Institute of Physics (IOP) Response to the House of Commons Science and Technology Committee Inquiry into Diversity in STEM

Executive Summary

The physics sector has a significant underrepresentation of women, people from disadvantaged backgrounds, disabled people, those who identify as LGBT+, and minority ethnic groups. The cause of this underrepresentation is clear; too many young people from these groups do not pursue physics as they are told it is not for them, feel they don't fit in, or see a viable career in the sector. Too many of those in the workforce are not retained due to poor workplace cultures and discrimination.

The resulting lack of diversity has both moral consequences; it is a matter of simple fairness and social justice that everyone should have the opportunity to thrive in the physics and STEM community - and economic implications; research shows that better diversity improves outcomes, for both business and the wider economy.

Efforts have been made to improve numbers of people coming into physics from underrepresented groups, such as the Institute of Physics'[1] (IOP) Limit Less campaign,[2] and to address workplace culture and misconduct. However, more needs to be done to make the sector welcoming to all and lift numbers to reflect the diversity of our society.

The IOP recommends the following to the UK Government and relevant devolved administrations:

1. Improve the quality, quantity and consistency of data on STEM employees
2. Publish and improve transparency of data on employee awards, pay and benefits within STEM
3. Implement the recommendations from the IOP's Limit Less campaign
4. Develop implementable codes of conduct to reduce professional misconduct

This submission presents the picture of equity, diversity and inclusion (EDI) in physics, and the evidence behind it.

[1] https://www.iop.org/about
[2] https://www.iop.org/strategy/limit-less

Introduction

About the IOP and this response

The IOP is the professional body and learned society for physics in the UK and Ireland. The IOP's mission is to support the development of a diverse and inclusive physics community, raise public awareness of physics, and inspire people to develop their knowledge, understanding and enjoyment for the subject.

As a charity, the IOP seeks to ensure that physics delivers on its exceptional potential to benefit society and reflects the diversity within the UK. The IOP is responding to this inquiry as a leader in STEM EDI, and on behalf of the physics sector. Our work on EDI is significant. EDI is a core theme running through the IOP's strategy, Unlocking the Future[3], and our Limit Less campaign aims to remedy the underrepresentation of certain groups studying physics, or beginning a physics-based apprenticeship, from age 16. We also focus on the environment of the physical sciences, from nurturing skills for the future and retaining our physicists, to supporting a vibrant physics industry. This includes a review of Project Juno to broaden it from the current gender focus.[4]

We are a sponsor and active member of the APPG on D&I in STEM and maintain industry codes of conduct and EDI programmes such as Project Juno. The IOP comprises around 22,000 members[5] from across the physics community: in industry, business, academia, the classroom, technician roles, in training programmes and in the public sector. As the next generation, we work closely with students and on the education system. We campaign and influence change by working with a range of partners to support and develop policy positions and recommendations aimed at making sure that the benefits of diversity and the value of inclusion are seen throughout the sector.

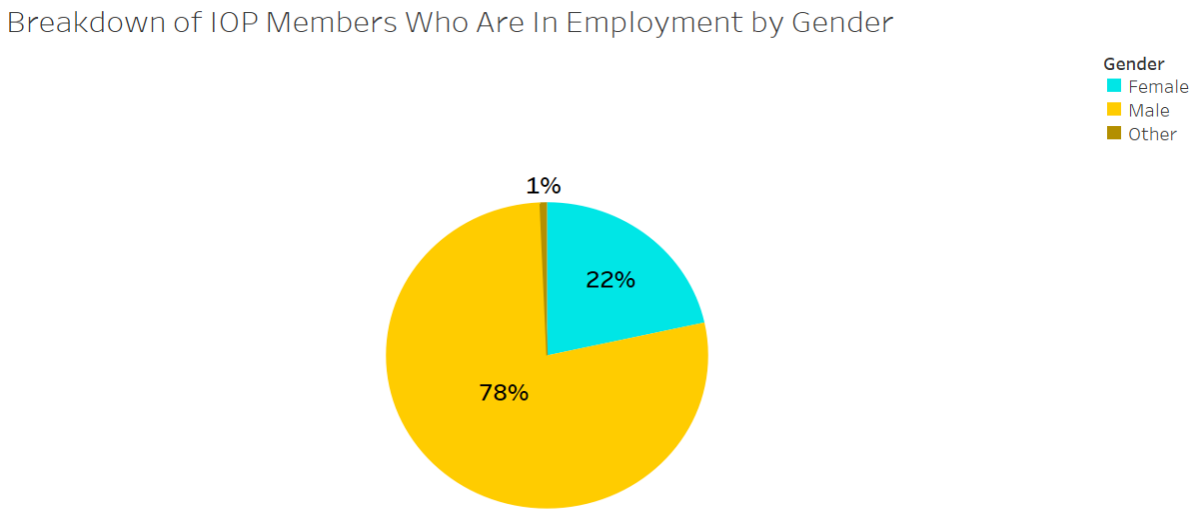
[3] https://www.iop.org/strategy
[4] https://www.iop.org/about/IOP-diversity-inclusion/project-juno#gref
[5] As of January 2022.

1. The nature of extent to which women, ethnic minorities, people with disabilities and those from disadvantaged socioeconomic backgrounds are underrepresented in STEM in academia and industry

The IOP has used membership data and results from diversity and inclusion member surveys to provide a snapshot of the demographics of the UK's physics workforce. The following insights include only members who are employed in physics and based in the UK. The number of UK-based working members who represent the protected characteristics has been detailed, and this has been expressed as a proportion of the total number of UK-based working IOP members. See the Annex for details on how this data is collected, stored, analysed and its limitations.

1.1. Gender

The IOP's member database shows that there is a large over-representation of those who identify as male (78%) in comparison to those who identify as female (22%), and compared to the gender breakdown within the general population (which sits at around 51% females and 49% males).[6] This is a historical trend.



Gender data from IOP membership figures, January 2022. N=13,340.
Data includes working members from the UK only.

Spotlight on Scotland

Specific information on STEM employment, broken down by gender, is available in Scotland, from the 2017 Scottish STEM strategy for Education and Training.[7] This is more detailed data than the IOP's membership data and more granular than is publicly available for the entire UK. This shows that in Scotland, men are more likely to be employed in STEM industries than women, and the gender split in STEM is more pronounced than in other sectors of the economy. Males have consistently accounted for 56-57% of employment in STEM sectors since 2010, a higher proportion

[6] 2011 Census, HMG.- https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/national-and-regional-populations/population-of-england-and-wales/latest
[7] Ekosgen (2017). Developing a Scottish STEM Evidence Base - https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2017/10/science-technology-engineering-mathematics-education-training-strategy-scotland/documents/00526538-pdf/00526538-pdf/govscot%3Adocument/00526538.pdf

than 51-52% for all other sectors, but a much more equitable picture than seen in UK physics as indicated by the IOP membership data.

Spotlight on Higher Education (HE)

Information about the demographics of the physics workforce in higher education (HE) is available through HESA Staff Records.[8] The staff record is a database of individualised data on the personal characteristics of staff, the details of their contracts, and the activities undertaken as a result of those contracts. It represents the physics HE workforce in the UK.

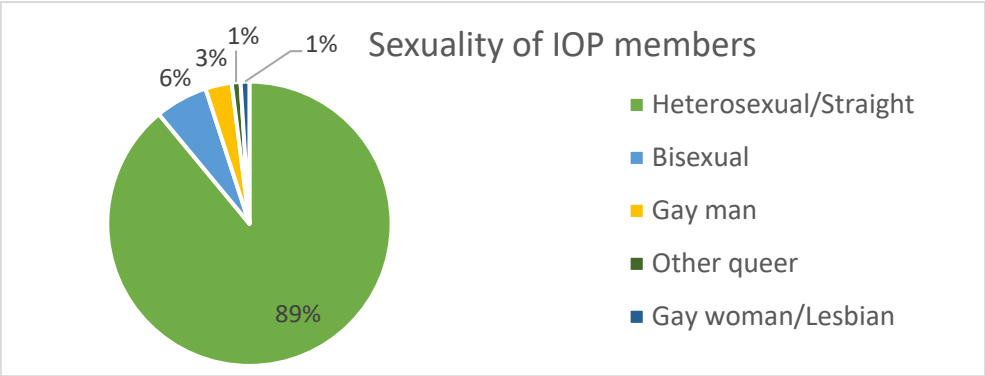
In the academic year 2019/20, 74% of staff in UK HE physics identified as male.[9] This vastly outweighs the proportion of those who identified as female, totalling 26%, and again highlights an underrepresentation of females in the sector. Despite this, the underrepresentation of females in HE is less profound than the physics sector as a whole when compared to the number of IOP UK-based members who are working physicists across sectors; where only 22% of working, UK-based IOP members are female. Please note, this HESA data can be broken down by devolved UK nation, to identify nuances in gender representation in STEM HE across the UK. This level of detail is available upon request.

