

Astronomy, a thing for women?

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Abstract

Over the centuries, women were not allowed to be part of the scientific community. However, they were present and with very significant contributions, also in astronomy. We know the role of classical astronomers, such as Caroline Herschel, Henrietta Leavitt, Annie Jump Cannon, and more modern ones, such as Vera Rubin and Andrea Ghez. Our Spanish pioneers of the 20th century paved the way for successive generations up to the present day. I will briefly review the situation of today's women astronomers both in the international and national context.

1 Introduction

This paper reflects a personal approach, presented in the invited talk I gave at the Scientific Meeting of the SEA, to the role of women in astronomy, initially based both on the work of Yaël Nazé in her book "L'astronomie au féminin" ([1]) and on all the collaborative efforts of the Spanish node of the "She is an Astronomer" (Ella es una astrónoma) pillar of the International Year of Astronomy 2009 (IYA2009), and reinterpreted in the years that followed, right up to the present day. [1] already stated that "over the centuries, women have had limited access to science in general and astronomy in particular", which she does not consider to be "a reason to take for granted the total absence of their contributions". In fact, she asks the reader who discovered an extraordinary number of comets and asteroids, who made it possible to organise stellar populations, or who provided a ladder to measure the universe. Throughout the text she argued that these and similar paramount questions in astronomy were solved thanks to the contributions of women who deserve a place in the history of astronomy.¹

The paper gives a brief overview of the role of women astronomers in the past (Sect. 2), and then focuses on women chosen to represent the four waves of feminism (Sect. 3). It then looks at the situation of women today in general, in the world, in Europe and in Spain (Sect.

¹Examples include Caroline Herchel in the discovery of comets, Annie Jump Cannon in stellar populations, Henrietta Leavitt in providing a novel method for deriving distances to stars, Cecilia Payne in stellar interiors, Vera Rubin in dark matter, and Jocelyn Bell in the discovery of pulsars.

5). A picture that clearly shows that action is still needed. Finally, some suggestions are made on how this change can take place (Sect. 7).

2 Women astronomers in history

The 2010 calendar² produced by the "Ella es una Astrónoma group" in Spain for the IYA2009 shows a very brief snapshot of a dozen women, from different epochs and countries, who significantly contributed to shaping our current vision of the Universe. The selected women were Wang Zhenyi, Hypathia from Alexandria, Annie Jump Cannon, Willamina Flemming, Maria W. Kirsh, Henrietta Leavitt, Nicole Leconte, Cecilia Payne, Caroline Herschel, Fátima from Madrid, Maria Mitchell and Paris Pismis.

In Spain we have our own pioneers, Antonia Ferrín and Assumpció Catalá, the first women to work in astronomy at the Universities of Santiago de Compostela and Barcelona, respectively.

3 Women astronomers in the four waves

In Western countries, the history of feminism is generally packaged as a story of "waves", grouped into four³. In this paper, the first wave is considered to be from the XVIIIth century to the second half of the XIXth century; the second, until the second half of the XXth century; the third, from the 60s to the 80s in the XXth century until the 2010s; the fourth wave began in the mid-2010s and continues now. For the sake of simplicity, I'll refer to them as 1) The Illustration, 2) The Suffragettes, 3) After May '68 and 4) "Me too". For each of these four waves I've chosen one (two in one case) representative women astronomers (other choices would be equally convincing, of course).

1) The Illustration. *"Woman has the right to mount the scaffold; she must equally have the right to mount the rostrum..." (Olympe des Gouges, 1748-1793)*

During this period, women did not appear in public as themselves, but as daughters, sisters or wives. One of the most prominent was **Caroline L. Herschel** (1751-1848), who in 1787 became the first woman to be paid as an astronomer's assistant (of his brother William). In 1822 she published the "Catalogue of the Nebulae which have been observed by W. Herschel in a series of sweeps", for the production of which the role of Caroline was essential. In 1828 she received the Gold Medal of the Royal Astronomical Society, the first to be awarded to a woman (the second had to wait until the middle of the XXth century).

2) The Suffragettes. *"There is no gate, no lock, no bolt that you can set upon the freedom of my mind" (Virginia Woolf, 1882-1941)*

Women in this period raised their voices and demanded to exist in their own right. Both Henrietta Swan Leavitt (1868-1921) and Annie Jump Cannon (1863-1941) perfectly exemplify the crucial, but much less visible, role of women astronomers in this period. The work of

²<https://www.sheisanastronomer.org/downloads/calendar>

³Different references indicate slightly different time periods

Henrietta Swan Leavitt made it possible to establish a relation between the period and the luminosity of type I Cepheid variables, which in the 90s was still being studied in Spanish universities as the "period-luminosity relation"; it seems to be verified whether this relation is now called Leavitt's law, as it would deserve. It was suggested that Henrietta Swan Leavitt should be awarded the Nobel Prize, but the idea came too late, as she had already passed away. **Annie Jump Cannon** produced the HD Star Catalogue with the spectral classification of some 300,000 stars. Her work was internationally recognised. Since 1934, the American Astronomical Society has presented the Annie Jump Cannon Award to a North American female postdoctoral astronomer within five years of receiving her Ph.D. for outstanding and promising future research.

