

An Institute of Physics and Royal Astronomical Society Report | **May 2015**

# Gazing at the future

The experiences of male and female physics and astronomy doctoral students in the UK

In partnership with



The **Institute of Physics** is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application.

The **Royal Astronomical Society**, founded in 1820, encourages and promotes the study of astronomy, solar-system science, geophysics and closely related branches of science.

**Cover image: Helix Nebula**

Colour-composite image of the Helix Nebula (NGC 7293) created from images obtained using the Wide Field Imager, an astronomical camera attached to the 2.2-metre Max-Planck Society/ESO telescope at the La Silla observatory in Chile. (ESO)

## Introduction

**This summary report is part of a wider project initiated by the Institute of Physics (IOP) in collaboration with the Royal Astronomical Society (RAS) to look at the overall experience of physics and astronomy doctoral students in the UK<sup>1</sup>.**

There are around 4000 doctoral students studying physics or astronomy in the UK<sup>2</sup>. As well as their research, doctoral students provide a vital source of talent for a huge range of complex industries. Meanwhile, a doctorate remains the primary route into academic and research careers in the UK. The average salary of doctoral students from physical sciences 7–9 years from graduation is £40,000 according to RCUK<sup>3</sup> and, as such, a doctorate in physics or astronomy remains a route towards a well-paid and productive career.

The underrepresentation of women in physics and astronomy is an ongoing concern and although there are proportionally more women studying towards doctorates than those studying at undergraduate level, women still only make up 25% of doctoral students<sup>4</sup>. The gender imbalance in science potentially holds back a significant cohort from using their talent and potential in physics, both in academia and industry. The reasons for the under-representation of girls and women in physics and astronomy are being explored and tackled at all levels. But women's experiences of doctoral study in physics and astronomy has been the subject of less focus until now.

The findings presented here are derived from a survey conducted by Oxford Research and Policy between March and May 2014, and completed by 995 physics and astronomy doctoral students at UK institutions<sup>5</sup>. Of those who responded, 70% were male and 30% were female<sup>6</sup>. The survey had two primary aims: firstly, to better understand the effects on student experience of the changing landscape of PhD provision in the UK with the recent introduction of Centres for Doctoral Training (CDTs); and secondly, to investigate any differences in the experiences of doctoral students from under-represented groups.

This briefing considers findings on the latter aim, providing a snapshot of the differing experiences of male and female physics and astronomy doctoral students in the UK. It includes a set of recommendations that draw on these findings targeted at physics and astronomy departments, funders and professional societies.

<sup>1</sup> We use the term “doctoral students” to refer to all students conducting doctoral study, including those registered on DPhil courses

<sup>2</sup> HESA statistics

<sup>3</sup> *The Impact of a Doctoral Researcher: Physical Science and Engineering Doctoral Graduate* (2014), a RCUK report, [www.rcuk.ac.uk/RCUK-prod/assets/documents/skills/timodc\\_sb\\_psaedg.pdf](http://www.rcuk.ac.uk/RCUK-prod/assets/documents/skills/timodc_sb_psaedg.pdf)

<sup>4</sup> *Physics Students in UK Higher Education Institutions* (2012), an IOP report, [www.iop.org/publications/iop/2012/file\\_54949.pdf](http://www.iop.org/publications/iop/2012/file_54949.pdf)

<sup>5</sup> *Survey of Physics and Astronomy Doctoral Research Students' Experiences and Career Intentions* (2015), an IOP report, [www.iop.org/publications/iop/2015/file\\_65623.pdf](http://www.iop.org/publications/iop/2015/file_65623.pdf)

<sup>6</sup> There were eight respondents who did not specify their gender. There are around twice as many responses from male doctoral students in their first year than for those in their fourth year. Among female doctoral students the response rate is relatively stable, with only a small decline in the number of fourth-year respondents

