# Our scientific community in 2016

The latest RAS demographic survey charts a research community that is growing and changing, in ways that may not be sustainable. **Robert Massey** summarizes the results.

An organization such as the RAS can function properly only if it understands both the people and the scientific interests it represents. Since 1988, the Society has tracked the changing nature of the astronomy and geophysics community in the UK. The late Helen Walker, whose obituary appears elsewhere in this issue of *A&G* (page 6.12), was a particularly powerful advocate for this work, recognizing its value in highlighting the demographic groups that are represented to differing degrees in our sciences.

In 2016, the RAS commissioned Sean McWhinnie of Oxford Research and Policy to set up and analyse data from the questionnaires for the survey, as he had also done in 2010. The design of the survey was shaped by RAS staff, Council and the Committee on Diversity in Astronomy and Geophysics. The full report, available on the RAS website, contains significantly more information than is presented here.

The 2016 survey was similar to that of 2010 (Massey *et al.* 2011), comprising a questionnaire for individual researchers, and one for university departments and research establishments. These were distributed through email lists held by the Society, and potential respondents were also alerted through social media. The questionnaire for individuals was shared through a web link.

Some 40 university departments and two research establishments returned institutional questionnaires; data from a further 47 departments and seven research establishments were mined from their respective websites. This is a significantly larger sample than in 2010, for two reasons. First, there has been an expansion in the number of research groups. Second, we adopted a broader definition of geophysics, on the advice of Fellows. Alongside the institutional data, 903 individuals completed the online survey, a large enough sample to draw broad demographic conclusions. However, most of them (756) were in astronomy and solar system science, making analysis of other subsets less reliable. We call fixed-term (typically postdoctoral) and permanent research staff "researchers", and lecturers, senior lecturers, readers and professors "academic staff".

## The size of the research community

Perhaps the most remarkable finding is the continued growth of the RAS research community. In 2016, astronomy had 1301 full time equivalent (FTE) staff in universities, and a further 110 in research establishments (1411 in total). Solar system science had 258, 234 FTE staff working in universities and 18 in research establishments. Solid-Earth geophysics had 787.5 FTE staff in universities and 638 in research establishments (1425.5 in all). In cross-disciplinary areas there were 282 FTE staff, 270 in universities and 12 in research establishments. (Within these totals, astronomy, solar system science, solid-Earth geophysics and cross-disciplinary areas have 46, 13, 0, and 6 academic visitors respectively, some of whom may be unpaid.)

**"The full report, available online, has more information than is presented here"**

## Employment

There is no direct match between the categories considered in the early surveys and the recent data, but some trends in the workforce are clear. For example, the overall number of paid staff in astronomy and solar system science has risen by 23% from 1302 in 1993 to 1604 in 2016. This masks a significant shift within the sector: the number of staff in universities rose from 908 to 1476, while numbers in research establishments declined from 394 to 128.

