

Women in Physics in the United Kingdom: Successes, Challenges, and Wider Diversity

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Abstract. Progress is being made in improving the environment for women in physics in the United Kingdom, although the proportion of women in the subject remains stubbornly low. Several initiatives have been launched to help encourage girls enter the field and to retain women. The sector is starting to target broader aspects of equality, diversity, and inclusion.

ATHENA SWAN CHARTER AND PROJECT JUNO

When the Athena Swan Charter was launched in 2005, its aim was to encourage and recognize commitment to the careers of women in science, technology, engineering, and mathematics (STEM). The complementary physics-specific Project Juno was introduced by the Institute of Physics (IOP) in 2006, with a reciprocal arrangement meaning that a successful Juno Champion can, with the provision of supplementary material, be submitted as evidence for an Athena Swan Bronze or Silver Award. Both schemes have developed over the years, with Athena Swan awards now being available to university departments beyond STEM and Juno “Principle 6,” which focuses on measures to eliminate bullying and harassment, now being fully embedded. A review of Athena Swan [1] and the early stages of a major review of Juno point towards the significant success and widespread influence of both. The percentage of Juno-recognized university physics departments that hold the highest Juno “Champion” award increased from 22% to 44% between 2014 and 2021, and physics departments hold the second highest proportion of Athena Swan Silver Awards. Juno has consistently been found to encourage discussions on gender equality, to increase the representation and visibility of women, and, more generally, to improve departmental culture [2].

Recent changes to Athena Swan are designed to support greater inclusivity for people in all roles, of all gender identities, and those facing intersectional inequalities [3]. The IOP Strategy [4] has diversity at its core, demonstrating commitment to access to physics education and training for the entire population, and the Institute works actively to promote equality and diversity across gender, ethnicity, disability, LGBT+ status, and socio-economic background, recognizing the complex interactions between different factors.

PARTICIPATION OF WOMEN IN PHYSICS

Notwithstanding the positive influence of Athena Swan and Juno, the number of girls choosing to study physics at age 16 remains stubbornly low. The qualifications that are most commonly studied between the ages of 16 and 18 in England, Wales, and Northern Ireland are Advanced levels (widely known as A-levels), and the percentage of physics A-level entries from female students has remained at just over 20% for many years (Figure 1). There has been a small

recent increase, to 23% in 2020, but Mary Curnock Cook commented in damnatory terms in the same year that it was as if physics was a “foreign language” to girls [5]. The ability of the students does not appear to be a factor, since girls’ results in the earlier-stage General Certificate of Secondary Education (GCSE) qualifications are on a par with those for boys. The situation in Scotland is slightly better, with around 30% participation at the equivalent stage [6].

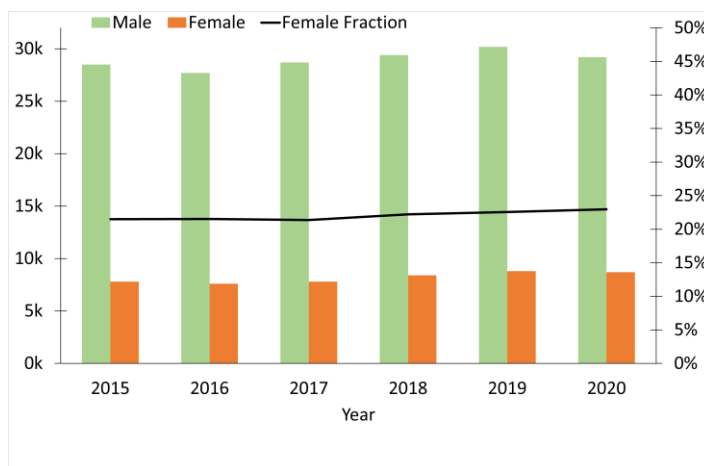


FIGURE 1. A-level physics entries by gender, 2015–2020 [5].

Paradoxically, the proportion of female university physics students is higher than at A level, increasing from 21% in 2012–2013 to 24% in 2017–2018 (23% for undergraduates, 26% on postgraduate masters programs, and 25% for PhD programs), although it remains one of the lowest levels in STEM [7]. This discrepancy may be partly explained by the number of students who come to the United Kingdom from other countries, of whom a greater proportion are women, as shown in Table 2. The physics degree outcomes for female undergraduate students are slightly better than for their male counterparts.

TABLE 2. Percentage of female university physics students and staff in 2012–2013 and 2017–2018 [7, 8].

	2012/2013	2017/2018		
	(All)	All	UK Domicile	Non-UK Domicile
All students	21%	24%	22%	30%
All academic staff	17%	19%	17%	21%
Professors	8%	12%	10%	16%

Table 2 also shows a growth in the percentage of physics staff in universities who are women and a marked increase in the proportion of full professors. Women from outside the United Kingdom are again disproportionately represented in these numbers, a factor that is worthy of further investigation and on which the impact of Brexit is not yet known.