3) After May '68. *"Obstacles are simply dares... and are to be conquered, not feared"* (Vera Rubin, 1928-2016)

The argument used as a rallying cry by student activist movements and the wave of feminism from the late 1960s was "the personal is political" (also called "the private is political"); it meant that the restriction of women to the private sphere was a political issue. **Vera C. Rubin** is chosen as a clear representative of this period. Several of her testimonies speak of the need to demonstrate again and again that her work deserved at least the same recognition as that of her male colleagues. She led the team that showed evidence for the presence of dark matter in the rotation curves of spiral galaxies.

4) Me too. *"I've always been interested in this question of how do you encourage girls into the sciences, and I think that the best way you can do that is by succeeding, visibly succeeding"* (Andrea Ghez, 1965-)

This last wave is the one we are experiencing today, characterised by the emergence of connected masses of women capable of acting transnationally, without a central command, simultaneously in the streets and on digital networks, to denounce the violence generated specifically against women. The women astronomer chosen for this period is Andrea Ghez, the first female astronomer to be awarded a joint Nobel Prize in Physics, in 2020, "for the discovery of a supermassive compact object at the centre of our galaxy".

4 The present: general context

Several documents from international institutions underline that gender equality is still a goal. In fact, at a worldwide level, it appears as one of the United Nations Sustainable Development Goals (number 5) for 2030, which aims to achieve gender equality and empower all women and girls. The dedicated website⁴ acknowledges that "the world is not on track to achieve gender equality by 2030" and points out, among other things, that "at the current rate, it will take 286 years to close gaps in legal protection and eliminate discriminatory laws, and 140 years to achieve equal representation in workplace leadership". On the other hand, the World Economic Forum's Global Gender Gap Report 2024 [2] shows that the two biggest gender gaps to be closed are in economic participation and opportunity, and political empowerment. In fact, women make up 42% of the global workforce, but only 31.7% of

⁴<https://sdgs.un.org/goals/goal5>

senior leadership positions. The projected year of parity is not the same for every region of the world, but interestingly, the projected year of parity in Europe is 2097.

Focusing on Europe, the European Commission has delivered a report that analyses the gender equality strategy in Europe 2020-2025 [3]. Among the various figures depicted in the report, it is to notice that: 44% of Europeans think that the most important role of a woman is to take care of her home and family; out of the high-performing students in maths or science in OECD countries, 1 in 4 boys expect a career as an engineer or scientist, compared to 1 in 6 girls; 1 in 3 girls expect to work as health professionals, compared to 1 in 8 boys; only 22% of AI programmers are women; the gender pay gap is 15.7%, and the gender pension gap is 30.1%; women in EU spend 22 hours/week on care/household work, while men spend only 9.

At the national level, in comparison with other European countries, it is worth mentioning that the overall gender equality index provided by the European Institute for Gender Equality (EIGE) for Spain, France and Germany are 76.6%, 75.7% and 70.8% respectively [5].

5 The present situation of women in Physics and Astronomy in Spain

We have access to the situation of women in physics in Spain thanks to the work of the **”Women in Physics”** group of the Spanish Royal Society of Physics (RSEF), which was founded in 2002 with the aim of increasing the presence of women in physics in Spain and making their achievements more visible, among other things (www.gemf-rsef.es). In the group’s presentation slide on their website, a graph shows the percentage of women studying biology (around 62%), chemistry (from 62% to 55%), geology and mathematics (from 42% to 35%) and physics (from 30% to 27%) from 1998 to 2020. In terms of staff, the figures vary considerably between the different disciplines of physics in universities, from around 15% in condensed matter, theoretical physics or electromagnetism, to around 25% in astronomy and astrophysics, applied physics, atomic, molecular and nuclear physics, almost 35% in geophysics and 40% in optics.

Also in 2002, the Governing Board of the Spanish National Research Council (CSIC) approved the **Women and Science Committee** to address the problem of the under-representation of women in the scientific work of the institution, which has been widespread since the creation of the CSIC. The Committee set itself two particularly important objectives: i) to study the possible causes that hinder women’s access to and pursuit of scientific careers, and ii) to propose measures that the Presidency could take to achieve equality between women and men at the CSIC. The CSIC was the first public and private research institution in Spain to set up a committee on women and science. In its 2024 annual report, the percentage of women researchers in physics in 2023 is shown at different staff levels [6]; the plot is an unclosed scissors plot, with less than 27% of women predocs down to 19% of women at the highest level (professors). These figures were 31% and 11% respectively in 2012; the increase of 8 points in 21 years for the highest level could be hopeful, but the decrease of 4 points at the predoc level is worrying, as the percentage of young women entering the scientific career at the CSIC in physics is decreasing.