Gender reassignment

The IOP does not have data on gender reassignment in its membership database, however the IOP collects information on this in its Member Diversity Survey. Data from the 2019 survey found that, out of 97% of the respondents who answered the question, 2% said their gender identity was different from the sex they were assigned at birth. Whilst there isn't an accurate figure for the size of the trans community, the best estimate at the moment is that around 1% of the population might identify as trans, including people who identify as non-binary.[10]

1.2. Sexuality

The IOP's Member Diversity Survey shows that, in 2019, 89% of respondents identified as heterosexual. Collectively, 11% identified as LGBT+, with bisexuality having the largest representation (6%).



Sexuality data from the IOP Member Diversity Survey, 2019. N=1908

[8] HESA Staff Record 2019/20. Copyright Higher Education Statistics Agency Limited. The Staff record is collected in respect of those staff, employed in the UK, who possess one or more contracts of employment with the HEP and/or for whom the HEP is liable to pay Class 1 National Insurance contributions for that individual.

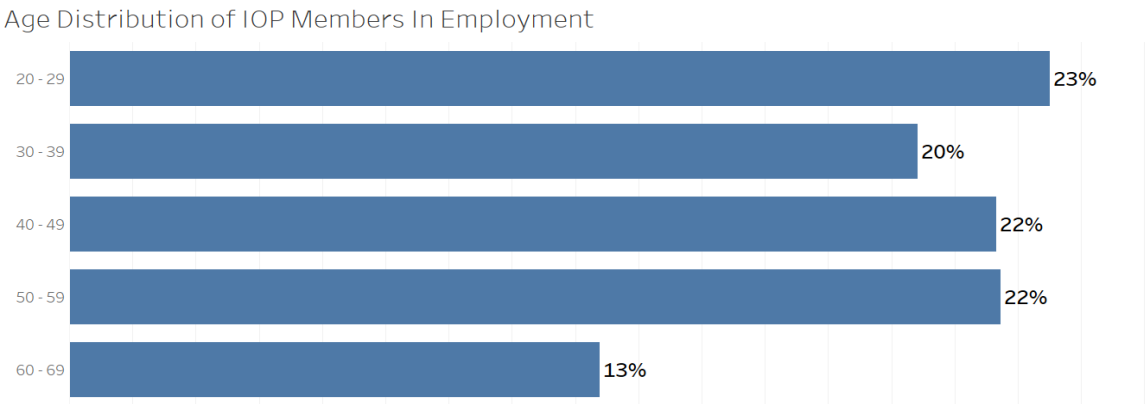
[9] Based on 7,515 staff working in HE physics.

[10] https://www.stonewall.org.uk/truth-about-trans#trans-people-britain

1.3. Age

As mentioned above, age is reported by members when joining the IOP, and this information is stored in the member database. When comparing the number of UK-based members in employment within defined age brackets, it was found that two thirds (64%) are aged between 30-60.

There is an equal distribution of those in the pre-retirement age brackets, suggesting there is good representation across the ages in physics. However, there are risks that those in the early stages of their career are underrepresented due to knowledge or relevance of professional bodies to them.



Age data from IOP membership figures, January 2022. N=13,340.
Data includes working members from the UK only.

Spotlight on Higher Education (HE)

HESA data from 2019/20[11] shows a different story for age representation. In physics, comparative to other non-physics subjects, there is a slight underrepresentation of HE staff over the age of 40, and a greater proportion of staff aged 21-35. Numbers of staff aged 36-40 is equal to other subjects.

The following table represents the ratio of proportions between the age of staff in HE physics and other disciplines. A figure of 1.0 means there is the same proportion between physics and other subjects. Numbers below 1.0 mean under-representation.

	2019/20
Age Group	Representation level in physics compared with all staff, 2019/20
21 to 25 years	1.3
26 to 30 years	1.5
31 to 35 years	1.2
36 to 40 years	1
41 to 45 years	0.9
46 to 50 years	0.8
51 to 55 years	0.8
56 to 60 years	0.9
61 to 65 years	0.8
66 years and over	1

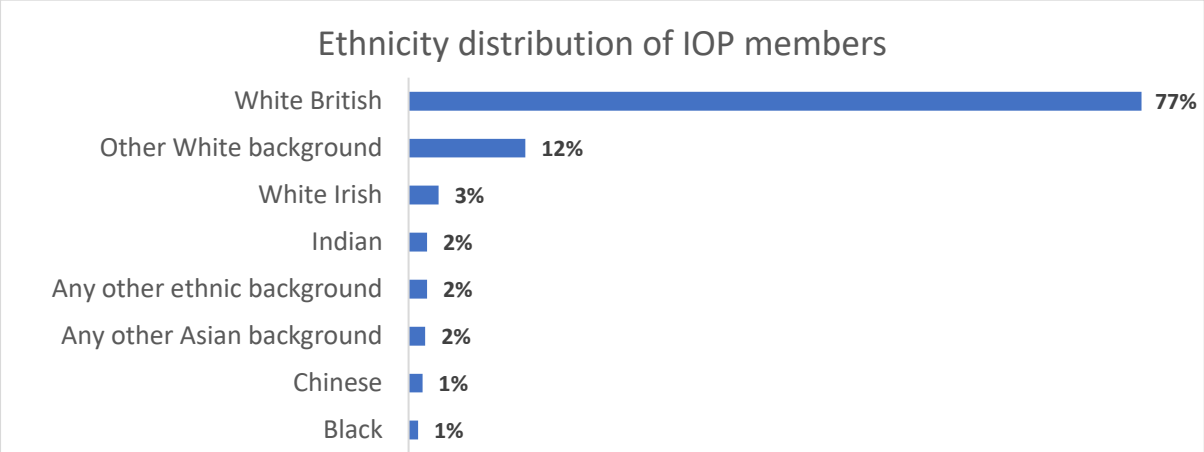
N=1,655 for physics staff, N=224,075 for all non-physics staff.

[11] HESA Staff Record 2019/20. Copyright Higher Education Statistics Agency Limited. The Staff record is collected in respect of those staff, employed in the UK, who possess one or more contracts of employment with the HEP and/or for whom the HEP is liable to pay Class 1 National Insurance contributions for that individual.

Please note, this HESA data can be broken down by devolved UK nation, to identify nuances in age representation in STEM HE across the UK. This level of detail is available upon request.

1.4. Ethnicity

Data from the IOP's 2019 Member Diversity Survey shows that, among respondents who volunteered their ethnicity, 77% were White British, with a further 15% from other White and White Irish backgrounds, leaving just 8% collectively from Indian, Chinese, Black and other Asian and ethnic minority backgrounds.



Ethnicity data from the IOP Member Diversity Survey, 2019. N=2,005.

This issue is seen across sectors and UK nations. The Business in the Community's 2015 Race at Work report showed that black, Asian, and minority ethnic (BAME) [sic] people were underrepresented at every management level in the workplace. One in eight of the working-age population was from a BAME background [sic], yet only one in ten were in the workforce and only one in 16 in top management positions.[12]

The McGregor-Smith review further found that in 2015, whilst 1 in 8 of working age people were from a BME [sic] background, those from this community made up only 10% of the UK workforce and held only 6% of management positions.[13] The employment rate for ethnic minorities was found to be 62.8% - compared with an employment rate for White workers of 75.6%; a gap of over 12 percentage points.

Spotlight on Higher Education (HE)

HESA data[14] reveals that in the academic year 2019/20, 84%[15] of physics staff were of white ethnicity, down from 89%[16] in 2012/13. This is reflective of non-physics disciplines, where 85%[17] of staff reported as white in 2019/20, compared to 89%[18] in other subject in 2012/13.

[12] BITC (2015) https://www.bitc.org.uk/report/race-at-work-2015/
[13] Race in the Workplace: The McGregor-Smith Review (2017) https://www.gov.uk/government/publications/race-in-the-workplace-the-mcgregor-smith-review
[14] HESA Staff Record 2019/20. Copyright Higher Education Statistics Agency Limited. The Staff record is collected in respect of those staff, employed in the UK, who possess one or more contracts of employment with the HEP and/or for whom the HEP is liable to pay Class 1 National Insurance contributions for that individual.
[15] Based on 1,540 staff working in HE physics where ethnicity is known.
[16] Based on 1,190 staff working in HE physics where ethnicity is known.
[17] Based on 215,375 staff working in non-physics HE where ethnicity is known.
[18] Based on 209,265 staff working in non-physics HE where ethnicity is known.

Individuals from other ethnicities are represented in much smaller proportions. In 2019/20:

- 4% of the HE physics workforce reported their ethnicity to be Chinese.
- 4% reported their ethnicity to be Asian or Asian British – Indian.
- 2% reported their ethnicity as Other Asian Background.
- Just 1% reported their ethnicity as Black.
- 5% reported their ethnicity as Mixed or Other.

