Liverpool Women in Physics: Initiatives and Progress

Costas Andreopoulos[1], Hannah Brown[1], Matthew J. Darnley[2], Selina Dhinsey[1], Leanne A. H. Jones[1], Christopher Lucas[1], Yvonne Gründer[1], Stacey M. Habergham[2], Cara J. Hawkins[1], Felicity Mayo[1], Andy M. Newsam[2], Ricardo Torres[1,] Helen Vaughan[1,3], Tim D. Veal[1], Olivia K. Voyce[1], Alexandra Welsch[1] and Carsten P. Welsch[1, a)]

[1]*Department of Physics, University of Liverpool, Oliver Lodge Laboratory, Liverpool, L69 3BX, UK*
[2]*Astrophysics Research Institute, Liverpool John Moores University, Liverpool L3 5RF, UK*
[3]*Central Teaching Laboratories, University of Liverpool, Liverpool, L69 3BX, UK*

[a)] *Corresponding author: C.P.Welsch@liverpool.ac.uk*

Abstract. Over the last four years, the Department of Physics at the University of Liverpool, has undertaken a range of initiatives to promote women in physics. These range from leading an event held simultaneously in three countries celebrating the 150th anniversary of Marie Skłodowska-Curie and school girl visits to the Liverpool-led beamline at the European Synchrotron Radiation Facility to the establishment of a Liverpool Women in Physics group and integration of equality, diversity and inclusivity in department activities, infrastructure and communications. An award-winning podcast series, showcasing a gender-balanced series of pioneering Liverpool scientists, has been established by one of our female undergraduates. Profiles of female-physicist role models from the department, ranging from undergraduates to professors, have been featured on the department website and promoted in social media campaigns to mark the annual International Day of Women and Girls in Science and International Women's Day. There has been a fivefold increase in female professors in the department and an enhanced profile of female physicists, resulting from their senior leadership roles in the department, wider University and beyond. However, in spite of the progress made, female physicists are still under-represented at all levels. Further initiatives and work are planned. These include the Liverpool Department of Physics hosting the UK Conference for Undergraduate Women in Physics in Spring 2023 in partnership with the Astrophysics Research Institute of Liverpool John Moores University. This meeting, which has run in the UK since 2015, aims to inspire those who identify as women who have chosen to study physics at university, to promote their careers in physics and to create a nationwide community of supportive women. Finally, while women in physics remains a very high priority for our department, there is an ever-increasing focus on intersectionality and broader equality, diversity and inclusivity initiatives.

INTRODUCTION

In this paper we describe our recent initiatives and progress on promoting women in physics at Liverpool. In the first part, recent improvements to departmental communications and infrastructure are detailed, along with the progress that has been made in improving gender balance in the department, including at senior levels. In the second part, brief case studies of recent and planned events and initiatives are presented.

WOMEN IN PHYSICS AT LIVERPOOL

Departmental Communications and Infrastructure

Our departmental communications have been significantly enhanced in recent years. Our regular newsletter had lapsed and was relaunched as a fortnightly bulletin emailed to all staff and students. This covers news and events from across the department and features a section on Equality, Diversity and Inclusivity in every edition, edited by the Department's Director of Equality and Diversity with contributions from academic staff, research staff, postgraduate and undergraduate students. Features include showcasing female alumni from the department as role models, items on historical figures from the department from under-represented groups, information on department and university policies, such as shared parental leave, maternity and paternity leave and bullying and harassment policies and

procedures, as well as upcoming events and initiatives. Recent articles have been about trans awareness and inclusivity, decolonization of the physics curriculum and evidence and opinions on gender bias in physics.

Occasions such as the *International Day of Women and Girls in Science* and *International Women's Day* have been marked by profiles of woman from across the department, from undergraduates to professors, detailing their physics interests and what attracted them to physics and what challenges they needed to overcome to study physics or become physicists. These profiles are featured on the department website and promoted via the bulletin and social media. Staff and students have also engaged with external media opportunities to highlight inclusivity issues. For example, the IOP has produced a series of films that illustrate access barriers in physics, including one featuring our postgraduate student Ms Selina Dhinsey [1] and other students from our Centre for Doctoral Training LIV.DAT [2]. Equality and diversity (E&D) considerations, including women in physics, are being increasingly integrated in departmental activities, with, for example, improved representation of women on departmental committees, while hopefully avoiding overburdening a minority group.