## Key findings

<sup>7</sup>In a number of cases, female doctoral students' level of satisfaction starts off at a similar level to male doctoral students in the first year but fall significantly over the course of their degree

### 2.1. Overall experience of physics and astronomy PhD students

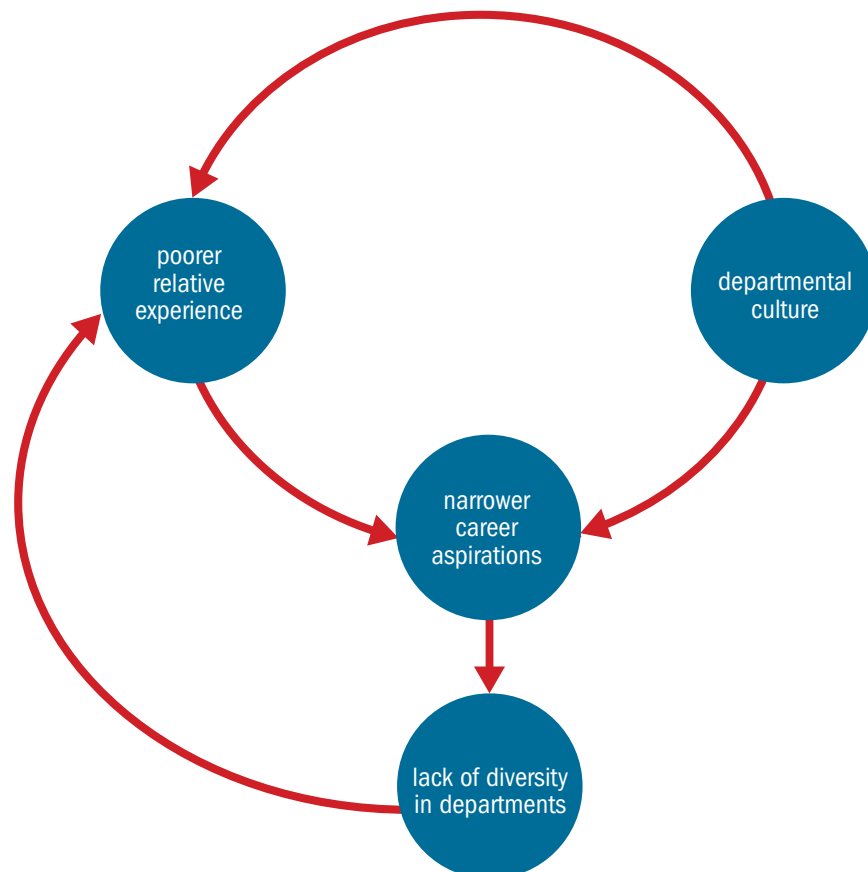
A clear majority of both male and female doctoral students in physics and astronomy report that they are happy with their doctorate; however, on average, **female doctoral students rate the overall experience of their doctorate lower than their male peers**. Female doctoral students also report far lower levels of satisfaction and across a number of substantive areas related to their doctorate<sup>7</sup>. **For example, the proportion of female doctoral students who say they are happy with their doctorate is on average 7% lower than for male doctoral students, and there appears to be a drop in satisfaction over the course of their degree.** Female doctoral students also report lower levels of

satisfaction with departmental culture, and are more likely to report a lack of diversity within departments.

### 2.2. Departmental culture

**There are noticeable differences in attitudes to diversity issues within departments between male and female doctoral students.** While 73% of female doctoral students strongly agree or agree that there should be more female academics, only 52% of male doctoral students hold similar views. Similarly, 45% of female doctoral students and only 29% of male doctoral students agree that a more diverse mix of people and staff in their department would be beneficial. While 70% of male doctoral students agree there was a strong equality

**Figure 1:** Female doctoral students' experience of their doctorate within a feedback loop



and diversity culture in their department, only 58% of female doctoral students do.