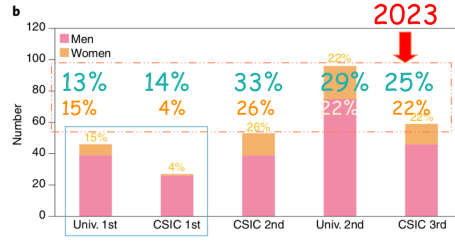


Figure 1: Permanent positions for women (orange) and men (magenta). Different categories are shown separately: the blue box corresponds to those with the highest levels at universities and CSIC. The numbers for women in 2016 are enlarged in orange. Update of Fig. 3b by [7], where the numbers for 2023 are shown in blue.

As far as astronomy is concerned, the pioneering work published in *Nature Astronomy* in 2028 by Pérez-Sedeño, Kiczkowski and Márquez [7] already showed the time evolution of women astronomers at different levels in all types of research centres in Spain from 2002 to 2016, with predocs increasing from 31% to 36%, postdocs around 30% for the whole period, and permanent staff from 17% to 24% (hence an average of 24% female astronomers in 2012 to 29% in 2016). The update of this figure provided by the SEA annual report [8] shows a decrease from 2016 to 2022, followed by an increase in pre- and post-docs (both around 33% in 2024) and an overall constant increase in permanent staff (to reach around 28% in 2024). Regarding permanent posts, the update to 2023 of the figures given in [7] shows a significant increase (from 4% to 14% at the highest levels in the CSIC, to be comparable to those in the universities (13%), and an average increase of around 5% at the lower levels (see Fig. 1).

In [7], the percentage of women astronomers in the IAU was also used as a reference. In 2017, 20% of Spanish IAU members were women (the average for all countries with more than 100 members was 16%). By 2024, the figure has risen slightly to just under 25% (around 22% overall, from 40% in Argentina and <10% in Japan).

6 Women astronomers at the top

Space does not permit a full analysis of the most prestigious prizes in astronomy, with all the years and names of the women winners (many of whom received more than one prize). A significant increase is seen in the last 3-4 years. Table 1 shows only the total numbers.

A very prestigious role is that of president of the International Astronomical Union (founded in 1919); the first woman to become IAU president was **Catherine Cesarsky**, in 2006, followed by Silvia Torres Castilleja (2015), Ewine van Dishoek (2019) and Debra Elmegreen (2022). At the Spanish level, the presidency of the SEA (founded in 1992) was taken over by **Cesca Figueras** in 2016; the second one will be Minia Manteiga, in 2025.

Table 1: Women in the most prestigious prizes in astronomy

| Prize | Date of 1st award | total awards | nr. women awarded (%) | 1st awarded woman |
|---------------------------------------|----------------------|-----------------|--------------------------|-------------------------|
| Golden Medal RAS | 1824 | 211 | 5 (2%) | Caroline Herschel, 1828 |
| Bruce Medal ASP | 1898 | 116 | 7 (6%) | Margaret Burbidge, 1982 |
| H. N. Russell Lectureship | 1946 | 67 | 7 (9%) | Cecilia Payne, 1976 |
| Jansky lectureship | 1966 | 58 | 8 (14%) | M. Burbidge, 1977 |
| CRAFOORD Astro. & Maths | 1982 | 30 | 3(10%) | Andrea Ghez, 2012 |
| GRUBER Prize Cosmology | 2000 | 49 | 4 (8%) | Vera Rubin, 2002 |
| SHAW Prize Astro. | 2004 | 36 | 4 (11%) | Jane Luu, 2012 |
| Kavli Fundation | 2008 | 19 | 2 (11%) | J. Luu, 2012 |
| Nobel Physics | 1901 | 226 | 5 (2%) | Marie S. Curie, 1903 |
| Nobel (Astro. & Cosmology) | 1936 | 26 | 1 (4%) | A. Ghez, 2020 |

7 The answer and suggestions to improve

To wrap up, the short answer would be "yes, astronomy is a thing for women", but the situation is still far from being completely satisfactory. Among the actions to be taken for a true change, I would list those given in [9]: *taking an active role in transforming; creating an open and welcoming space for female scientists; building a participatory, inclusive and supportive scientific community where teamwork is fostered; bringing women to the front, since power gives the ability to make changes, create new possibilities and participate in decision making; counter-acting gender-bias; freeing our community from microaggressions, harassment...* (no more invisible or uncomfortable women); and using different approach to evaluating quality (i.e., acknowledging diverse career paths).

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