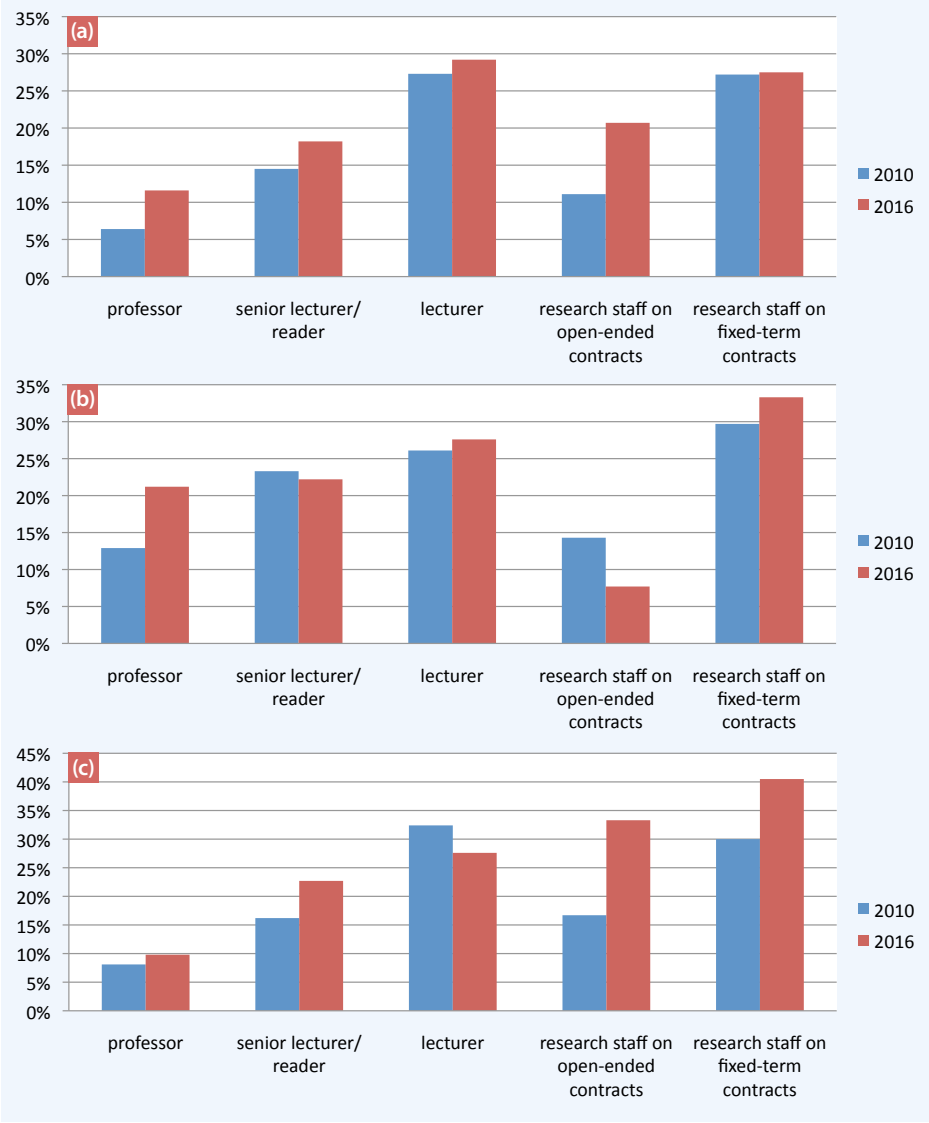
There are also some obvious changes in the number of researchers at different grades, with the proportion of professors growing significantly. In 1993, there were 77.5 FTE professors working in astronomy and solar system science (8.5% of all staff), rising to 302 by 2016 (just over 20% of all staff, and 49% of academic staff). The number of senior lecturers/readers rose from 99.5 to 204, whereas lecturer numbers grew more slowly, from 114.7 to 135.

Numbers of research staff on fixed-term contracts (mostly postdoc research associates and fellowship holders) rose from 322.7 in 1993 to a peak of 473 in 2010. By 2016, this had fallen to 395. This is likely to result from the real-terms decline since 2010 in grant funding from research councils including the Science and Technology Facilities Council (STFC) and Natural Environment Research Council (NERC), only partly offset by successful bids from Horizon 2020 and elsewhere. Of postdocs who responded to the survey, 45% are funded by STFC, 27% by EU sources such as the European Research Council, and 5% by NERC.

## Students

PhD student numbers remain strong. The 2016 survey included a significantly greater proportion of solid-Earth geophysics researchers in general and the overall postgraduate student count across subjects rose from 1232 in 2010 to 2007 in 2016. In astronomy and solar system science, the total increased from 1021 to 1289 over the same period. Funding for UK PhD students in astronomy and geophysics predominantly originates from STFC, NERC, the Engineering and Physical Sciences Research Council (EPSRC), the European Union and universities. Among respondents to our survey, 62% of UK astronomy and solar system science PhD students received funding from STFC, and 5% from NERC. A majority (65%) of solid-Earth geophysics students receive funding from NERC (but too few responded individually to draw reliable conclusions). One major change is an increase in funding from universities: in 2010, 11% of astronomy and solar system science PhD students were supported this way, and 23% in 2016.

Overseas students, including those from the 27 European Union countries excluding the UK (EU27), have a different funding profile. 41% were supported by their university, 27% by the UK research councils, and 33% were self-funding. 11% stated that they had "other" sources of funding including support from their home governments (some cite multiple funding sources).




**1** Proportion of female staff at each grade by broad research area: (a) astronomy, (b) solar system science, (c) solid-Earth geophysics.