Actions have begun to enhance the inclusivity of the Department of Physics building. Toilet facilities have been refurbished and amended in the building. This introduced female access to toilet facilities to parts of the building that previously had none, it gave a five-fold increase in disabled-access toilets and introduced unisex/gender neutral toilets to the building for the first time. The architect produced the design for the changes based on 50/50 female/male occupancy of the building, something that remains an ambition for physics, but which is certainly not yet the reality. The changes to the toilet facilities prompted some controversies and discussions in the department, particularly while the building work was underway, but the inclusivity of provision has been enhanced. New laboratory spaces were also created with provision for disabled access and supporting features such as height-adjustable desks. Plans for the immediate future include improvements to department common room and the floor 1 corridor which shall feature a timeline about the history of the physics department which will acknowledge the extent of the lack of diversity in the past, while highlighting the diversity, from a gender perspective and otherwise, that has been and is present.

Female Physicist Role Models and Improving Gender Balance

While the proportion of physics undergraduates who are women in our department persistently remains at the national average of about 20%, the proportion of PhD students who are female is closer to 30% and has been for a few years. The reasons for this difference are not entirely clear, but it may be related to women being in both postgraduate-research-leadership and research-leadership roles in the department. For the three major large hadron collider experiments at CERN that we are involved in, ATLAS, ALICE and LHCb, our departmental groups are led by female professors. Since 2015, the number of female professors has increased from one to five and the proportion of professors in the department who are women has increased from 6% to 15%. Two new female lecturers have been appointed in the last year. There has also been a significant increase in number and proportion of female Liverpool physicists in senior roles within the department, the university and beyond, including leadership of the UK Physics Learning and Teaching in Higher Education Community meetings [3], Deputy Head of Department (Research), School Director of Postgraduate Research (Chemistry, Maths and Physics), and Faculty Associate Pro-Vice Chancellor for Research. We recognize that there is still much work to be done, but progress is being made.

EVENTS AND INITIATIVES

Celebrating the 150th Birth Anniversary of Marie Skłodowska-Curie in 2017

The 150th anniversary of the birth of Marie Skłodowska-Curie was celebrated as Marie Curie Day [4] in November 2017 with parallel events in Liverpool, Munich and Geneva organized by the QUASAR Group in our department in association with Liverpool-led Marie Skłodowska-Curie Action (MSCA) Training Networks. Through the DITANET (beam diagnostics), oPAC (Optimization of Particle Accelerators), LA^{3}NET (Laser Applications at Accelerators), OMA (Optimization of Medical Accelerators) and AVA (Accelerators Validating Antimatter physics) projects Liverpool has coordinated several MSCA training initiatives. Activities in Liverpool on the day included hosting school children at the university for a program of events consisting of a live stream from CERN, Geneva, about Marie Curie actions, hands-on activities, and a schools poster competition on "Women in Science". The Marie Curie Day website describes the life and achievements of Marie Curie. As well as being the first woman to win a Nobel Prize and the first person to win in two different fields, Physics and Chemistry, she also broke down many barriers in science and played a leading role in redefining women's role in society and science.

Liverpool Women in Physics Group (LivWiP)

The Liverpool Women in Physics (LivWiP) group was established in the summer of 2019 by PhD students Hannah Brown and Olivia Voyce. It runs regular informal events, including coffee mornings, afternoon tea and evening quizzes, for all women and gender minorities in the department. It is an inclusive group for all people who identify as female, trans or non-binary in the department, regardless of their role. Participants are encouraged to bring their children with them if they would like to and have done so. The group gives an opportunity for Liverpool women in physics to network and provide support to each other and discuss the challenges they face as a minority.

XMaS Scientist Experience for Female High School Physics Students

The XMaS (X-ray Materials Science) beamline at the European Synchrotron Radiation Facility (ESRF) has been funded by the UK's Engineering and Physical Science Research Council since its inception in 1992 and has been a jointly managed project by the University of Liverpool and the University of Warwick. In the 2012-2018 operational period of XMaS, a new outreach activity was initiated to tackle the gender bias in Physics [5]. A competition for female students was advertised in Schools in the Liverpool and Warwick areas – each year the competition involves writing a two-page essay about a different female physicist (such as Kathleen Lonsdale and Jocelyn Bell Burnell) and her contributions to science and society. From the entries, 14 winners were selected and participated in a 3-day visit to the European Photon and Neutron Science Campus and tour the ESRF, Institut Laue-Langevin (ILL) and XMaS facility, the aim being to encourage young women to consider a career in STEM, by showing them the career opportunities as well as introducing them to inspirational role models in an international setting. The annual competition and trip receives a lot of attention on social media (@XMaSSchoolTrip) as well as blogs on the WISE Campaign, plotr, Science grrl and girlmuseum and strong partnerships have been formed with these organisations as well as STEMettes**,** BIG BANG, Uppsala University, CERN, IGGY, the Ogden Trust Network and the National Science Centres in addressing the gender balance problem. A major part of the on-site visit has included participation in the Synchrotron@School programme that is run by the ESRF and involves a series of hands-on activities and the development of presentation skills.