Table of Higher Education Staff by ethnicity

		2012/13			2019/20		
Ethnicity		**Physics**	All other Academic Disciplines	All Higher Education Staff	**Physics**	All other Academic Disciplines	All Higher Education Staff
White	White	**89%**	89%	89%	**84%**	85%	85%
Asian	Asian or Asian British – Pakistani	**1%**	1%	1%	**0%**	1%	1%
	Asian or Asian British – Bangladeshi	**0%**	0%	0%	**0%**	0%	0%
	Other Asian background	**2%**	1%	1%	**2%**	2%	2%
	Asian or Asian British – Indian	**3%**	2%	2%	**4%**	3%	3%
	Chinese	**3%**	2%	2%	**4%**	3%	3%
	All Asian	**8%**	7%	7%	**10%**	9%	9%
Black	Black or Black British – African	**0%**	1%	1%	**0%**	2%	2%
	Black or Black British – Caribbean	**0%**	1%	1%	**0%**	1%	1%
	Other Black background	**0%**	0%	0%	**0%**	0%	0%
	All Black	**1%**	2%	2%	**1%**	3%	3%
Mixed	Mixed	**2%**	1%	1%	**3%**	2%	2%
Other	Other	**1%**	1%	1%	**2%**	2%	2%

Proportion, rounded to the nearest one per cent. 2012/13 – N=210,445 for all staff. 2019/20 – N=219,915 for all staff.

The following table represents the ratio of proportions between the ethnicity of staff in HE physics and other disciplines. A figure of 1.0 means there is the same proportion between physics and other subjects. Numbers below 1.0 mean under-representation.

Table of Higher Education Staff by Ethnicity: Relative Representation in Physics

	Representation level in physics compared with all staff, 2019/20
White	1.0
Asian or Asian British – Pakistani	0.5
Asian or Asian British – Bangladeshi	0.4
Other Asian background	1.1
Asian or Asian British – Indian	1.3
Chinese	1.6
All Asian	1.2
Black or Black British – African	0.3
Black or Black British – Caribbean	0.4
Other Black background	0.2
All Black	0.3
Mixed	1.1
Other	1.0

Please note, this HESA data can be broken down by devolved UK nation, to identify nuances in ethnicity representation in STEM HE across the UK. This level of detail is available upon request.

The proportional comparison shows that staff from Pakistani and Bangladeshi backgrounds are poorly represented in physics. The proportions of physics staff from Pakistani and Bangladeshi backgrounds are each half of the equivalent proportions across all disciplines. Similarly, black staff are extremely underrepresented. The proportion of staff in physics who are black is particularly low compared to other disciplines.

The same proportion of physics staff are white compared with the average academic staff population in other subjects. Mixed, Indian, and other Asian staff are somewhat better represented in physics than in other disciplines, and Chinese is substantially better represented.

In the 2011 census, the proportion of the England and Wales population classified as white was 86%.[19] People from Asian ethnic groups made up the second largest percentage of the population, at 7.5%, followed by Black ethnic groups, at 3.3%. Comparing the figures in physics to the UK population shows that there is an underrepresentation of BAME staff in HE physics, particularly among Black or Black British, African or Caribbean, who collectively represent 1% just of the total staff.

19 2011 Census, HMG.- https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/national-and-regional-populations/population-of-england-and-wales/latest

1.5. Disability

The IOP's 2019 Member Diversity Survey found that:

- 9% of respondents reported a disability, of whom 26% had a longstanding illness or health condition.
- 25% had a mental health condition such as depression, schizophrenia, or anxiety disorder.
- 19% had a physical impairment or mobility issues.
- 17% had a social / communication impairment such as Asperger's syndrome or another autistic spectrum disorder.

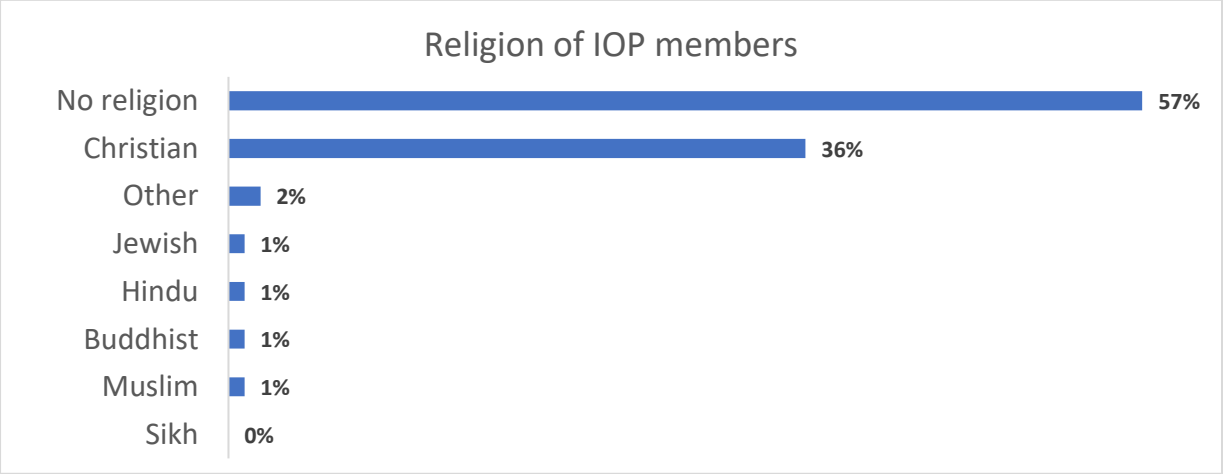
In 2017–18, 13% of physics undergraduates in the UK had a known disability. This is below the percentage for all working age adults (19%).[20] In the UK in 2019, 14.1 million people reported that they had a disability. This is around 21% of the population.[21]

Compared to the 2011 and 2015 surveys, mental health conditions remained one of the highest reported conditions in 2019 and increased in prevalence, with 25% of respondents reporting a mental health disability, compared to 17.2% in 2011 and 18.3% in 2015. Additionally, in 2019, of those who reported having a disability, 26% reported having a longstanding health condition.

1.6. Religion or belief

The IOP's Member Diversity Survey shows that, in 2019, among IOP members who responded to the survey, 57% who responded to our question on belief had no religion.

The religion with the largest representation was Christianity, with 36% identifying as Christians. This was also the most prevalent religion in the previous two surveys: 35% in 2011 and 29% in 2015. All other religions collectively represented 7% of the surveyed members.



Religion data from the IOP Member Diversity Survey, 2019. N=1,954.

[20] Higher Education Statistics Agency (2018), Students in UK Physics Departments Report. Available at: www.iop.org/sites/ default/files/2020-07/Student-characteristics-2017-18.pdf

[21] https://www.gov.uk/government/statistics/family-resources-survey-financial-year-2019-to-2020/family-resources-survey-financial-year-2019-to-2020

1.7. Socio-economic background

Although socio-economic background is not currently a protected characteristic under the Equality Act 2010, the IOP collects this data every four years in its anonymous Member Diversity Survey, as it is an important metric. It can be difficult to accurately measure an individual's socio-economic background accurately, and a variety of proxy measures are frequently used. For the 2015 and 2019 surveys, the IOP used highest parental qualification as a proxy for the socio-economic background of respondents, in line with recommendations to use this metric.

In 2015, 11% of respondents reported that their parents held no qualifications and 53% had a first degree or higher, compared to 2019 where 7% of respondents' parents held no qualifications and 55% had a first degree or higher. For many, particularly older respondents, their parents' qualifications were not known to them. Although not directly comparable with the data we collected in the survey, the ONS 2011 UK census reported that 27% of the UK population aged 16 and over had achieved a Level 4 or above qualification such as a degree or other higher qualification or equivalent, a figure significantly lower than the one reported by IOP survey respondents. In the ONS data, 23% held no qualifications.

2. What are the reasons why these groups are underrepresented?

Underrepresentation in physics is both a social/ethical and economic injustice, however the evidence shows significant underrepresentation exists in the sector. EDI is therefore at the heart of the IOP's strategy, and our activities have identified the main causes of underrepresentation in physics among these groups. These include: barriers to studying the subject, which in turn reduce the numbers of people from underrepresented groups progressing into the workforce; and a lower attraction and retention rate among underrepresented groups in the workforce.

2.1. Low numbers of people from underrepresented group studying physics and STEM and progressing into the workforce

A) Social norms and misconceptions

Research by the IOP for the Limit Less campaign[22] has found that some young people are put off by misconceived ideas about what physics is. Others are denied the opportunity to study physics due to the prejudice and stereotypes that they experience because of who they are. Many girls are told that physics is more suited to boys, and both girls and boys are told that physics is not for the likes of them if they are of a particular ethnicity, socio-economic background, sexual orientation, or have a disability.

As a result, too many young people are made to feel that they can't do physics, or they just don't fit in. Experiences include:

"My dad told me not to study physics because it wasn't for women and the maths was too hard"

"A Black girl studying and being good at physics wasn't the stereotype my teachers were used to. I'm very sure the bias they had towards me was unconscious"

"My A-level teacher told me that girls didn't tend to be very good at physics, so I might struggle at uni. He said there was only one girl on his undergraduate course and that she wasn't very good."

[22] https://www.iop.org/strategy/limit-less

"I was recommended not to take physics and mathematics, despite these being my best subjects. My impression was that the intention was to discourage me from being overambitious since someone from my social class should not be expected to aim too high in life"

"I was told by my family that I wasn't going to be good at maths, because none of them were. And I should study English or history or take up a trade. When I tried to take a physics course, they refused to sign off on it, as they "weren't going to sign on a course I'd obviously fail out of".