Since 2010, the number of astronomy and geophysics technical staff in universities rose from 140 to 208. 33 of those responded to the survey, divided 2:1 between men and women, but this is too small a cohort for significant quantitative results.

## Gender balance

Previous surveys have characterized the astronomy and geophysics research communities as predominantly white and male – far more so than the UK population as a whole. In 2016 this remains the case, although there are signs of change.

There are more women working in all fields than in 2010. In general, the proportion of female staff has increased at all levels, but the "leaky pipeline" persists: the fraction of women declines with seniority. For example, in astronomy in this survey (figure 1a), women made up 27.5% of fixed-term researchers and 29% of lecturers, but 18% of senior lecturers/readers and only 12% of professors (up from 6% in 2010). The picture was brighter in other fields, particularly in solar system science (figure 1b), where women comprised 21% of professors (compared with 13% in 2010). Solid-Earth geophysics (figure 1c) had women as 41% of fixed-term researchers, but only 10% of professors (rising from 8% in 2010).

The pool of applicants is to some extent restricted by entries to undergraduate courses and PhD programmes (and thus to A-levels and Scottish Highers) in physics-related subjects. Here astronomy and geophysics continue to recruit more women than physics in general. The most recent (2014) data reported to RAS Council indicated that women made up 30% and 39% of applicants to astronomy-related and geophysics undergraduate courses respectively, compared to 22% of applicants to physics courses in general. Our 2016 survey indicates that 30% of postgraduate students in astronomy, 26% in solar system science, 41% in geophysics, and 29% of those in cross-disciplinary work are female. The data suggest that women obtain postdoctoral posts in similar proportions, but are still not moving into permanent jobs in the numbers expected. There is also tentative evidence of a small decline in the proportion of women entering astronomy, solar system science and cross-disciplinary postgraduate programmes.

## Ethnic background

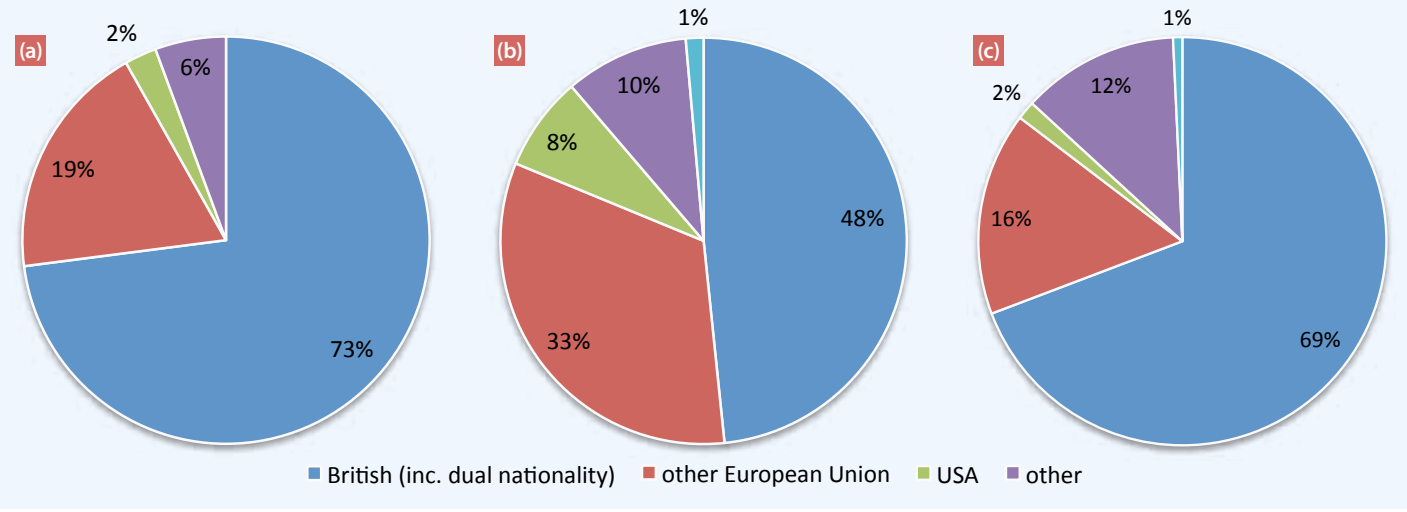
University groups are often thought to be ethnically diverse, as a result of their successful recruitment of staff from around the world. But our survey data suggest that British members of research groups are much more homogenous than the wider UK population. The most recent (2011) national census found that 87% of the UK population is white. In 2016, 88% of permanent staff who completed the survey described themselves as white, but among British respondents, the figure was 95%. Among fixed-term researchers, 97% of the British postdocs (48% of this cohort) identify as white. At postgraduate level, the sample more closely matched the UK population, with 87% of British postgrads indicating that they were white.