INCREASING PARTICIPATION

Much of the gender disparity in physics participation in the United Kingdom arises as a result of subject choice at age 16. Therefore, to improve the situation at higher levels, the most pressing need is to improve interest in physics among younger students. There are a number of new initiatives underway to address this goal, many taking an approach based on Science Capital, a concept arising from the longitudinal ASPIRES study, which recognizes the importance of influences beyond school in addressing societal bias [9]. The initiatives include the following:

- **IOP’s Limit Less:** aiming to increase physics take-up for under 16s by influencing families and communities and media and social media as well as education and skills providers [6].
- **Science and Technology Facilities Council’s (STFC’s) Wonder Initiative:** aiming to connect children and their families with science and technology [10].
- **NUSTEM STEM Person of the Week [11]:** aiming to showcase varied role models, not just the academic high flyers, to improve the likelihood that students will identify with them.
- **Gatsby Career Benchmarks:** aiming to improve and formalize careers teaching in schools [12].

SUPPORTING THE PIPELINE

Recent years have also seen new or expanded initiatives to support and retain women in physics careers:

- Now in its sixth year, the Conference for Undergraduate Women in Physics (CUWIP) United Kingdom has successfully broadened the participation of women and supported and built the confidence of participants [13].
- The Bell Burnell Graduate Scholarship Fund, instigated by Professor Dame Jocelyn Bell Burnell and the IOP to encourage greater diversity in physics by assisting PhD students from under-represented groups [14].
- Funders of senior postdoctoral fellowships, including the Royal Society, Engineering and Physical Sciences Research Council, and STFC, now monitor the fraction of women at each stage of the award process.
- Funders have established policies to ensure that long-term leave and other individual circumstances are taken into account when applicants are assessed. Similarly, many universities take these factors into account when considering promotion cases, although practice remains inconsistent for both funding and promotion.
- In recent years, the proportion of women winning IOP awards has increased steadily from a shockingly low base prior to the 1970s (Figure 2), and a proactive approach is now taken to increase the diversity of award nominees, for example, by engaging with diverse groups and introducing the possibility of self-nomination.

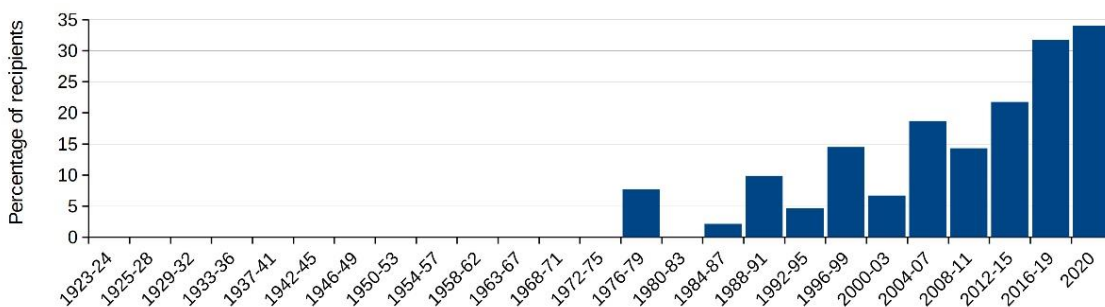


FIGURE 2. Proportion of women winning an IOP award or medal, 1923–2020 [15].

CONCLUSION

Project Juno and the Athena Swan Charter have improved the environment for women in physics in the United Kingdom, and are being modified to widen their impact. However female participation in physics remains low, with less than a quarter of students at age 16 being girls. Initiatives are underway to increase this proportion and to retain women.

REFERENCES

1. A. Graves, A. Rowell, and E. Hunsicker, *An Impact Evaluation of the Athena SWAN Charter* (Ortis Economic Research, Newcastle upon Tyne, 2019).
2. IOP, *Evaluation of Project Juno: Summary of Final Report* (IOP, London, 2013).
3. “Athena Swan Charter,” AdvanceHE, n.d.m, <https://www.advance-he.ac.uk/equality-charters/athena-swan-charter>.
4. IOP, *Unlocking the Future: Institute of Physics Strategy 2020-2024* (IOP, London, 2019).
5. M. Curnock Cook, HEPI, September 1, 2020, <https://www.hepi.ac.uk/2020/09/01/english-is-now-a-modern-foreign-language-for-boys-physics-is-a-foreign-language-for-girls-too-grades-aside-what-do-this-years-a-level-entry-trends-tell-us>.
6. “What We’re Doing to Address Gender Imbalance in Physics, IOP, n.d., <https://www.iop.org/what-were-doing-address-gender-imbalance-physics>.
7. IOP, *Students in UK Physics Departments* (IOP, London, 2019).
8. IOP, *Academic Staff in UK Physics Departments* (IOP, London, 2019).
9. S. Godec, H. King and L. Archer, *The Science Capital Teaching Approach* (UCL, London, 2017).
10. “Public Engagement: Wonder Initiative,” UK Research and Innovation, June 21, 2022, <https://stfc.ukri.org/public-engagement/wonder/>.

11. “Stem Person of the Week,” NUSTEM, n.d., <https://nustem.uk/stem-person-of-the-week/>.
12. Gatsby Charitable Foundation, <https://www.goodcareerguidance.org.uk/benchmarks-and-background>, accessed August 2021.
13. IOP, <https://www.iop.org/conference-undergraduate-women-physics-uk>, accessed August 2021.
14. IOP, <https://www.iop.org/about/support-grants/bell-burnell-fund>, accessed August 2021.
15. IOP, <https://www.iop.org/about/awards>, accessed August 2021.