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50 Years of the *Brazilian Journal of Physics* and female participation in scientific research

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ABSTRACT

This study was carried out on the occasion of the 50th anniversary of the *Brazilian Journal of Physics* in 2021. In response to an increase in research on female participation in science, we carried out a survey of the sex of the authors of scientific articles published in the journal over these 50 years. The results of our survey reveal an overall increase in female participation as first authors of articles, albeit a slow one.

PALAVRAS-CHAVE: Female Participation. Scientific Research. Physics.

INTRODUCTION

Historically, the presence of women in academia has been rather muted in comparison to that of men. This is even more evident in the natural sciences and, in the present case, physics. The underrepresentation of women in physics and in the natural sciences, in general, has increasingly become a matter of interest among researchers. Agrello and Garg (2009) note that low representation is present across numerous areas of research—be it governmental, private-sector, or academic—stressing that women have represented only 10 to 12% of all physics professionals over the last 100 years.

Starting at an already low level of female participation during the initial levels of education and training (undergraduate degrees), female participation drops even further at higher levels, such as master's, doctoral, and post-doctoral degrees (Menezes; Brito; Anteneodo, 2017). This observation is particularly relevant when we consider that diversity, equality, and inclusion present in spaces of power are directly related to economic, creative, and, consequently, scientific advancement (Anteneodo et al., 2020). Reflecting on the aforementioned facts, as well as on the high levels of inequality present in Brazil, this article proposes an analysis of the representation of women researchers as first authors in the *Brazilian Journal of Physics*. The *Brazilian Journal of Physics* traces its roots back to the "Information Bulletin between Physicists" created at the Institute of Theoretical Physics (IFT) in São Paulo in 1958. Starting in 1971, this bulletin became the journal *Revista Brasileira de Física*, associated with the Brazilian Society of Physics, before being renamed the *Brazilian Journal of Physics* (BJP) in the mid-1990s.

The BJP showcases original and current research on diverse aspects of experimental, theoretical, and computational physics from around the world. The journal's scope encompasses a wide range of fields, from traditional fundamental and applied physics (atomic, condensed matter, molecular, nuclear, optical, particle, and statistical) to relevant topics of an interdisciplinary nature, including biophysics, nonlinear dynamics, and complex systems, among others (SBF, 2021a). From its inception in 1971 until the publication of its 51st volume, the BJP has published approximately 4,240 articles. Over these 50 years, while the number of articles appearing in the journal has steadily grown, the number of women as first authors has not increased in equal measure.

THE BJP AND THE PROMOTION OF FEMALE PARTICIPATION IN SCIENTIFIC RESEARCH

In July 2021, the Brazilian Society of Physics held a workshop titled "Present and Future" (SBF, 2021b), which was broadcast on the SBF's YouTube channel on account of the pandemic. The aim of the event was to present an array of activities developed by the SBF as well as to discuss proposals for future initiatives. The workshop program included presentations of events and journal publications by various working groups, commissions, MNPEF (the Graduate Program for Education in Physics), the Physics Olympics, and EUF (the Unified Graduate Examination in Physics). Activities at the event were divided into two blocks. The second one included a session titled "Revistas da SBF" (SBF publications), with a presentation by the BJP's editorial board. Apart from all of the board members hailing exclusively from states in the South and Southeast regions of Brazil—which

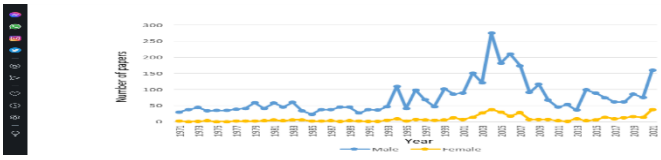
continue to be disproportionately overrepresented in Brazilian science—it was composed of 8 men and only 1 woman.

The BJP has sought to encourage female participation through various initiatives, including the publication, for the first time in English, of the article "On the Disintegration of the Positive Heavy Meson" (Frota-Pessoa; Margem, 2021) in the December 2021 issue of the BJP by researchers Elisa Frota-Pessoa (1921–2018) and Neusa Margem (1926–2015) from the Brazilian Center for Physics Research (CBPF). This pioneering work by these two female physicists presented strong evidence for the description of the axial-vector current for weak interactions (SBF, 2021c).

RESULTS AND DISCUSSION

This paper aims to discuss the (non-)representation of women in physics. On this basis, a qualitative and quantitative analysis was conducted in the *Brazilian Journal of Physics*. We compared the number of papers produced by women and men as first authors, and the journal's website was used as the main source for the research. The data presented in Figure 1 indicate that women entered science slowly and gradually (Casagrande, 2005).

Figure 1 – Distribution of papers by sex.



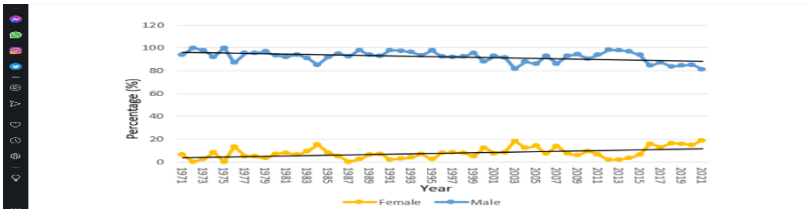
Source: Authors.