In all cohorts of staff and students, there were small numbers of respondents from different ethnic groups. In most cases, these subsamples were too low for significant comparisons; only one UK respondent (a PhD student) identified as black, indicating exceptional under-representation.

It was striking that 52% of postdoctoral researchers originate from outside the UK (figure 2b). As the UK moves to leave the European Union in 2019, the nationality of respondents matters more. The 2016 survey found that EU27 nationals made up a significant component of the research workforce (figure 2): 19% of permanent staff in universities and research establishments, 33% of postdocs, and 16% of postgraduate students. The United States was the next most common country of origin, accounting for 2.5% of permanent staff, 7.5% of postdocs, and 1.5% of postgraduate students.

## Religion

The 2011 census indicated that 26% of the UK population has no religion. We found that astronomers and geophysicists are much less likely to be religious than the wider UK population, with the largest proportions of each cohort professing no religious faith or describing themselves as atheist (77% of permanent staff who responded, 72% of postdocs and 75% of postgraduates). Among the minority of respondents who specified a religion, most were Christians (27% of permanent staff, 24% of postdocs, 18% of postgraduate students). There were very low numbers of staff (1%) and postdocs (3%) who indicated they held any other religious faiths (named as Islam, Hinduism and Judaism), and a slightly larger (7%) proportion of postgraduates.




**2** Nationality of: (a) permanent staff, (b) postdoc research associates, (c) postgraduate students.

## Disabilities

The new survey found very few staff who described themselves as disabled, just 2% of permanent staff, postdocs and postgraduate students, much the same as in 2010. UK government data suggest that 16% of working-age adults are disabled; they are significantly under-represented in the astronomy and geophysics community.

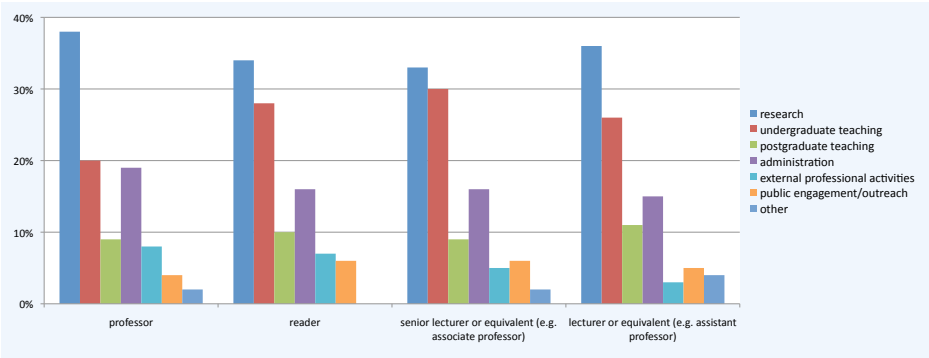
## Sexual orientation

For the first time, the 2016 questionnaire asked individual respondents to indicate their sexual orientation. The results suggest that astronomers and geophysicists, particularly younger staff and students, are less likely to be exclusively heterosexual than the population as a whole. Among permanent staff, 95% of those giving this information are heterosexual, 2% are lesbian or gay and 3% are bisexual. For postdoctoral researchers the figures are 91%, 5% and 4%; and for postgraduate students 83%, 8% and 9% respectively.

Questions on sexual orientation are not included in the census, but UK Annual Population Survey data suggest 97% of the wider population identify as heterosexual or "straight", 1.8% as lesbian or gay, and 0.9% as bisexual.