The Liverpool Scientific Podcast

The Liverpool Scientific podcast (see Fig. 1) [6] was started in October 2020, by Liverpool Physics undergraduate student, Cara Hawkins. Her goal was to promote the STEM research happening at the University of Liverpool to the wider university community and beyond. Inspired by Jim Al-Khalili's popular BBC podcast 'The Life Scientific', each episode focuses on an academic working within one of the Liverpool STEM departments and explores their research along with their pathway to university lecturer. As well as encouraging university-wide, national and international engagement in the exciting research at Liverpool, The Liverpool Scientific also champions the diversity within Liverpool's STEM faculties. Academics from lots of different backgrounds have taken part, including many from groups under-represented in higher education and particularly in STEM. For example, the 50:50 gender balance in each season highlights the profiles of women in STEM conducting world-leading research. Topics such as first-generation university graduates and completing higher education with dyslexia are also explored in the episodes. This highlights the many different profiles of people working in academia and challenges stereotypes of what an academic 'should' look like.

One episode won The Rutherford Communications Prize, awarded by the Institute of Physics (IoP) to scientists who exemplify excellence in outreach to the public via communication of plasma physics. In the prize-winning episode, Dr Laura Corner talks about her research into plasma-based acceleration at Liverpool and the Cockcroft Institute. Cara Hawkins and Dr Corner also gave an invited Rutherford prize talk at the 47th IoP Plasma Physics Conference.

Upcoming seasons of The Liverpool Scientific will include a special 'Diversity in STEM' season focusing on promoting STEM careers for those from under-represented groups. The show will continue to showcase academics at Liverpool to the wider community, with the aim of inspiring more people to study STEM subjects.

Figure 1: The Liverpool Scientific podcast logo.

Figure 2: The CUWiP logo.

UK Conference for Undergraduate Women in Physics, Liverpool 2023

The UK Conference for Undergraduate Women in Physics (see Fig. 2) is modelled on its US counterpart. It originated in Oxford in 2015 with the "goal of helping undergraduate women continue in physics through participation in a conference focused on their development as scientists and showcasing options for their educational and professional futures" [7].

The 2023 meeting will be hosted at the University of Liverpool and co-organized by the Department of Physics and the Liverpool John Moores University Astrophysics Research Institute. The meeting will include presentations by distinguished female physicists on their cutting-edge research and personal career paths; a mini science jamboree with local Brownies and Guides based on a previous successful "SciJams" [8]; panels of experts to answer questions on graduate study and career opportunities outside academia for physics graduates; networking opportunities; and a range of workshops and tours of local research laboratories.

CONCLUSION AND FUTURE PLANS

Recent progress has been reported in departmental communications and infrastructure in support of women in physics and inclusivity more generally. Enhanced representation of women has been achieved and more women are now in senior positions, but much is still to be done. Some recent and future events and initiatives have been described. Next steps will continue our journey towards greater gender balance in physics and also to improve equality of opportunity, not only for women, but for other under-represented groups in physics.

ACKNOWLEDGMENTS

Prof Tom Hase, Prof Malcolm Cooper and colleagues from University of Warwick are thanked for their role in the ESRF XMaS beamline school girls outreach scheme. Everyone else involved in the initiatives mentioned in the article is thanked for their contributions. STFC, EPSRC and the EU Commission are acknowledged for funding.

REFERENCES

1. https://youtu.be/cjU2pZ_PVdQ Accessed 29 June 2021.
2. https://www.liverpool.ac.uk/livdat/ Accessed 29 June 2021.
3. https://www.liverpool.ac.uk/central-teaching-hub/physicslthe/ Accessed 3 July 2021.
4. https://marie-curie-day-2017.org/ Accessed 29 June 2021.
5. https://warwick.ac.uk/fac/cross_fac/xmas/outreach/xmas_scientist_experienceb/ Accessed 29 June 2021.
6. https://www.liverpool.ac.uk/science-and-engineering/meet-our-researchers/liverpool-scientific/ Accessed 29 June 2021.
7. https://www.iop.org/conference-undergraduate-women-physics-uk Accessed 29 June 2021.
8. https://www.liverpool.ac.uk/central-teaching-hub/science-jamboree/ Access 3 July 2021.