**Female doctoral students' relationship with their main supervisor appears to deteriorate more over the course of their doctorate compared to their male peers.**

Only 70% of female doctoral students in their fourth year rate their relationship as good or excellent compared to 93% in their first year of study. Among male doctoral students, the figures were 85% and 91% for fourth and first years respectively.

### 2.3. Career paths

Despite reporting as much confidence in their technical, transferable and general skills as their male counterparts, **only just over half (55%) of female doctoral students across all years of study agree that they would make good research scientists, with the proportion agreeing dropping to 46% in the third year.** In contrast, male doctoral students remain consistently confident that they would make good research scientists throughout their doctorate, with 70% overall agreeing on average across all years of study.

There is a significant decline across the four years of a doctorate in female doctoral students' expectations of a research position, while male doctoral students' expectations

remain stable and relatively high compared to the number of positions available<sup>8</sup>. When asked if they envisage that they might have a university role in 3–5 years' time, in the first year, 78% of male doctoral students feel that this is likely compared to 65% in the fourth year of study. In contrast, **82% of female doctoral students in their first year share these expectations, falling to 48% in the fourth year.**

As can be seen in **figure 1**, each of these aspects may have a relational effect on each other as part of a feedback loop. For female doctoral students, overall satisfaction with their doctorate declines more quickly than male doctoral students, while their confidence that they would make a good research scientist seems to fluctuate considerably across the years of their doctorate. Female students report fewer meetings with their supervisor as their PhD progresses and their expectations of a research position in the future decline. These changes in career expectations are likely to have an effect on the diversity of departments, as lower numbers of female doctoral students choose to pursue a career through academia. Finally, the lack of diversity within departments may have a negative impact on female doctoral students' overall experience.

<sup>8</sup> A Vitae study (*What Do Researchers Do?* 2013, [www.vitae.ac.uk/impact-and-evaluation/what-do-researchers-do](http://www.vitae.ac.uk/impact-and-evaluation/what-do-researchers-do)) finds that only around 20% of doctoral students from the physical sciences and engineering are in positions as researchers in higher education after 3.5 years



## Key recommendations

### Departments should:

- Work closely with equality and diversity/Juno committees to provide training on unconscious bias for all staff and students, including highlighting its effects on diversity within departments.
- Scrutinise the support provided to doctoral students, particularly female doctoral students, to avert falling levels of satisfaction during PhDs, including regularly collecting feedback, involving students in departmental decision-making and working more closely with students to assess skills and career options; include doctoral students on equality and diversity/Juno committees.
- Provide closer monitoring of doctoral students' career intentions across their degrees through dedicated, continuous and consistent CPD; provide opportunities for female doctoral students to formally network with one another and women in science and academia.
- Develop mechanisms to ensure closer scrutiny of doctoral students' relationships with supervisors, take measures to ensure greater transparency in the level of support offered and ensure supervisors are proactive in identifying when support is needed.
- Improve the access to, and quality of, information on doctorates for applicants, as well as providing clarity on what students should expect in pursuing a PhD, particularly for those students entering a new institution.
- Explore ways to address the significant minority of doctoral students who report feeling socially isolated, by looking at ways to improve departmental cohesion and promotion of social activities.

### Funders should:

- Explore ways to provide greater funding for courses to prepare doctoral students without a postgraduate master's qualification for the rigours of doctoral research.
- Work with departments and professional societies to explore ways of financing improved and impartial careers advice for doctoral students in order to improve the knowledge of, and aspirations towards, a range of relevant careers.

### Professional societies should:

- Work with departments and funders to develop improved and coordinated impartial careers advice from undergraduate to PhD level to ensure students have access to the best possible information on their choices and to make more informed decisions.
- Work closely with Juno/equality and diversity committees to assess the needs of female doctoral students and provide dedicated support, such as mentoring, networking sessions (both within and between departments and elsewhere) and bespoke careers advice to improve satisfaction and widen career aspirations.
- Support departments and Juno/equality and diversity committees with guidance and resources to aid the provision of unconscious bias training.