"I was told by a close female family member that physics was boring and a waste of time."

Parents participating in a focus group said:

Physics is *"For individuals who lack social skills ... a bit geeky … for duller people"*

These social misunderstandings about who could, and should, study physics create barriers for young people who have the potential to engage with, and succeed in, the subject.

B) Being unsure of the opportunities physics and STEM provide

The Limit Less campaign further shows that many young people and their parents do not understand the potential career routes that physics could open. This poor understanding of future pathways and possibilities is a barrier to some young people who instead select a route they see as more secure or directed towards a specific career.

"I'm just not sure where you would go with physics... You'd need some sort of fallback, as options will be limited."

"When I had decided to study physics in college, my mother would repeatedly ask me 'if I was sure'. Neighbours and acquaintances (adults) would always say 'physics - what will you get out of that?' or 'physics? so you want to be a teacher'. Several people even told me that physics was a very 'cold' subject."

"I was told… that if I didn't want to be an engineer there was no point."

Students who are told these misconceptions can be influenced away from the subject and are missing out on the many benefits that studying physics brings, such as a career in a broad-reaching, innovative and well-compensated sector[23] that supports the UK's economy and contributes knowledge and technology to critical sub-sectors and issues such as national and global challenges.

As young people from underrepresented groups are being influenced away from the subject by those they trust and what they see in the media, numbers in these groups remains low post-16 (at level 3 or beyond). This is highlighted by the breakdown of student demographics that follows.

Gender

In 2020:

- In England, just 2.6% of girls chose to study A-level physics, compared to 8.6% of boys.[24]
- In Scotland, just 27.5% of girls chose to study Higher Physics, compared to 72.5% of boys.[25]

[23] Data from the 2021 Physics and the Economy project shows that on average in the UK, employees in the physics sector receive £41,000 in compensation (pay), a salary higher than those in the Transport and Storage (c. £36,000), Construction (£29,000) and Retail (£20,000) sectors.
[24] Joint Council for Qualifications
[25] Scottish Qualifications Authority

- In Wales, just 2% of girls chose to study A-level physics, compared to 9% of boys.[26]
- In Northern Ireland, just 1% of girls chose to study A-level physics, compared to 2.6% of boys.[27]

Ethnicity

- In England in 2019, just 0.3% of physics students aged 16-19 were Black Caribbean. 0.5% were Mixed White/Black Caribbean. 0.6% were black other.[28]

Social background

- In England in 2019, just 2.7% of students studying physics were from the most deprived socio-economic background (using the Income Deprivation Affecting Children Index as an indicator of socio-economic background).[29]

Disability

- In 2017–18, 13% of physics undergraduates in the UK had a known disability. This is below the percentage for all working age adults (19%).[30]

To improve the number of young people choosing to study physics post-16, and into the STEM workforce in years to come, young people and their families need to know the positive benefits of continuing with physics, either through study or an apprenticeship or technical role. They need to know that studying physics doesn't narrow career opportunities but opens doors to jobs in many sectors, such as research, medicine, energy, manufacturing and aerospace. More also needs to be done to increase young people's knowledge of the contribution that physics makes to our society and the opportunities it gives young people to change their world.

To achieve this, the IOP's Limit Less campaign recommends the following:

- A whole-school approach to ensure that no young people are deterred from studying physics. All educators must ensure that young people are encouraged to study physics no matter who they are or what their background.
- Physics teachers must use teaching techniques and resources to make their lessons as inclusive as possible. Physics lessons should show young people a contemporary view of physics that includes examples of physicists from underrepresented groups.
- Careers advisers must challenge their own preconceptions and ensure that young people and their parents and carers receive accurate information about the opportunities that studying physics provides. For young people and their families in underrepresented groups, careers advisers must also actively dispel misconceptions about who can do physics that currently discourage them from considering studying physics from age 16.

Among the recommendations in the campaign, the IOP has set out the following four points which need addressing by the UK Government and devolved governments.

[26] StatsWales
[27] Joint Council for Qualifications
[28] All state schools in England, 2019. Source: Improving Gender Balance and Drayson Foundation Pilot Project Evaluation Report. Note – this data it not available for the other devolved nations.
[29] All state schools in England, 2019. Source: Improving Gender Balance and Drayson Foundation Pilot Project Evaluation Report Note – this data it not available for the other devolved nations.
[30] Higher Education Statistics Agency (2018), Students in UK Physics Departments Report. Available at: www.iop.org/sites/ default/files/2020-07/Student-characteristics-2017-18.pdf

1. Revise teachers' standards to set out an expectation that teachers will address injustice in their professional practice and actively dismantle sexism, racism, homophobia, ableism and classism in their own work and their schools'.
2. Ensure that all teachers are trained in inclusive teaching and tackling injustice so that they can achieve these robust standards. This should be in both their initial teacher education and their continuing professional development.
3. Instruct those responsible for school inspections to place greater emphasis on the importance of inclusive teaching and schools' efforts to address injustice.
4. Mandate nurseries and schools to develop whole-school equity action plans that:
    a. are informed by ongoing data and evidence collection including students' choices.
    b. promote equity and equality for young people in underrepresented groups.

See the Limit Less report for the full recommendations.

2.2. Retention: workplace culture, gross misconduct, bullying and harassment

A) Lower numbers being attracted into the workforce

Evidence has been provided to illustrate the significant underrepresentation of women, people from disadvantaged backgrounds, disabled people, those who identify as LGBT+, and minority ethnic groups in physics, as detailed in section one of this response. Individuals from these groups may be less willing to go into a workplace where they are the only person of their demographic or with their background, or where they may be overlooked or not treated fairly or equally.

In their review of Race in the workplace, McGregor-Smith's Roadmap to success recommended greater data collection on representation, transparency of decision making within organisations, target setting, and for an examination of recruitment processes.[31] These positive steps could improve workplace culture and outcomes for all underrepresented groups.

More needs to be done to lift the visibility of underrepresented individuals in STEM, to create role models and encourage others into these positions. The Blackett Lab Family[32] from Imperial College London have started a project documenting and celebrating some of the contributions Imperial's black physicists have made to science, in an effort to raise the visibility and demonstrate representation for prospective and current graduates.

B) Workplace misconduct and being undervalued, leading to a lower retention rate

When individuals from underrepresented groups progress into the workplace, they face a greater chance of leaving the profession and/or sector, possibly due to workplace culture, gross misconduct, and/or bullying and harassment, or due to being overlooked and undervalued at work. Data is not available on retention, as individuals cannot be surveyed once they leave the sector, and exit interviews are anonymous. However, the following evidence on workplace culture is indicative of this issue.

Data from the 'Power in the Academy'[33] report shows that 41% of respondents to the HE staff survey had experienced at least one instance of sexualised behaviour from staff, with a further 5% aware of

[31] Race in the Workplace: The McGregor-Smith Review (2017) https://www.gov.uk/government/publications/race-in-the-workplace-the-mcgregor-smith-review
[32] https://theblackettlabfamily.com/
[33] https://1752group.com/power-in-the-academy-report/

someone they know experiencing this.[34] UKRI initiated an evidence review[35] in the research landscape, which could be used as a framework across the sector.

Looking at the physics sector, in our 2019 Member Diversity Survey[36] the IOP gathered information from our members on their working or studying environment as part of our commitment to developing and promoting professional conduct and behaviours across our membership and the wider community. When asked about awareness of discriminative actions, 17% of respondents reported observing or being made aware of discriminative actions towards others over the last two years, and 19% over the last five years. Around a third of the respondents who had observed discrimination mentioned gender issues in their response. These included mentions of harassment, bullying, assault, and exclusion based on perceived gender difference, primarily towards women.

In the two years before the survey, 9% of respondents reported personally experiencing discriminative actions, rising to 11% over the preceding five years. Half of those who reported experiencing discriminatory behaviour in the preceding two years were female (50%), making up 18% of the total female respondents to the survey. Additionally, 50% of transgender respondents reported having experienced discrimination.

Bullying was the prevalent behaviour reported by respondents. It was felt that managers did not know enough about how to handle situations, how to report, monitor or reprimand such behaviours, and placed too much of the burden for resolving the situation on the victim. Much of the bullying mentioned and observed was caused by those in senior roles, directed at more junior colleagues. Causes for this included gender, sexuality and ethnicity.

The types of actions which generated an environment of bullying or harassment for our respondents included:

- Aggressive or abusive emails
- Discriminatory statements on social media or personal blog posts
- Shouting and raised voices
- Other types of verbal assault, including derogatory remarks, slurs, and ill-placed humour
- Physical or sexual assault
- Overlooking individuals, accidentally blocking access to opportunities or not listening to their needs
- Deliberately withholding access to relevant information
- Plagiarism
- Exclusion through lack of access for events and conferences, including lack of safe spaces, poor timings, or physical access issues.

While gender-discrimination dominated the comments, racism, homophobia, transphobia, ableism, and ageism were all reported, as well as discrimination against those with different beliefs, often in conjunction with one another.

