliary positions, and objects of sexual harassment.

Professional networks (which provide information and visibility) are an integral part of men's academic careers. Since sociability is crucial for inclusion, a sense of belonging, and learning the tacit and informal norms of academia and career progression, as a minority in STEM fields, women do not have supportive networks of other women in horizontal relations, nor backing from superiors and mentors of the same sex in vertical relations (as do men) (Lacampagne et al., 2010; Öhrn et al., 2009; Leonard, 2001). Moreover, they are not easily included in male networks, and thus remain isolated.

This is illustrated by the trajectories of the three female professors who worked at the physics department studied, interviewed by Silva (2017).

Professor 1, interviewed in 2011 and 2015, at ages 57 and 62, can be described as a fading star. In 1977, at the age of 22, she was a rare and brilliant female physics student, and was invited to join the teaching staff, as an instructor. However, she did not come to stand out except for her dedication to undergraduate teaching; she did not compete with her male peers in research nor in administration; she gave priority to her family, her four children and her husband's professional success; and retired without completing her doctorate, in 2003.

She recounted the challenge of reconciling teaching, marriage and motherhood:

When I was doing my master's, I became pregnant with my first son... Two years later came another. It was a very complicated process for me because I had to divide my time between motherhood, maintaining the home, being a wife and a professional [...] it was really tiring.

She earned a master's degree 10 years after beginning her career, but her attempts to get a PhD were frustrated. Her master's advisor, who would supervise her doctorate, passed away; another potential advisor moved away from Brazil. She began a doctorate program at a nearby university, without a work leave or reduced class load, but retired without completing it, due to interruptions to care for an ill father and an ill son. After retiring, she worked in a distance education program and helped her husband, who is also a physicist, complete his doctorate: his dissertation involved an experience in distance learning with science teachers, in which he was the professor and she was the tutor.

In 1986 a new, promising female professor arrived at the Physics Department. She had obtained two postdoctoral fellowships, one in Germany, at a time when there were few doctors in the department. She soon became coordinator of the graduate program, from 1989 to 1991, but later left; she said that her specialty, nuclear physics, had gone "out of fashion". There were no

external, family-related factors that hindered her professional development – she had married, but soon divorced and had no children.

The interviews with Professor 2 took place in 2011, and 2015 when she was 63. She showed knowledge of and interest in the issue of gender relations in science:

This is not only a Brazilian problem. It is international and there are institutions concerned with the problem, which promote women's participation in physics research. They provide incentives, and create scholarships specifically for women.

She recalled that during her undergraduate studies in physics at the University of São Paulo (USP), half of her classmates were women, and she had many female professors.

Professor 2 was strongly dedicated to the department:

[helping with] the infrastructure, research conditions, motivating people [...] I was the library coordinator, the laboratory coordinator, before it was formally created, we started it from scratch... and I was the graduate program coordinator. Then I had enough: 'I don't want to anymore, it's too demanding [...] I've given my contribution, now I'll leave it to others'.

She said that when she decided to engage in research and publishing, she became disappointed "with the way physics was being done", with peer relations in conferences,

then I began to close myself off a bit. I lost interest in that way of doing research. [...] I think it's not only physics, other fields are also suffering with this question of productivity, it's quantity over quality. [...] I missed the excitement [...] at a workshop, in the old days, you would work with everyone, each person came up with an idea, questions, answers, and nobody wanted to show off as the best, we wanted to discover something new [...] without that concern, that kind of 'macho' thing, really, of not showing you know less.

Even while revealing her criticism towards the androcentrism of scientific culture, she said that she did not feel discriminated in the department: "As a woman I was never discriminated, I never felt that". But she points out difficulties in interacting with colleagues despite trying to blend in:

men don't feel at ease... I feel at ease, but when I realize it, I change my attitude. For example, I don't usually dress up to come to work, I come really comfortable. I'm not very feminine in everyday work, I'm more practical and objective. And what I have faced very often was precisely the depreciation of my work because of envy, you know? [...] We feel highly undervalued in that sense, but it's not institutional.

She remembered that when she was in the master's program she was referred to the doctoral program by her advisor, and completed both programs in four years:

I went straight to the doctorate, something no macho did at the time, so they try to demean it by saying: 'ah, it's because she had an affair with the advisor' (...) because, it's very difficult for them to swallow a woman showing a man that she is better than him.

In that context of homosociability and fierce competition, she felt vulnerable for being a woman and decided not to enter the struggle for academic distinction:

It's a very competitive field. They fight among themselves, I would watch, because as women we don't get into these fights. At least I don't feel like getting into a fight and going around showing others I'm better than them. I focus on doing my work with love, with pleasure, which is what I like to do. But they don't. They want to show their CV is better than the other person's. They have met each other in the hallway exchanging punches, tearing each other's paper up. It's really macho stuff, very fierce competition, and, in my case, since I am also a competitor, the easiest way to for them to deal with it is by depreciating me because I am a woman. So they use all those weapons, in all directions. I am vulnerable in that aspect.