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### 4.1. Candidates' background

The survey results show a clear difference between male and female doctoral students with regards to their prior work experience. While 42% of male doctoral students gained experience via a work placement as part of their previous degree, only 29% of female doctoral students did. However, 84% of female doctoral students completed an internship prior to their doctorate, compared to 68% of male doctoral students.

The survey also reports that British female doctoral students are more likely than male doctoral students to be studying at a different institution from where they studied for their first degree. While a majority of male doctoral students studying astronomy also record that they are studying in a different institution, it is not clear why proportionately more females move. A majority of male doctoral students studying astronomy also record that they are studying in a different institution. This may be as a result of there being fewer institutions in which a doctorate in astronomy can be pursued, forcing students to move institution. This survey also finds that astronomy students are more likely to make a decision on moving to an institution based on its reputation in their field, leading them to explore different institutions.

### 4.2. Choosing and applying for a PhD

Doctoral students' motivations for undertaking a PhD are relatively consistent across physics and astronomy and across genders, with over 60% selecting "Because I love my subject and wanted to learn more" as either their main or secondary motivation. Astronomers are more likely than physicists to be motivated by the reputation of the institution or research group than physicists, and far higher proportions of female astronomers chose their doctorate

due to a perceived aptitude than female physicists.

The vast majority of students received funding for their PhDs. Among those reporting having received funding, female doctoral students were much more likely to receive combined sources of funding, in particular UK Research Council (including CASE awards) or department funding combined with another source. No British female doctoral student received solely industrial funding to cover all the PhD costs, compared to 4% of male doctoral students.

There is more parity between the reported funding levels of males and females in non-CDTs than CDTs and the range of funding received by male CDT members is wider both at the higher and lower ends of the scale. The fact that there are larger gender pay differences in CDTs compared to non-CDTs may be concerning and may warrant further investigation.

Almost half of doctoral students feel that there were ways in which they could have been better prepared for their doctorate, but consistently higher proportions of female doctoral students report that they could have benefited from further training in preparation. While a majority of each gender agree that they were prepared, 25% of female doctoral students either disagree or strongly disagree that they felt prepared from their previous studies and experience to pursue independent research, compared to 14% of male doctoral students. Nearly 50% of those students that did not possess a postgraduate master's qualification agree that a funded master's course would have helped them prepare for independent research and that a short research taster course would have helped, with slightly higher proportions of female doctoral students agreeing with this.

<sup>9</sup>Project Juno is a scheme run by the IOP which aims to recognise and reward departments that can demonstrate they have taken action to address the under-representation of women in university physics and to encourage better practice for both women and men. A university Juno committee will be standing committee that oversees the scheme

### 4.3. Experience whilst undertaking a PhD

Consistently, both in terms of their overall experience of their PhD and through their experience of individual areas, female doctoral students express lower levels of satisfaction in the progress of their PhD. While some of the proportional differences between male and female doctoral students are small, they exist as part of a recurring theme in the data (see [table 1](#)).

There is also an observed drop in satisfaction on the part of female doctoral students compared to male doctoral students in a number of measures across the years of a degree (such as question *d* in [table 1](#)). However, although this drop is replicated in the responses to a number of questions, it is not clear whether is statistically significant.

While a majority of doctoral students rate their relationship with their main supervisor as excellent or good overall, students do on average rate their relationship lower as the year of study increases. In particular, female doctoral students' rating of their relationship with their main supervisor drops significantly compared to male doctoral students, with 70% of female students in their fourth year rating their relationship as good or excellent compared to 93% in their first year of study. For male doctoral students, the comparative figures are 85% and 91%, respectively.