## Age

This survey was again used to collect data on the ages of individual respondents. Astronomy and solar system science (combined) in universities was the only cohort large enough for analysis. The median age band for fixed-term researchers is 30–34 years, much the same as in 2010, and for permanent academic staff, 45–49 years, compared with 40–44 in 2010. The median age band for professors in 2016 is slightly younger at 50–54 years, compared with 55–59 years. Academic staff below professorial grade are typically older than in 2010, perhaps indicating a decline in recruitment for permanent jobs at earlier career stages.




**3** Proportion of time spent by academic staff respondents on specific activities.

## Research activity

The survey also examines the activity of permanent academic research staff and postdoctoral researchers on fixed-term contracts. Respondents were asked to indicate how they divide their work time (figure 3), the areas of research where they are active (in astronomy and solar system science: figure 4), the facilities they use and, for observational astronomers, which regions of the electromagnetic spectrum they use (figure 5, also for the astronomy and solar system science cohort combined).

In 2016, lecturers, senior lecturers, readers and professors all spent 33–38% of their time on research. Professors spent a little less (20%) of time on undergraduate teaching than other university faculty staff (26–30%). These groups all taught postgraduates for around 10% each week, devoted around 5% of their time to public engagement work (as did permanent research staff), and 15–19% of their time on administration.

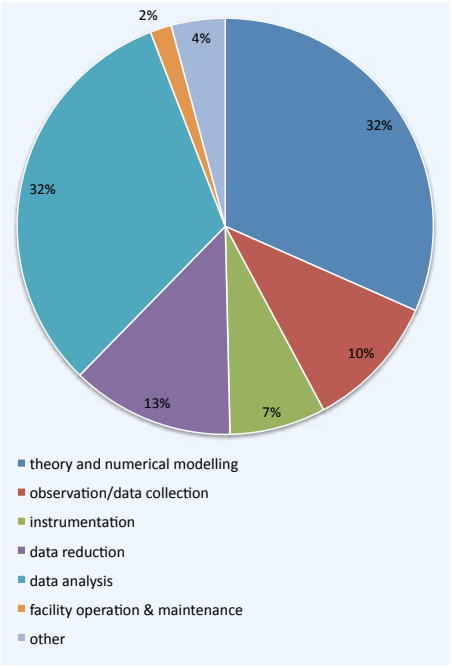
Permanent research staff – as expected – have a different pattern of work. In universities this group dedicated 60% of their time to research, and in research establishments 68%. This cohort spent less than 10% of their time on undergraduate teaching, and a similarly low proportion on teaching postgraduates. Research staff spent less time on administration too, with this taking up under 10% of their work time. This shows little change since 2010, with the exception that research staff now spend more time on research, and less on other tasks.

In astronomy and solar science, staff who responded to the survey indicated that the largest amount of their effort (figure 4) goes into theory and numerical modelling (accounting for 32%) and data analysis (also around 32%). Observation and data collection accounts for 11%, data reduction 13% and instrumentation 8%, with 2% on facility operation and maintenance and 4% on other activities. 29% of effort was related to space-based and 59% to ground-based work. Again, this shows little change since 2010.

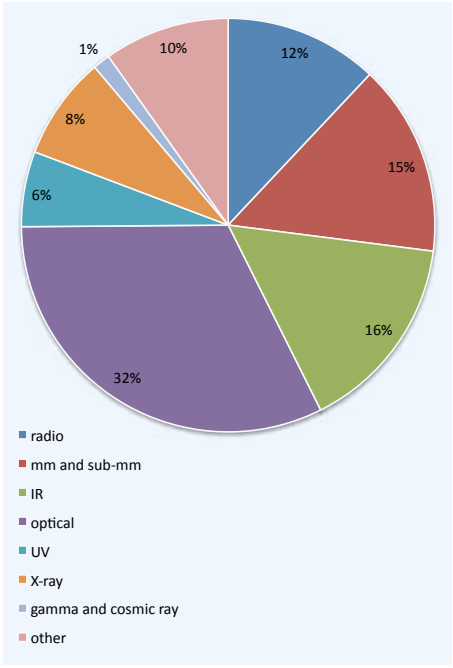
Geophysicists who responded to the survey were similarly eclectic. 33% of their research effort related to data analysis, 30% to theory and numerical modelling, and 9% to observation/data collection, with smaller proportions on data reduction (10%), instrumentation (7%), other activities (6%) and facility maintenance (4%). For this cohort 84% of effort related to ground-based and 7% to space-based activities.