Similarly, the Business in the Community's 2015 Race at Work report, reviewing the experiences of more than 24,450 workers sectors in the UK, found that racial harassment and bullying within the workplace is prevalent. 30% of employees who had witnessed or experienced racial harassment or bullying from managers, colleagues, customers or suppliers, reported it had occurred in the past year.[37]

[34] https://1752group.files.wordpress.com/2021/09/4f9f6-nus_staff-student_misconduct_report.pdf
[35] https://www.ukri.org/wp-content/uploads/2020/10/UKRI-020920-BullyingAndHarassmentEvidenceReview.pdf
[36] IOP (2020). We are physicists: Results of the IOP member diversity survey 2019.
[37] BITC (2015) https://www.bitc.org.uk/report/race-at-work-2015/

Looking at biases in how staff are valued, the results indicating staff from underrepresented groups are overlooked is supported by evidence across sectors and UK nations. The Business in the Community's 2015 Race at Work report found that people from a BAME [sic] background were less likely to be rated as top performers compared to their white counterparts. Additionally, the McGregor-Smith review found that BME [sic] groups are more likely to be overqualified than White ethnic groups, but White employees are more likely to be promoted than all other groups.[38] Addressing workplace culture to remove biases, improving transparency and creating targets could work to remove existing double standards.

Recruitment and retention issues and their link to professional misconduct and workplace culture has been gaining increasing attention in recent years, with numerous reports citing concerning and unacceptable figures of staff experiences. Work should be done to develop actionable recommendations for change, to improve cultures and experiences and ultimately increase numbers coming into, and staying, in STEM. An example of this has been completed in Wales. The recent Race Equality Plan incorporates recommendations for retention, including:[39]

- Improving recruitment methods to improve representation.
- Mentoring and sponsorship programmes for underrepresented groups to create support networks and role models.
- Increasing participation through apprenticeships, paid work experience and skills development.
- Challenging workplace prejudice and workplace cultures to address biases.
- Securing leadership-level buy-in to create impactful change.

3. The implications of these groups being underrepresented in STEM

The implications of underrepresentation in STEM are wide-ranging, but often under-measured. They fall within two categories; ethical/social, impacts which unfairly detriment individuals who are excluded from the sector, and economic.

Ethical impact

As detailed in response to section two, barriers to studying and working in STEM mean that people from underrepresented groups are denied the opportunity to work in the exciting and rewarding STEM sector. It is a matter of simple fairness and social justice that everyone should have the opportunity to thrive in the physics community. These individuals are missing out on the many benefits that studying and working in physics brings, such as a career in innovative sectors which support the UK's economy and contribute knowledge and technologies to critical sub-sectors and national and global challenges.

Many people, including young people, are well aware of the unprecedented challenges facing the world today and the impact these will have on their future. In response to climate change, poverty and pollution, many are taking actions themselves to make a positive difference. Their drive to

[38] Race in the Workplace: The McGregor-Smith Review (2017) https://www.gov.uk/government/publications/race-in-the-workplace-the-mcgregor-smith-review
[38] https://theblackettlabfamily.com/
[39] Improving Race Equality in Employment and Income (2021) https://www.wcpp.org.uk/wp-content/uploads/2021/03/Improving-Race-Equality-in-Employment-and-Income.pdf

change the world and improve their future should be supported, and they must not face barriers to entering the STEM sector.

Economic impacts

Alongside the ethical injustice, underrepresentation creates economic impacts which damage and limit economic prosperity of individuals, communities and the wider UK.

A) Improved performance of industry creating improved economic returns:

Economically, evidence indicates that diversity in teams and leadership improves outcomes and performance.

- Research by the Financial Conduct Authority (FCA) found that D&I in the workplace leads to "more positive outcomes for business performance".[40] The report found the following:
    - Inclusion is not well measured, but there are signs it correlates positively with business performance outcomes.
    - Diverse teams can have differences of opinion but are more innovative and better at solving problems creatively.
    - Gender-diverse senior leadership is associated with positive business performance outcomes, especially when there is a 'critical mass' of women.
    - Gender-diverse senior leadership appears to lead to positive risk management outcomes.
    - Gender-diverse senior leadership is most strongly correlated with positive corporate governance and firm conduct outcomes.
- McKinsey and Company completed a three-part series on the business case for diversity and inclusion, finding that there is a positive correlation between diversity and business performance.[41] They found that companies in the top quartile for racial and ethnic diversity are 35% more likely to have financial returns above their respective national industry medians.
- The 2017 McGregor-Smith review of Race in the Workforce found the potential benefit to the UK economy from full representation of BME individuals across the labour market through improved participation and progression is estimated to be £24 billion a year, which represents 1.3% of GDP.[42]

The IOP's Case for EDI[43] displays the evidence that diverse organisations and teams have been shown to outperform those that are not, in innovation, problem solving and business success. These insights suggest that boosting representation, and in turn improving diversity of thought within physics, would improve outcomes, increasing both the positive impact the sector has on society and in turn, lifting performance for business and industry through improved turnover, productivity and economic performance generally.

However, diversity in physics is currently narrower than it both could and should be. Improving diversity of thought and increasing numbers within the STEM sector as those who were

[40] FCA Research on the impact of diversity in the workplace (2021) https://www.fca.org.uk/publication/research/review-research-literature-evidence-impact-diversity-inclusion-workplace.pdf

[41] https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-wins-how-inclusion-matters

[42] Race in the Workplace: The McGregor-Smith Review (2017) https://www.gov.uk/government/publications/race-in-the-workplace-the-mcgregor-smith-review

[43] https://www.iop.org/sites/default/files/2021-11/IOP-Case-for-EDI-English.pdf

disenfranchised seek STEM employment will moreover lift the output and capability of STEM. There is a considerable opportunity to enhance physics' already significant economic contribution to the UK, which today stands at £2.72 billion in GVA contribution, 11% of total UK GDP,[44] and to support the Government's ambitions to make the UK a scientific superpower.

B) Improving outcomes for individuals, communities and regions, social mobility and levelling up

Moreover, improving representation creates significant benefits for underrepresented individuals. Physics is well-compensated sector: data from the 2021 Physics and the Economy project shows that on average in the UK, employees in the physics sector receive £41,000 in compensation (pay), a salary higher than those in the Transport and Storage (c. £36,000), Construction (£29,000) and Retail (£20,000) sectors.

Improved employee compensation will create spill over economic impacts at both personal and community levels. The economic return to underrepresented groups will improve individual and community-wide socio-economic mobility, as well as regional levelling up.

In 2022, the IOP is commissioning a project to investigate these economic benefits, to establish the financial benefits directly to business. The insights of this research can be shared with the committee once complete.

4. What has been done to address underrepresentation of particular groups in STEM roles?

4.1. Interventions from the IOP

Leadership – placing EDI at the heart of culture

'Diversity and skills' is a core pillar in the IOP strategy, Unlocking the Future[45], and the IOP maintains a number of different initiatives to promote inclusive behaviours. As part of the IOP's strategy 2020-2024, we have worked on defining our organisational values – to be objective, open, inclusive and exemplary – which are important in shaping the culture of our organisation, and how we work with other STEM organisations.

The IOP has been a leader in EDI for the last decade, engaging with key representatives in its membership and it has seen impact. We have made progress through our Diversity and Inclusion Committee which is populated by members with an interest in, and expertise across the broad range of diversity characteristics and issues. This committee gives space for members to raise concerns around bullying and harassment within the physics community and academic institutions. The committee worked in partnership with the IOP Project Juno team to incorporate addressing professional misconduct into its framework, leading to the creation of principle 6; Professional Conduct, Harassment and Bullying.[46]

We participate in an Inclusive Leadership Working Group that brings the Engineering and Physical Sciences Research Council (EPSRC), IOP and the Royal Society of Chemistry (RSC) together to discuss EDI initiatives, particularly focusing on research funding, leadership training and EDI funding in STEM.

[44] Physics and the Economy report (2021) https://cebr.com/wp-content/uploads/2021/11/Physics-and-the-Economy-UK.pdf
[45] Unlocking the Future, the IOP Strategy: https://www.iop.org/about/strategy#gref
[46] https://www.iop.org/about/IOP-diversity-inclusion/Project-Juno/Juno-principles#gref

We also hosted a workshop with European member societies, funded by the European Physical Society (EPS), on creating and developing a code of conduct[47]. The workshop was attended by 23 delegates from across 19 countries, with a number of presentations from across the sector, including UKRI, C.E.R.N and example templates from physical societies. A follow-up meeting will occur in June 2022, to review progress and action plans and continue momentum for addressing professional conduct in STEM across Europe.

Publishing

As a learned society, we publish EDI journal articles that discuss STEM in the workplace that demonstrate us to be a peer reviewed educator in the field.

We first published a report on D&I in peer review[48] in 2018, where we looked at the spread of our authors', reviewers' and board members' gender and geography since 2014. This showed underrepresentation of women, especially in peer review, as well as underrepresentation from some countries, most notably China and India. Since then, we have been actively working to tackle these issues and ensure our journals are more reflective of the communities they serve.

As a result of this, five of our journals now offer authors the option of single or double-blind review,[49] with uptake for double-blind currently sitting between 10-20% depending on sub-discipline. We are now actively looking to flip several of our journals to exclusively double-blind. Additionally, three of our journals now offer transparent peer review, whereby the peer review reports are published alongside the article.