Overall, 57% of male and 49% of female doctoral students report having prearranged meetings with their supervisor. It is notable that the proportion of female doctoral students reporting having prearranged meetings with their supervisor falls from 60% in their first year of study to 42% in their third and fourth years, while the proportion of male doctoral students reporting having prearranged meetings only falls slightly between their first and fourth years. The survey finds a correlation between the likelihood that a student will describe having a positive relationship with their supervisor and having prearranged meetings, and this latter finding may explain the lower proportions of female doctoral students

satisfied with their relationship with their supervisor.

### 4.4. Departmental culture

A significant minority of both genders report having felt socially isolated during their doctorate. 30% of female and 25% of male doctoral students. This finding may be of concern to departments and suggests that they need to do more to integrate students and promote more social opportunities.

Larger proportions of female doctoral students confirm that there is doctoral student representation on their departments' equality and diversity or Juno committee<sup>9</sup>, but a majority express a lack of knowledge – 60% of doctoral female students and 67% of male doctoral students respectively. While the majority of both male and female doctoral students agree that they have been treated as an equal by their fellow students, lower proportions of female doctoral students agree, 83% against 93% for male doctoral students.

Questions surrounding attitudes to diversity within departments overall find a larger disparity between male and female doctoral students. For example, 52% of male doctoral students and 73% of female doctoral students strongly agree or agree that there should be more female academics in their department (see [figure 2](#)).

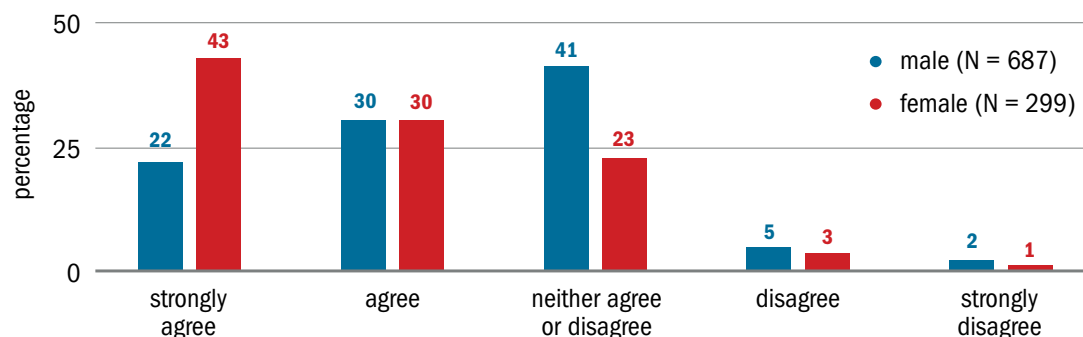
It is perhaps not surprising to find such a large difference between the responses of male and female doctoral students, and

**Table 1:** Selected responses to questions relating to satisfaction by gender

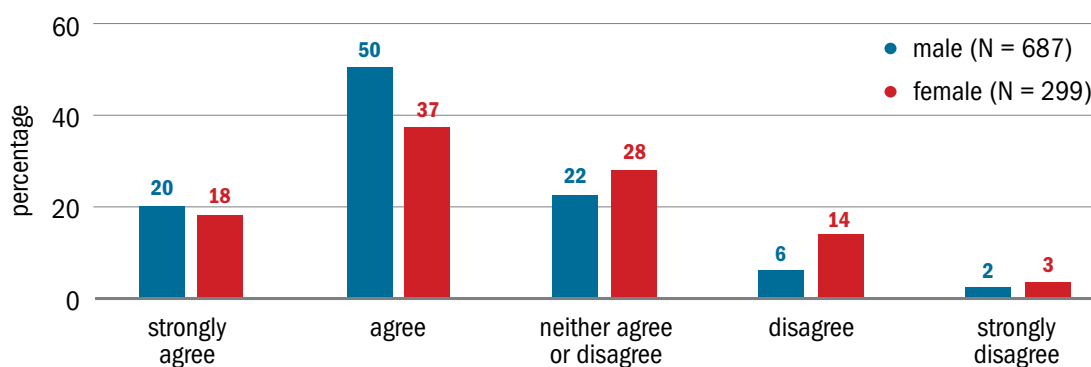
Question	Male %	Female %
<i>a</i> Doctorate met expectations	68	58
<i>b</i> Pleased with the decision to do a doctorate	86	83
<i>c</i> There is little that can be improved about the doctorate	43	40
<i>d</i> Happy with the way that the doctorate is going	72	65