In Figure 1, we illustrate the number of publications in which men (in blue) and women (in yellow) are placed as the first author from 1971 to 2021. We can see that, despite an increase in the number of articles published over the years—especially in 2005, featuring a commemoration of Einstein's "miraculous year" of physics in 1905—the number of women as first authors did not grow in tandem. Similar numbers can be found in *Revista Brasileira de Ensino de Física* (RBEF) when considering the participation of women independent of authorial order (Gomes; Carvalho; Rocha, 2021).

Since the total number of published articles varied over the years, Figure 2 shows the percentage of the total number of published papers with the first author being a man (in blue) or a woman (in yellow), from 1971 to 2021. The graph shows a small increase from 6.2% in 1971 to 18.7% in 2021. This small percentage of participation of women as first authors does not reflect women's participation in the field. As graduate students in physics in 2015, women accounted for 22% (Areas; Barbosa; Santana, 2019), which is larger than the 6.3% of first authors in that same year (traditionally the student).

On the other hand, in 2021, the Brazilian Society of Physics launched a workshop to promote women's participation in physics (SBF, 2021). As shown in Figure 2, we examined the progress of women publishing as first authors in the journal.

Figure 2 – Distribution of authors by sex.



Source: Authors.

The percentage of women first authors at the BJP is similar to the percentage of women professors in graduate programs in physics, and women who hold a CNPq fellowship (*Produtividade em Pesquisa*), which is around 12% (Areas; Barbosa; Santana, 2019; Guedes; Azevedo; Ferreira, 2015). Men far outnumber women among holders of CNPq scholarships. Here, female representation among CNPq scholarship holders in the natural and earth sciences barely increased between 2001 and 2012, growing from 19.1% to just 23.3% during this period. Despite the very high number of scholarships available for research in the natural and earth sciences, the representation of female researchers is extremely low. This trend does not seem to have changed much over time, as reflected in our analysis of women as first authors in the BJP.

Another similarity between the slow increase in the number of articles by women at the BJP and the participation of women in research is the slow change when the numbers are analyzed over time. In the case of the BJP, an increase of 12.5% was observed when analyzing a 50-year window. In the case of professors in graduate programs (Areas; Barbosa; Santana, 2019) or researchers from CNPq (BARBOSA; LIMA, 2013), no change is observed when the data are compared over a 10-year period. Why is it so slow? The absence of a clear policy promoting diversity might be one of the reasons why that change, when it occurs, takes long periods of time. When evaluation bodies are aware of gender bias, they develop better evaluation methodologies for women applicants than when they ignore the existence of such bias (RÉGNER, 2019). Therefore, the implementation of affirmative action policies is a relevant mechanism to guarantee better evaluation.

FINAL CONSIDERATIONS

In order for Brazilian science to become more productive and achieve a greater gender balance, new subsidies should be created to support publication in scientific journals. Future research that examines the processes behind the composition of journal editorial boards also has the potential to improve the gender balance. For example, after consulting the journal's editors on what could be done to promote increased female participation in its publications, the journal *Frontiers in Physics* is launching a new article collection to showcase the work of women researchers, titled *Women in Science: Physics*, with the goal of spotlighting the work of women researchers in physics, a group that has historically been underrepresented in STEM fields. The overall goal would be to include articles from female researchers working in various fields, covering all the specialty sections of *Frontiers in Physics* (Frontiers in Physics, 2021). Here in Brazil, we hope that highlighting these findings will promote actions that expand scientific space, not

only within the journals themselves but also for women as first authors of scientific publications.

50 Anos do *Brazilian Journal of Physics* e a participação feminina na pesquisa científica

RESUMO

Este estudo foi realizado por ocasião do 50º aniversário do *Brazilian Journal of Physics* em 2021. Em resposta ao aumento das pesquisas sobre a participação feminina na ciência, realizamos um levantamento do sexo dos autores dos artigos científicos publicados na revista ao longo desses 50 anos. Os resultados do nosso levantamento revelam um aumento geral na participação feminina como primeiras autoras de artigos, embora lento.

PALAVRAS-CHAVE: Participação feminina. Pesquisa científica. Física.

50 Años del *Brazilian Journal of Physics* y la participación femenina en la investigación científica

RESUMÉN

Este estudio se llevó a cabo con motivo del 50º aniversario del *Brazilian Journal of Physics* en 2021. En respuesta al incremento de las investigaciones sobre la participación femenina en la ciencia, realizamos un relevamiento del sexo de los autores de los artículos científicos publicados en la revista a lo largo de estos 50 años. Los resultados de nuestro estudio revelan un aumento general en la participación femenina como primeras autoras de artículos, aunque lento.

PALABRAS CLAVE: Participación femenina. Investigación científica. Física.

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