When asked about how she was seen by her co-workers, she answered: “They think I am a person they don’t need to fear.” Thus, she did not join the department’s culture of competition and showing off, and remained on the sidelines, where she felt safer.

I distance myself a bit, as if I am observing their behavior [...] I’m not interested in showing I’m better than anyone [...] they are all motivated by showing they are better. You go to a department meeting, you see how they express themselves... one says something, then another says the same thing, and I keep watching that unnecessary showing off. What I notice is that competition among them, and I stay more as an observer. I don’t have a problem... Now if I wanted to go around showing that I am better than them, then I would feel something. I usually say this: their lives are much harder than ours because they have to be the best. I don’t have to be the best in anything, I don’t have to prove anything. But they do, they suffer a lot.

At the same time, she highlights that “the personal relationship with them is good. I have had colleagues for many years, who have been here since I joined the department and are my friends and we talk naturally, without any problems”. About her only female colleague, she says “in fact, we don’t see each other because she works over at the lab. I meet her more at cultural events [outside the university], than here”.

About the perspectives for inclusion of other female professors in the Physics Department, she does not sound optimistic: “The problem is that there are many highly qualified physicists in the market and most of them are men, so the chances are really low that we can increase our percentage”.

Thus, Professor 2 – who had very high qualifications and could compete not as an equal but above the men in the department (in the words of the department head quoted previously) – either put herself or was placed on the sidelines of academic life. She could be considered a wasted talent. She retired in 2017, the year when Professor 3 moved to another university, leaving the department with no female professor.

Professor 3 is a foreigner and joined the Physics Department as a visiting fellow in 1995, along with her Brazilian husband. She earned a doctorate in France and two postdoctoral fellowships, one in Brazil and another in the United States. When a position for professor opened, her husband applied and was approved. In 1997 another position opened, and she was approved, but did not take office because the department questioned the validity of her doctoral diploma, which had been obtained in the same year and university as her husband’s. She was only hired in 1999, after appealing and winning the case:

And I was eventually hired, but the problem was that two years I could have done research were wasted because I became more of a specialist in the Constitution, in the laws, than in doing research. I didn’t really have time to read articles, and do research.

The interviews with Professor 3 took place in 2011, and in 2015 when she was 50 years old. She had three children, two girls and a boy. The first girl was born before she started as a visiting fellow, the other girl and boy were born when she was already a professor. According to her, maternity

does not interfere that much because we are lucky here in Brazil to work close to our home and to have domestic help, although we don’t have any relatives here, and that was a bit problematic. It disrupted things a little, at times, when they were very young because they required more care. But I left the children at the nursery all day since they were babies, I had someone at home to help, and the schedule is relatively flexible in the university, you don’t have to punch in. So you work as you can but that indeed decreases your availability. With three children you certainly cannot be that productive.

She stated that what she likes the most in her career is to research and supervise. She considers that it is “very important for students to have professors that are active in cutting edge research. I highly value teaching, but 80% of my stress comes from research”. She was the leader of a research group, coordinator of a funded project and had a productivity scholarship from CNPq (the national research council), and was the first woman to participate in the field of experimental

physics in the department. However, she did not supervise or teach any course in the graduate program, which was a context of constant political disputes: “It’s precisely a problem among men, a masculine culture of disputes”. At the undergraduate level she only taught basic physics for engineering. She remarks that “there are women who are real go-getters, I am not.”

Professor 3 revealed she was aware of gender and homosociability in department relations:

You see, here in, Brazil, men will talk to men, and that is what we see in the department, too. It’s even a little shocking because there are issues that concern me directly and someone calls here and asks to talk to my husband. My situation is a little special, though, because my husband works with me [they share an office], so we are a couple, and even when an issue concerns me there are people who will call him. And since I am not a very aggressive person, I don’t insist on the matter, all I do is observe.

She recognizes that men have more credibility and advantages thanks to the male network in which women, as an isolated minority, do not participate:

To say that being a woman is not a hindrance is to truly deny what happens. There are no obvious obstacles, it is more subtle. One of the things that I don’t know if it encumbers women, but it does help men, is a kind of network they naturally maintain among themselves, and which we don’t have. Well, in the Physics Department there are only two women, but I believe it is a general problem. Men are used to it and they will quickly create that network, and women don’t do that. [...] In the Physics Department, there are men who arrive, recently hired, who do not even have much expertise, are not aggressive or anything, but you see that things move for them more than they would for women, I’m sure of this. I am convinced, in general terms, that women have to fight more than men to achieve the same things. Since I am not a go-getter... and don’t have a network... In terms of a network we here are only two and we don’t even interact.