**Figure 2:** How strongly respondents agree with the statement, “I feel that there should be more female academics”, by gender



**Figure 3:** How strongly respondents agree with the statement, “I feel confident that I would make a good research scientist”, by gender



female doctoral students are perhaps more likely to be aware of the gender imbalance in physics/astronomy academic staff and consequently hold stronger opinions.

Respondents were also asked how strongly they agree that their department would benefit from greater diversity in staff and people, with which 45% of female doctoral students and 29% of male doctoral students agree. Large proportions, 49% of male and 37% of female doctoral students, neither agree nor disagree. Conversely, 70% of male doctoral students agree there was a strong equality and diversity culture in their department against only 58% of female doctoral students.

While a majority agree, a significant minority of female doctoral students, 22%, feel that they are not being provided with good role models during their studies. There is an ongoing issue with the underrepresentation of women in lecturer and senior academic positions, with women for example making up

just one in five lecturers<sup>10</sup>. This is likely to be a major underlying cause of the higher levels of female doctoral students not finding good role models throughout their studies.

#### 4.5. Careers

In contrast to the pattern of lower overall satisfaction among female doctoral students, when asked whether they are gaining transferable skills, 84% of female doctoral students compared to 80% of male doctoral students agree or strongly agree. Similar majorities of respondents of both genders also agree that they possess the majority of technical and general skills that are often looked for by employers.

However, when asked whether they felt they would make good research scientists, just 55% of female doctoral students agree, compared to 70% of male doctoral students (see [figure 3](#)).

Respondents were also asked what effect

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<sup>11</sup> Similarly, respondents who had not already accepted a job or training offer were asked whether they intended to seek employment as a research scientist, or undertake further study related to research. While the proportion of male doctoral students indicating a positive response increases slightly from 59% in the first year to 64% in the fourth year, the proportion of female doctoral students falls from 58% on the first year to 43% in the fourth year