## Wavelengths and facilities

A future demographic survey should probably ask if astronomers observe the universe using gravitational waves. For now, though, the questionnaire asked respondents to identify their effort in different bands of the electromagnetic




**4** Research effort by area (academic staff), in astronomy and solar system science.




**5** Research effort by wavelength (academic staff and postdocs).

spectrum (figure 5). The past 18 years have shown some remarkably consistent data. For example, in 1993, 33% of the reported research effort used optical wavelengths, with the figure at 35% in 2010 and 32% in 2016; this remains the single most popular wavelength region. Infrared amounted to 17% of observational astronomy in 1998, rising to 24% in 2010, and falling back to 16% in 2016, probably tracking the lifetimes of missions including Herschel. The Atacama Large Millimetre/submillimetre Array (ALMA) started operations in 2011; the survey shows a rise in the proportion of effort at millimetre and submillimetre wavelengths, from 7% in 1998 and 8% in 2010, to 15% in 2016.

Astronomers and geophysicists in general continue to make a great deal of use of international and space-based facilities. Although slightly fewer people responded in 2016 than in 2010, there were 1264 reported uses of these different facilities, compared with 1002 six years earlier. For astronomers, the most popular facilities were the European Southern Observatory telescopes, Hubble Space Telescope, ALMA and the Herschel Space Observatory. The UK is essentially no longer contributing to the support of the Gemini Observatory or the UK Infrared Telescope, but the facilities are still being used; their ranking had dropped to 11th and 12th respectively compared to 3rd and 8th in 2010.

## What does it mean?

One of the reasons for the RAS undertaking such a survey is to ask how well we as a society represent the demographics of the research community. The answer seems to be "reasonably well". For example, just over 21% of RAS Fellows are women, which is a smaller proportion than all students and employees who responded to this survey, with the exception of professors. But the Society has a large number of Fellows over 70 years of age; our gender balance is significantly better for younger members, as we found in a survey of the membership in 2014 (Massey 2015), which showed that women made up 37% of Fellows under 40.

Women also make up a growing fraction of more senior academic staff. As recently as 2009, the "She is an Astronomer" initiative noted that the proportion of women in senior roles had remained static, despite an improvement in recruitment at PhD level. The work of the Institute of Physics on Project Juno and the focus on Athena Swan in universities may be starting to make a difference. Girls still comprise 21% of candidates for A-level physics, so gender parity among university staff is likely to be a long way off.

The RAS has a low proportion of UK Fellows from minority ethnic backgrounds (7% in the most recent survey), comparable to the data reported here, and in both cases significantly fewer than the wider UK population and below levels among undergraduate students. UCAS figures indicate that students from ethnic minorities make up 12% of (UK and non-UK combined) undergraduates starting physics courses, 13% in astronomy and 7.5% in geophysics. There has been little progress in this area in the past six years; it remains a cause for concern for the RAS.

One striking finding is that disabled employees and postgraduate students made up a very small fraction (2%) of respondents to this survey, compared with the RAS membership (11%: probably skewed by the number of Fellows aged over 70 years old) and the national figure of 16% of the working age population. Arguments about supply seem less convincing here; the Universities and Colleges Applications Service data suggest that disabled candidates make up 7.5% and 10.3% of students on undergraduate astronomy and geophysics courses respectively. Action in this area is overdue, and our Committee on Diversity in Astronomy and Geophysics should look at this in more detail.

The data on sexual orientation are also fascinating. Postgraduates and early-career researchers in particular may be more likely to identify as lesbian, gay or bisexual as a result of long-term campaigning by the LGBT community: as same-sex relationships become more usual in society, the fear of stigmatization at work may be receding.

Despite a community that continues to be successful at winning time on national and international facilities, there are some areas of concern. The survey confirms, for example, that EU nationals are a major part of research in astronomy and geophysics, and the efforts of the Society to highlight this to government (and we hope those conducting the Brexit negotiations) are as important as ever. The growth of the research community in general also prompts questions about its financial sustainability, if we face a "perfect storm" of lost EU funding combined with the shift to applied research and experimental development implied in the government's UK Industrial Strategy. However the national landscape develops, there is no room for complacency. ●

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