We have updated our authors' guidelines and now encourage authors to use gender-neutral language in their submissions. Our reviewer guidelines now include information on how to combat implicit bias, and since 2018 publishing staff attend compulsory unconscious-bias training. A new code of conduct has been introduced for board members, which sets out our expectations relating to inclusivity and respect for all, which aligns with our ethical policy[50] that now includes a section on respect for others. Most recently we have signed a joint statement with other publishers initiated by the RSC, which commits us all to setting a new standard for diversity and inclusion within publishing[51].

Project Juno and the Athena Forum

The IOP has been running Project Juno[52] since 2008. Project Juno works to boost the diversity of the physics workforce by recognising employers for their diverse and inclusive staff force and efforts towards gender equality. Our Juno scheme has six principles[53] for applicants to measure themselves against and asks for them to provide both qualitative and quantitative data to show evidence of progress.

We currently have 53 institutions/departments engaged in the Juno scheme out of 62 in total in the UK. From an evaluation of Juno undertaken in 2013,[54] over the first five years of operation, we saw increased awareness from staff and senior management surrounding the issues regarding women in

[47] https://www.iop.org/about/international/working-to-improve-inclusivity-europe
[48] http://ioppublishing.org/wp-content/uploads/2018/09/J-VAR-BK-0818-PRW-report-final.pdf
[49] https://publishingsupport.iopscience.iop.org/questions/peer-review-models-on-iop-journals/
[50] https://publishingsupport.iopscience.iop.org/ethical-policy-journals/
[51] https://ioppublishing.org/news/iop-publishing-joins-forces-with-other-publishers-to-make-research-publishing-more-inclusive-and-diverse/
[52] https://www.iop.org/about/IOP-diversity-inclusion/project-juno
[53] Principle 1: Organisational Framework, Principle 2: Appointment and Selection, Principle 3: Career Progression and Promotion, Principle 4: Working Culture and Workload Allocation, Principle 5: Flexible Working, and Principle 6: Professional Conduct, Harassment and Bullying.
[54] IOP (2013). Evaluation of Project Juno: Summary of Final Report. https://www.iop.org/sites/default/files/2020-07/Juno-evaluation-summary_0.pdf

STEM, discussion of gender issues within departments, and visibility of female staff. We are pleased to report that the proportion of female physics professors increased from 6% in 2008 to 12% in 2018,[55] although we are frustrated with the slow pace of progress.

In 2022 we will be reviewing Project Juno to broaden the scope beyond gender to consider all protected characteristics, in order to improve diversity and inclusion across all underrepresented groups and improve retention in the physics ecosystem.

We are also a member of Athena Forum,[56] that has recently merged with STEMM-DAC (Disability committee for STEM), which is a forum where representatives from the UK's leading scientific professional and learned societies, with an Independent Chair and Deputy Chair, work on common issues regarding EDI in STEM.

Promoting the STEM LGBT+ workforce

The IOP, Royal Astronomical Society (RAS) and the Royal Society of Chemistry (RSC) worked together to create a network of support for members of the physical sciences community who identify as LGBT+ and their allies, and conducted a survey of members to explore the workplace culture for LGBT+ physical scientists. The resulting report[57] notes the number of LGBT+ workers leaving the physical sciences and advocates for improved retention.

The survey showed that 28% of LGBT+ respondents had at some point considered leaving their workplace because of the climate or discrimination towards LGBT+ people. It found that cisgender men (males whose gender identify matches that which they were assigned at birth) felt more comfortable in the workplace than cisgender women or transgender respondents.

Respondents from both academia and industry stated that working with people from cultures that are less accepting of LGBT+ people brings particular issues. In some cases, these are colleagues and students within the individual's workplace, in others, clients outside of their company or institution. This resulted in a range of impacts – for some, being open about their LGBT+ status causes small discomfort, while others risk losing clients and work, that could have significant consequences for the rest of their career. Such consequences are not limited to industry. An academic described his work teaching in China as putting him 'in limbo', because while being gay wasn't illegal there, it was still considered shocking. Being 'out' with colleagues would have created negative perceptions of his work.

The report had three main recommendations for an improved culture for LGBT+ STEM staff:

- Building a visible and welcoming community: Support for LGBT+ staff needs to be visible and not just in place on paper. Senior leaders and managers should proactively act as champions and advocates by speaking out about LGBT+ issues.
- Reviewing and improving policies: All workplace policies and provision should be audited to ensure that LGBT+ staff are specifically protected. Policies addressing poor or difficult behaviour should be implemented to address discrimination and harassment of every kind, from the use of homophobic language in jest to the exclusion of subgroups from LGBT+ networks.
- Introducing and improving training: Training that supports LGBT+ staff could be used more effectively in nearly all work environments, including training on transgender inclusion and correct pronoun usage, and bystander training. LGBT+ staff groups should be consulted in

[55] IOP (2020). Academic staff in UK physics departments. https://www.iop.org/sites/default/files/2020-07/Staff-characteristics-2017-18.pdf

[56] https://www.athenaforum.org.uk/

[57] IOP, RAS and RSC (2019). Exploring the workplace for LGBT+ physical scientists. https://d25f0oghafsja7.cloudfront.net/sites/default/files/2019-06/exploring-the-workplace-for-lgbtplus-physical-scientists_1.pdf

the development of training and be given the opportunity to participate in its delivery, to ensure relevance and increase visibility of LGBT+ staff.

The IOP itself is working towards implementing these recommendations:

- It has gender neutral toilets in the building.
- Staff are encouraged to include pronouns in their signatures and have pronoun stickers at conferences, meetings and events.
- We have pride-flag lanyards, badges and pronoun pins, and have supported Pride events at our London office and also across the regions, partnering and funding local campaigns and charities that support LGBT+ inclusion.
- We are reviewing our policies to ensure LGBT+ inclusion and commencing EDI training in 2022 with all staff.

Disability

Our inclusive learning report, 'Building momentum towards inclusive teaching and learning'[58], published in 2017, forms a guide and support manual for the community and universities' physics departments to implement good practice to support those with a disability. We share this with our members and departments in our Juno award schemes.

Bullying and harassment

The results of our 2019 member diversity survey[59] revealed concerning statistics on workplace cultures across the physics sector (see response to question 2, 2.1. Retention: workplace culture, gross misconduct, bullying and harassment for the findings). We've taken steps to improve this through the following actions.

- The IOP maintains a code of conduct,[60] which all members and advocates of the IOP must adhere to when representing the IOP, such as at conferences, meetings and events. This code works to protect IOP representatives and their peers by including a broader definition of bullying and harassment. In 2020, the IOP Code of Conduct was revised to include all IOP meetings, conferences and events, and now includes anyone in attendance, both members and non-members. All attendees are asked to sign up to this upon registration of a physical meeting or, more recently, online webinars. All members reaffirm their commitment to the Code through the annual renewal of their membership.
- Addressing bullying and harassment is now embedded in Project Juno principle 6, and we disseminate good practice to our Juno Champions and to run good practice workshops. We regularly discuss these issues at the Heads of University Physics Departments' Forum, carrying out bespoke workshops to engage the community in the difficulties of professional conduct, and discuss how we can work as a community to ensure the respect, safety and progress of our colleagues free from bullying, harassment and discrimination.

Improving fairness in recruitment

Internally, the IOP has recently started undertaking blind shortlisting, known as candidate anonymisation, when recruiting, a recognised best practice to reduce bias. In order to monitor the extent to which the IOP achieves inclusive recruitment, we monitor recruitment data for application, shortlisting and appointments. We ask all applicants to complete an optional diversity monitoring form to review the effectiveness of our processes. We have previously offered staff unconscious bias

[58] https://www.iop.org/sites/default/files/2019-03/building-momentum.pdf

[59] IOP (2020). We are physicists: Results of the IOP member diversity survey 2019.

[60] IOP Code of Conduct: https://www.iop.org/about-code-conduct

training and have encouraged them to watch the 'Making Better Decisions in Groups[61]' Royal Society video. We have ambitions in our own EDI action plan to ensure that those who interview, or are in decision making roles, receive regular and refresher unconscious bias training. We aim for inclusive interview panels that display a variety of experience, gender, and ethnicity balance and other characteristics.

Limit Less campaign

The IOP's Limit Less campaign[62] is a campaign for public good which aims to increase the numbers of people from underrepresented groups studying physics. See more information on the campaign in our response to question 2: 2.2. Low numbers of people from underrepresented group studying physics and STEM and progressing into the workforce.

Spotlight on Wales

The IOP is proud to have delivered an Improving Gender Balance project[63] on behalf of the Welsh Government, and is now rolling-out its successor Whole School Equity and Inclusion project, supporting schools in Wales to identify and address imbalances across a range of protected characteristics.

The IOP is also represented on the Welsh Government's Equality in STEM Board, which advises on equality in STEM-related study and careers. In 2016, the board published a report[64] on the recruitment, retention and promotion of women in STEM. The recommendations were wide-ranging and of relevance to STEM organisations in all sectors.