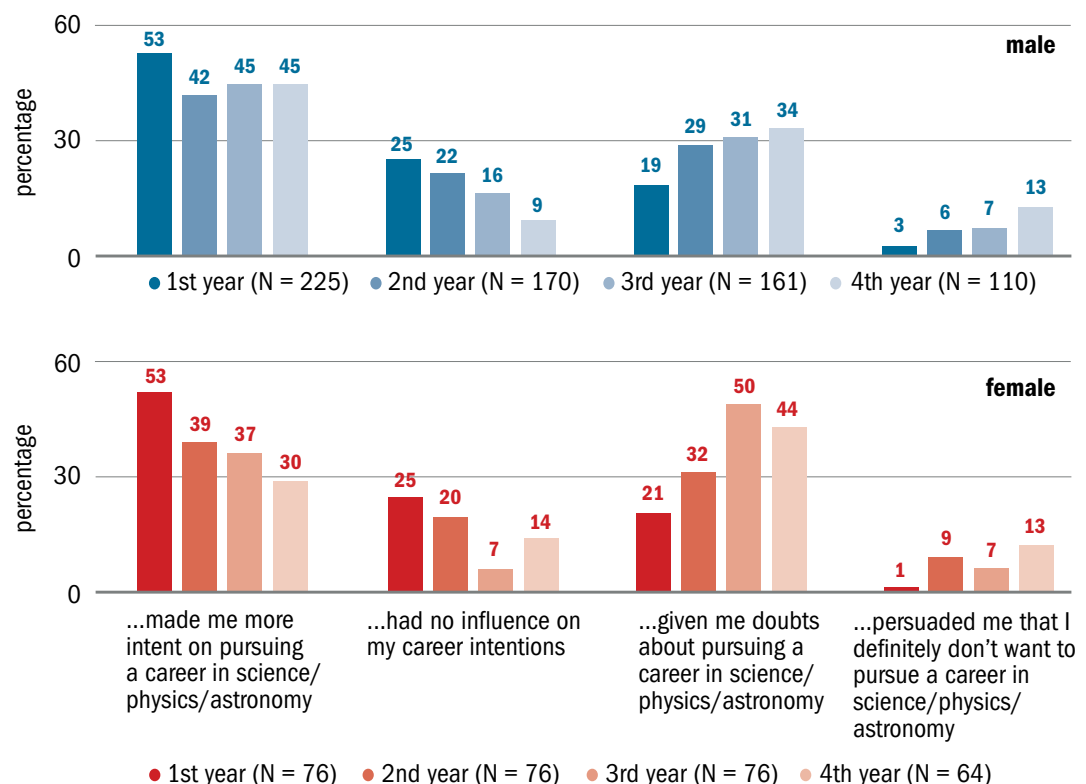
their experience as a physics or astronomy student has had on their career intentions (figure 4). The data suggest that as length of study increases the proportions of both male and female doctoral students with “doubts about” or “definitely not wanting” to pursue a career in science (in areas related to either physics or astronomy) increases. Overall, female doctoral students report being more likely than male doctoral students to have doubts about, or definitely don’t want, pursue a career in science – 45% and 34%, respectively. Students of both genders report similar intentions in their first year. However, while the proportion of male doctoral students more intent on a career in science falls a little, from 53% in the first year to 45% in the fourth year, the proportion of female doctoral students falls from 53% in the first year to 30% in the fourth year. By their third and fourth years of study, 57% of female doctoral students have doubts or do not want to pursue a career in science compared to 38% of male doctoral students in the third

and 47% in the fourth year<sup>11</sup>.

These findings present somewhat of a contradiction. While similar proportions of both male and female doctoral students believe they possess the right transferable, general and technical skills for employers, significantly fewer female doctoral students see themselves as being well suited for academia, and are also more likely to be put off from a career in science. That studying towards a doctorate has a negative effect on both male and female doctoral students’ satisfaction with science and academia is not in itself surprising; students face new challenges and have more time to question their skills and their work across the four years of a doctorate. But the differences between male and female doctoral students are particularly pronounced.

Respondents were also asked about which types of roles they expected they would be in both 3–5 and 6–10 years from graduation. In 3–5 years, relatively similar proportions of male and female doctoral students overall

**Figure 4:** The effect of respondents’ experiences as physics/astronomy doctoral students on career intentions by year of study and gender



**Table 2:** Percentage of respondents specifying selected roles they believe they are most likely to be doing in 3–5 years' time, by gender and year of study

	Male				Female			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
Postdoc/research assistant	76%	66%	69%	61%	76%	64%	59%	45%
Scientist: industry/commerce (including start-ups)	31%	32%	30%	27%	24%	24%	38%	13%
Academic	18%	12%	13%	21%	16%	11%	9%	13%
Scientist: public sector	5%	12%	9%	8%	12%	13%	11%	14%
Teacher	6%	6%	3%	11%	5%	11%	11%	17%
<b>Total respondents</b>	<b>225</b>	<b>170</b>	<b>161</b>	<b>110</b>	<b>76</b>	<b>75</b>	<b>76</b>	<b>64</b>

across all four years of study see themselves in a research career. However, this masks a drastic narrowing in the expected range of careers of female doctoral across the years of their doctorate (see [table 2](#)). Male doctoral students' confidence in a research career remains resilient. Considering those individuals who envisage that they might have a role in a university either as an academic and/or a postdoctoral researcher, in the first year, 78% of male doctoral students feel that this is likely compared to 65% in the fourth year of study. In contrast, 82% of female doctoral students in their first year feel that they are likely to have a university role in 3–5 years' time, falling to 48% in the fourth year.