How can the situation as a sexual minority be overcome? Professor 3 has a political proposal, but cannot fight for it alone:

I wish there were more women... I think the reasons why there are more men than women are not genetic, they are really cultural. There should be affirmative actions to encourage girls to pursue scientific careers. I hope difficulties ease over time, but they won’t ease by themselves [...] I think it’s more of a societal problem. We have improved, I am already a physicist, I am biased... I think the problem is in the family and in society itself. If it were possible to form a center [of women] in physics, but then we would have to hire more women, but I would really agree to do something specific for women, which would be affirmative action, in the sense of necessarily doing more for women than for men, because women are more discriminated than men.

It would be fair to suppose that Professor 3 moved to another university because she did not feel included or satisfied with the work environment and conditions, or because she did not visualize promising opportunities for professional development, even in a couple, a situation that may provide a shield against discrimination or operate favorably when family responsibilities and opportunities are shared.

Conclusion

It can be said that the women who enter the physics programs and then the corresponding teaching career are self-selected and extraordinary, considering the gender filters operating in the family, at school and in higher education, which affect their career paths. Although it is not possible to sketch a single profile of professors or students, it is possible to outline the patterns of inclusion and exclusion of women in physics based on their trajectories amid the dominant cultural practices.

The students interviewed exposed gender barriers, both implicit and explicit: the chilly climate, the masculine image of the physicist, the lack of credibility of women in the field, and the presence of sexist prejudice, discrimination and harassment, which is often naturalized, among classmates and professors.

The women professors, each with unique backgrounds in differing circumstances, and with greater or lesser gender awareness, have in common attitudes of adaptation, resistance, and non-confrontation, since they are not only a minority but are also isolated in the field.

The concept of gender is not very well known at the university studied and the professors and students interviewed did not reveal a broad or sharp perception of gender inequality and discrimination in academic relationships, except for Professors 2 and 3. The discomfort, caused by a lack of recognition and opportunity, in the case of the professors, and by the discredit and moral or sexual harassment, in the case of students, is not always seen as a result of gender injustice.

Female socialization/*habitus* imposes specific expectations and self-exclusion on women, including younger ones; and the masculine hegemony in academic life and culture is materialized in tangible yet subtle limits to positive valuation of the academic performance (of female students) and the professional performance (of female professors), and to the advancement of women in the hard sciences. Moreover, the masculine *habitus* of the academic field influences women's behavior, leading them to withdraw and avoid conflicts. They even dress so as to not draw attention. They experience a situation of professional invisibility (and discredit) as colleagues and possible competitors; and try to remain invisible as women, to avoid becoming objects of sexual desire or harassment, particularly the younger ones (students).

In general, my broader research (Carvalho, 2017) found that talented, successful women in male departments do not feel entirely included and only partially recognized or even devalued, although they are the object of occasional condescension from colleagues. They take on many more basic than specialized classes (and larger classes), and many more undergraduate than graduate classes. They do much more teaching than research and hold administrative positions only in supporting roles (sub, vice). They do not always realize how gender relations affect their career paths – the inclination to teaching, the non-competitive stance in department disputes, their non-inclusion in research and graduate programs. Even female professors with gender awareness opted to not wear themselves out and did not fight for changes in the academic dynamic, foreseeing a tough, unequal struggle.

This study (especially the interviews) has contributed to making gender problems visible and to provoking reflection on internal and external obstacles – in academic culture and practices and in family life – to the development of the female professors' careers.

However, it is important to emphasize that neither Brazil or the university studied have gender equity and parity policies for higher education and professional recruiting and development. A first and important initiative in that direction was the release, in 2013, of the public call for projects “Girls and Young Women in the Exact Sciences, Engineering and Computing” by the Ministry of Science, Technology and Innovation (MCTI), the National Council for Scientific and Technological Development (CNPq), and the Secretariat for Women's Policies (SPM), which sought to increase the number of female students in STEM careers. In 2018 a new call was issued. It would be interesting to see how many of the projects developed from it focus on physics.

The challenge remains to include female students in undergraduate physics programs, considering that the low enrollment has remained stable (as shown in the graph for the university studied), and on the faculty in departments where they are absent or a small minority, considering that affirmative actions for women have not been contemplated in Brazil (except in electoral politics).

In this regard, it is necessary to make visible the gender gap in physics (and other STEM disciplines) and the barriers women face to inclusion and longevity in programs and departments, and to promote models of successful women scientists. It is also important to continuously identify and report sexist practices in academic life so that women do not feel symbolically abused and excluded. The inclusion of a course on gender and science could help to advance gender mainstreaming in the curriculum, without eliminating the need for a cross curricular approach.

To conclude, it is worth reflecting on a statement by Londa Schienbinger (2001:40):

... getting more women into science, reforming the cultures of science, and opening new questions for research – depend on proper tools of gender analysis. All three are institutional *and* intellectual problems.

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