The board also conducted a baseline evidence and research project for gender equality in STEM, which reported in 2020. The project resulted in a literature review, data review, presentation of stakeholder views and infographic.[65] The IOP draws this data review to the attention of the committee, as it will be of vital use to draw comparisons across the UK.[66]

4.2. Activities in the wider community

Many of the physics organisations and departments that work closely and engage with the IOP maintain well-delivered inclusive policies and undertake activities which promote discussion around EDI and best practice, such as the following examples.

Placing EDI at the heart of decisions and activities

The Engineering and Physical Sciences Research Council (EPSRC) prioritised EDI by creating and resourcing Inclusion Matters[67] in 2018. This programme consisted of 11 projects which aimed to 'accelerate culture change with respect to equality, diversity and inclusion'. The projects are a collaboration between universities working across the UK and businesses and learned societies. They revolve around research, innovation, and embedding activities already in progress more widely, to

[61] https://www.youtube.com/watch?v=ptOhoizsHaw
[62] https://www.iop.org/strategy/limit-less
[63] Institute of Physics. 2021. *What we're doing to address imbalances in physics*. London: Institute of Physics.
[64] Welsh Government. 2016. *Talented Women for a Successful Wales: a report on the education; recruitment; retention and promotion of women in STEM-related study and careers*. Cardiff: Welsh Government.
[65] Welsh Government. 2020. *Baseline evidence and research project for gender equality in STEM*. Cardiff: Welsh Government.
[66] Arad Research. 2020. *Baseline evidence and research project for gender equality in STEM final report: data review*. Cardiff: Welsh Government.
[67] https://epsrc.ukri.org/funding/edi-at-epsrc/inclusion-matters/

promote a more diverse, fair and inclusive engineering and physical sciences community as well as disseminating their findings and embedding good practice more broadly in the community.

This places EDI at the core of EPSRC's aims. As well as being uniquely dedicated to increasing EDI, the programme engages STEM workers across sectors, from academia to industry, boosting the potential for its impact to go beyond one sector.

APPG on D&I in STEM

The APPG on D&I in STEM launched an inquiry across 2021 on Equity in the STEM workforce. The APPG reviewed underrepresentation in the sector and the data gap affecting the ability to measure this. It explored the impact of COVID on STEM equity. For the findings and recommendations for improvement in STEM, see the full report.[68] The IOP submitted evidence[69] to this, and participated in the follow up roundtables to discuss evidence and solutions for the sector.

Science Council and Royal Academy of Engineering Progression Framework

The Science Council and the Royal Academy of Engineering maintain and promote a framework, called the Progression Framework,[70] to help professional bodies assess and monitor their progress on diversity and inclusion.

Professional bodies play an important role in supporting scientists and engineers throughout their careers, recognising and upholding their professional standards as well as providing continuous professional development. The framework builds on the Engineering Diversity Concordat and the Science Council Declaration on Diversity, Equality and Inclusion, and centres on identifying diversity and inclusion practice in relation to eight functions common to professional bodies. It gives professional bodies the opportunity to assess each of these functions against a four-level maturing model. The aim is to support discussion, initiation, planning and assessment of diversity and inclusion work.

Gender Inclusive Careers Guidance

As part of the Department for Education-funded Improving Gender Balance (IGB) project, the IOP education team developed support and guidance for those in secondary education who lead on Careers Education, Advice, Information and Guidance. IGB is a randomised control trial working in over 75 schools in England (with a further 70-plus in the control group). It scales up a whole-school approach to challenging bias and societal norms in school structures, curricula, attitudes and resources to create an environment where fewer subject choices are made on gender stereotypical lines.

The guidance works with the Gatsby Benchmarks, the 2018 statutory guidance for schools to deliver careers education, and highlights where gender expectations can creep into careers guidance and suggests ways to reduce these inequalities.

The IOP had input from the Gatsby Foundation, the Careers and Enterprise Company, and the Northeast Local Enterprise Partnership to complete the guide.

EDI events

Events which bring together STEM communities and sectors to discuss EDI issues can be effective in boosting awareness of best practice in EDI. By way of example, the IOP attended an international

[68] https://www.britishscienceassociation.org/appg
[69] https://www.iop.org/sites/default/files/2021-02/IOP-Final-Submission-to-the-APPG-DandI-in-STEM-Consultation.pdf
[70] https://sciencecouncil.org/professional-bodies/diversity-equality-and-inclusion/diversity-framework/

conference to share good-practice internationally on gender programmes, on which AIP published a conference report.[71]

For example, in Scotland, the IOP, Photonics Scotland, University of Glasgow and the Knowledge Transfer Network (KTN) partnered with Equate Scotland to launch The Opening Up Photonics Initiative[72]. The initiative delivered a series of training workshops exploring practical suggestions for improving gender diversity. In addition, Technology Scotland hosted Opening Up Photonics: Fostering Innovation Through Diversity & Inclusion[73] in November 2018, where 50 professionals from across the photonics community in Scotland met to discuss promoting EDI in the sector.

The IOP works across the UK and Ireland to engage the public with physics by supporting our members to run events, working with partner organisations on shared goals. Inclusive practice is at the heart of everything we do: ranging from events for specific under-served audiences and long-running partnerships with community organisations, to the principles of accessibility and inclusion, which underpin our event and activity design process. Projects include the production of new Irish Sign Language signs in physics and design technology (the first of its kind) with Dublin City University, the production of a guide for academic staff on supporting STEM students with dyslexia, and a project looking at how to improve the Disabled Students Allowance needs assessments process for STEM students.

Formal networks of peers

Networks of peers bringing together those at a similar career stage can be used to discuss EDI issues and share experiences. For example, the University of Liverpool, in collaboration with the IOP and the IOP Higher Education Group, hosted a series of meetings to support the physics HE community to develop good practice for remote, virtual or hybrid learning and teaching, called the Physics Learning and Teaching in Higher Education Community meetings.[74] This was an online network for departments to share good practice in EDI, and to learn more about the activities in other universities.

As mentioned above, the IOP is a co-founder of the LGBT+ Physical Sciences Network alongside the Royal Society of Chemistry and Royal Astronomical Society. A key action in our *Exploring the workplace*[75] report identified by respondents was having LGBT+ networks for staff or students. The survey indicated that environments with a focus on students were much more likely to have formal and/or informal networks in place, with student networks contributing significantly to the responses for teachers, doctoral students and other university employees.

Spotlight on Wales

A range of reforms are being implemented as part of Wales's new curriculum. When designing their own curricula, teachers are being asked to embed five 'cross-cutting themes': relationships and sexuality education (RSE); human rights education and the United Nations Convention on the Rights of the Child (UNCRC); diversity; careers and work-related experiences; and local, national and international contexts.

Such themes need to be embedded in all 'areas of learning and experience', which includes mathematics and numeracy, and science and technology. Accordingly, guidance to teachers on science and technology states:

[71] https://aip.scitation.org/doi/10.1063/1.5110113
[72] https://photonicsuk.org/photonicsevent/opening-up-photonics
[73] https://technologyscotland.scot/16113-2/
[74] https://www.liverpool.ac.uk/central-teaching-hub/physicslthe/
[75] Exploring the Workplace for LGBT+ Physical Scientists: https://www.iop.org/sites/default/files/2019-06/exploring-the-workplace-for-lgbtplus-physical-scientists_1.pdf

> *"While there isn't a 'typical' science and technology job, stereotypes persist and need to be challenged. Women, disabled people and those from minority or socially-disadvantaged groups are consistently under-represented. With the introduction of careers-related education in primary schools, these sorts of stereotypes can be addressed from an early age; an age when they are often formed. A more diverse workforce with rounded scientific and technological understanding is not just desirable in terms of equality, but essential to maximising opportunities for all learners and meeting Wales' economic needs."*[76]

Further efforts are underway as part of the Welsh Government's Race Equality Action Plan[77] and Professor Charlotte Williams OBE's review of how the curriculum can improve the teaching of themes and experiences relating to Black, Asian and Minority Ethnic communities *across all parts of the school curriculum*.[78] The Welsh Government has accepted all 51 recommendations of the Williams review, which are wide-ranging and cover resources available to teachers; education workforce training and development; initial teacher training; early career teaching; established teachers and leadership; school governance; and sustainability.

To stress, the Williams recommendations relate to the whole of the curriculum, *applying as much to STEM as do to other parts of the curriculum*. For example, new resources will now be developed to improve the teaching of themes and experiences relating to Black, Asian and Minority Ethnic communities within STEM.

A draft LGBTQ+ Action Plan for Wales[79] was published for consultation in 2021. It included a range of actions that would support diversity within STEM:

- Strategic, comprehensive investment in professional learning and training on designing a fully LGBTQ+ inclusive curriculum, including LGBTQ+-inclusive RSE for all.
- Training that empowers teaching professionals to adequately support LGBTQ+ young people and tackle homophobic, biphobic and transphobic bullying.
- Statutory national trans guidance for schools and local authorities.
- Ensuring colleges and universities are LGBTQ+-inclusive environments for learners and staff, identifying and building on best practice.