These findings are reinforced in response to the question of expected roles in 6–10 years' time. By their third and fourth years of study, around 1 in 5 male students envisage being a postdoctoral researcher in 6–10 years' time compared to around 1 in 10 female students<sup>12</sup>.

#### 4.5.1. Discussion: A vicious circle?

Exploring and addressing the reasons behind the divergence in career expectations between male and female doctoral students is vital. Female students clearly see themselves as having the right skills to enter academia, research and careers in science, yet higher proportions question their ability and are put off from such careers, while they are also less likely to see themselves in a research position.

This results in women feeling that their career options are being limited and a substantial number of talented people are being withheld from certain sectors.

Certainly, female doctoral students' less satisfactory experience could contribute to this narrowing of career expectations in any of three ways: one of them unconscious and two of them conscious. Firstly, their experience, combined with a status quo in which women are vastly underrepresented, may serve to reduce their perceived expectation of an academic or research career. Secondly, this perception, while accurate, may itself become a self-fulfilling prophecy by actively affecting the career decisions that they make. Thirdly, their doctoral experience may simply put them off, making them less likely to want a career in research and academia.

Unconscious bias may also be contributing to the lower level of representation of women within academic professions in the first place and may also be reinforcing the expectations and career paths, perhaps in students and within careers advice, of successive generations. As they choose to go into the roles in which they see others, they may then gravitate more towards positions outside of academia. The end result is less representation of women in academia and in research roles, which, completing a vicious circle, then reinforces itself by lowering female students' expectations of such a career and the perception of a lack of role

Respondents were allowed to specify one or two roles. 273 specified a single role and 723 specified two roles (abridged table)

<sup>12</sup> It is also worth noting the proportions of male and female doctoral students indicating choices outside the top four (academic, industrial scientist, postdoctoral researcher and public sector scientist – all clearly roles as scientists). While little difference is observed in the short term, in the longer term, 47% of male students in their third and fourth years select roles outside the top four compared with 65% of female students

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models on the part of some.

Additional questions show that similar proportions of both genders believe that they have a good knowledge of careers within academia. However, female students judge the quality of careers advice they received from both their university careers service and their supervisor as lower than their male peers. That they assess their skills as on par with their male colleagues, but are less likely to see themselves in a research career, in academia, or in science, cannot just be as a result of

their lower levels of satisfaction with their doctorate. Lower levels of confidence in being good potential research scientists suggests that there is an issue with confidence relating to careers, and that the career needs of female students are not being met by the existing careers provision.

It is clear that the career decisions of male and female doctoral students are neither being made on a level playing field, nor from shared experiences.

## Further reading

*It's Different for Girls: The influence of schools* (2012)

An IOP report

**[www.iop.org/education/teacher/support/girls\\_physics/file\\_58196.pdf](http://www.iop.org/education/teacher/support/girls_physics/file_58196.pdf)**

*Closing Doors: Exploring gender and subject choice in schools* (2013)

An IOP report

**[www.iop.org/publications/iop/2013/file\\_62083.pdf](http://www.iop.org/publications/iop/2013/file_62083.pdf)**

*Evaluation of Project Juno* (2013)

An IOP report

**[www.iop.org/policy/diversity/initiatives/juno/juno-evaluation/file\\_62014.pdf](http://www.iop.org/policy/diversity/initiatives/juno/juno-evaluation/file_62014.pdf)**

*Opportunities from Physics: Interventions in a multi-ethnic school to increase post-16 participation* (2014)

An IOP report

**[www.iop.org/publications/iop/2014/file\\_63749.pdf](http://www.iop.org/publications/iop/2014/file_63749.pdf)**







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