The Welsh Government has also created a Disability Equality Rights Task Force, but this is earlier in its development than the action plans outlined above. It will be progressing themes of, and gathering new data related to, the findings of a report from the Welsh Government's Disability Equality Forum regarding the impact that COVID-19 has had on people with disability. The report had included calls for understanding of ableism and disability rights to be integrated in the new curriculum (both in primary and secondary settings).[80]

[76] Hwb. 2021. *Science and Technology*. Cardiff: Welsh Government.
[77] Welsh Government. 2021. *Race Equality Action Plan: An Anti-racist Wales*. Cardiff: Welsh Government.
[78] Williams, C. 2021. *Black, Asian and Minority Ethnic Communities, Contributions and Cynefin in the New Curriculum Working Group: Final Report*. Cardiff: Welsh Government.
[79] Welsh Government. 2021. *LGBTQ+ Action Plan*. Cardiff: Welsh Government.
[80] Welsh Government. 2021. *Locked out: liberating disabled people's lives and rights in Wales beyond COVID-19*. Cardiff: Welsh Government.

5. What could and should be done by the UK Government, UK Research and Innovation, other funding bodies, industry and academia to address the issues identified?

The IOP proposes a number of recommendations for change to the UK Government, research agencies and funding bodies, and to the public and third sector.

1. Improve the quality, quantity and consistency of data on STEM employees

There is currently no UK-wide, sector-wide or enforceable method for collecting data on the demographics of those working in STEM. The lack of comprehensive quantitative data on the picture of UK STEM makes change in the sector difficult to track and benchmark, meaning diversity improvement and the effectiveness of interventions cannot be measured. It is important for the sector to complete a check of what quantitative data is available, followed by advocacy for improvement and standardisation of data collection, to enable future STEM EDI targets to be based on knowledge of the current state of the sector and realistic.

The IOP proposes that there should be a Government-led investigation into the extent to which quantitative data is collected on the demographics of:

- employees in the STEM workplace,

and/or

- students in STEM education.

As education is a devolved matter, the IOP recommends that the committee encourage the UK Government to work cohesively with the devolved administrations to capture uniform data on STEM education.

The investigation could include a deep dive review of:

- Methods of quantitative data collection (polling, staff surveys, course entry or qualification award data), and the breadth of this across the UK.
- Gaps and/or inconsistencies in quantitative data collection across the UK.
- Which metrics are collected (which of the protected characteristics, to enable a full picture of diversity including intersectionality).
- Sensitivities of quantitative data collection.

This can be investigated across the STEM sectors (including public and private employment), education, and across the UK's nations, where the extent of data collection differs.

The review would:

1. Create a comprehensive picture of which quantitative data is available on those in UK STEM, to establish what evidence on representation is available and how much is known about STEM diversity.
2. Identify gaps in quantitative data collection, leading to recommendations to be formed to make ethical, comprehensive, consistent and high-quality data collection standard practice.
3. Work with the STEM sector and STEM-relevant government departments (BEIS, DEFRA, DfT, DfE, etc) to develop best practice in quantitative data collection and share this to enable data collection to be undertaken by each responsible party in line with a sector standard (due to the sensitivity of collecting and publishing personal information).

In the long run, when quantitative data is uniformly collected to a comprehensive level, this will enable benchmarking on how diverse the sector is, allowing the tracking of EDI targets and

progression, as well as robust evaluation of the effectiveness of interventions in support of evidence-based policy.

2. **Publish and improve transparency of data on employee awards, pay and benefits within STEM**

In 2020, UKRI published an analysis of the seven Research Councils' diversity data.[81] The IOP welcomed the publication of this data as it improved transparency regarding equity among applicants for, and awardees of, publicly funded grants, which should enable greater scrutiny and improvements to EDI in the future. The IOP would urge action to be taken on the basis of this evidence to provide greater support and opportunities to under-represented groups.

The IOP recommends the sector-wide publication of anonymised grant, award and pay data broken down by the protected characteristics, and would like to see a particular focus on intersectionality to explore marginalised groups.

3. **Implement the recommendations from the IOP's Limit Less campaign**

In the Limit Less campaign, the IOP has four calls to the UK Government, and the devolved nations where relevant or not yet enacted, to:

- Revise teachers' standards to set out an expectation that teachers will address injustice in their professional practice and actively dismantle sexism, racism, homophobia, ableism and classism in their own work and their schools'.
- Ensure that all teachers are trained in inclusive teaching and tackling injustice so that they can achieve these robust standards. This should be in both their initial teacher education and their continuing professional development.
- Instruct those responsible for school inspections to place greater emphasis on the importance of inclusive teaching and schools' efforts to address injustice.
- Mandate nurseries and schools to develop whole-school equity action plans that:
    - are informed by ongoing data and evidence collection including students' choices.
    - promote equity and equality for young people in underrepresented groups.

The campaign contains recommendations further to education providers, media bodies and society. See the Limit Less manifesto for the recommendations in full.

4. **Develop implementable codes of conduct to reduce professional misconduct**

Data from the STEM sector show unacceptable levels of workplace professional misconduct. Work should be done to build concrete recommendations for change, to improve cultures and experiences, and start to bring an end to misconduct at work.

An investigation should build a full picture of professional misconduct within the sector, and lead to the development of:

- A sector-wide formation of an industry code of practice which is implementable
- Agreed definitions of bullying, harassment and sexual misconduct
- Forums and support groups for those who have experienced professional misconduct
- Clear instruction to employers on how to manage and respond to incidents of professional misconduct
- Improved workplace cultures

[81] UKRI (2020). Diversity data. https://www.ukri.org/our-work/supporting-healthy-research-and-innovation-culture/equality-diversity-and-inclusion/diversity-data/

Annex

Details on the data, and gaps in the quality of evidence, monitoring or reporting

The IOP maintains a database of members' essential characteristics and runs frequent Member Diversity Surveys every four years to supplement this information. However, there are some limitations to these data which must be considered when interpreting the submitted evidence. These are detailed here.

The IOP's member database

The IOP holds a database of member information which includes age, gender, employer, and residential address, recorded at the time when members join the Institute. This allows the IOP to understand some of the demographics of its members. Members can amend their personal information via the member platform, IOP Connect. Despite reminders to members to login and check their information, some may not keep this information up to date, which could mean that the data is not fully accurate and thus does not truly reflect the member's current situation. Furthermore, employer data is indicative based on their reported employer, and does not identify job role/position.

The IOP has a number of different membership categories: Associate Membership, for undergraduates, apprentices, trainees and professionals with a connection to physics; Full Membership, for Graduates and those in the middle of their career - early, mid and experienced professionals; and Fellowship, for distinguished physicists in recognition of their accomplishments. These categories allow the IOP to broadly understand the stage that members are at in their careers. For the purpose of this response, the IOP has filtered its membership data to omit those members who are students and those who are retired from the database. The IOP could offer figures of those who are students to enable a comparison of EDI among a group who will be progressing into the workforce in coming years.

It is important to note that the IOP's database includes some over- and under-representation, as certain individuals are more or less likely to pay for membership. For example, IOP members aged 29 or below are less numerous than other age brackets, and it is considered that the IOP member data does not reflect a full picture of early career physicists. Despite this limitation, the membership data provides information on a sizeable number of physicists in the UK.

Whilst the membership data curated by the IOP enables characterisation of the working physics sector in the UK and Ireland, it does not include all physicists in the community or sector. Indeed, no data set currently exist which fully reflects the physics sector in the UK. It should be noted that the IOP omitted members from the Republic of Ireland due to the UK focus of the inquiry. Data on EDI in Ireland is available for comparison upon request.

Despite the discussed limitations, IOP membership data provides a useful picture of the demographics of the UK's physics workforce.

The Member Diversity survey

In this response, membership data is supplemented by data from the IOP's Member Diversity survey. This survey is run every four years as there are challenges to collecting sensitive and protected EDI data from members at the time which they join the IOP. The survey is anonymous and helps build understanding of the make-up of our membership. Unlike the IOP curated membership data, data

from these surveys reveal a snapshot of a sub-sample of the membership, and does not represent the entire membership body, nor the entire UK physics sector.

The most recent survey, undertaken in 2019, saw response rates of around 10% of the membership, totalling 2,006 IOP members. This survey cannot be broken down by employment status, however the findings provide important insights which build a picture of EDI in physics across the UK.

These insights are further skewed by some individuals being more likely than others to respond to surveys, potentially leading to over- and under-representation within the sample. On average, 10-15% of IOP members respond to surveys. Response rates for D&I surveys usually elicit this low volume of response due the difficulties and challenges of trust, transparency, GDPR, and sensitive data. The IOP acknowledges that, as a result, this is not an exact reflection of our membership.

Other limitations

Some demographic data are currently not available to the IOP, or in other external data sets. These are largely highly personal data, which may elicit a lower number of responses or disclosure in surveys. These include parenthood, pregnancy and maternity/paternity history, gender reassignment, and marital status.

The IOP has further not provided data on representation among the members who sit on IOP boards, groups and committees, nor on award winners. The IOP believes that it is important for under-represented groups to be included and active in these groups, and the IOP could analyse the demographics among these groups to assess representation among those who are highly engaged in steering and influencing the agenda of the IOP.

More information:

For more information, contact policy@iop.org