Commons Science and Technology Committee: The Balance and effectiveness of research and innovation spending

Written evidence submitted by the Royal Astronomical Society

1. This is the official response from the Royal Astronomical Society (RAS) to the inquiry by the House of Commons Science and Technology Committee into the balance and effectiveness of research and innovation spending.

2. The RAS represents more than 4,000 astronomers and geophysicists, predominantly in the UK, in occupations in academia, industry, education and public engagement, and journalism, as well as others in the wider economy. Our members are described as ‘Fellows’.

3. This response was shaped by input from our governing Council, and more generally from RAS Fellows in UK universities, research establishments and industry.

<u>Declaration of interests</u>

4. The Society receives no funding from the sources listed in this report, with two exceptions:

5. The first is support from the Science and Technology Facilities Council (STFC) for our annual National Astronomy Meeting. In 2018 this amounted to a single payment of £25k.

6. In the second case a staff member at the RAS is currently the named holder of a £15k public engagement grant, also from STFC.

<u>Executive summary</u>

7. The uplift in R&D investment towards a target of 2.4% of GDP by 2027 is welcome, as is the implied commitment to raise public investment in R&D to 0.8% of GDP in the same period.

8. Astronomy, space science and geophysics in academia are principally supported by STFC, the Natural Environment Research Council (NERC) and the UK Space Agency, with the first two of these bodies now within UK Research and Innovation (UKRI).

9. We welcome the statement in the UKRI Strategic Prospectus that a cornerstone of work in science is to ‘push the frontiers of human knowledge and understanding’.

10. Despite that statement, and the general and welcome growth in public investment in R&D, the real terms cut to investment in the sciences we represent, at least 20% since 2010, shows no sign of ending.

11. Additional pressures arising from Brexit could seriously undermine UK leadership in these areas. For example, around 30% of resource funding for astronomy and space science could be lost if the UK ends its participation in EU Framework Programmes after 2020.

12. The overarching future commitment to R&D spending is shaped by the Industrial Strategy. The document describing that strategy rightly noted the low investment in experimental development as a proportion of R&D. Without comment by its authors, the same document states that UK investment in blue-skies or curiosity-driven research is also very low by OECD standards.

13. Curiosity-driven research in subjects like space science and astronomy is unlikely to benefit significantly from targeted allocations in R&D spend, for example the Global Challenges Research Fund where compliance with Official Development Assistance rules is essential, or in the Industrial Strategy Challenge Fund, where there is also limited overlap.

14. Some geophysics projects are more easily able to align with these programmes, given their geographic focus. Other projects are though less compatible. The Industrial Strategy is also missing important targets where geophysics is important and for example, the potential of geothermal energy has been almost overlooked.

15. As with astronomy and space science, resources for geophysics are subject to serious constraints on core research funding, in this case provided through NERC.

16. The Society therefore calls for a commitment to grow resources for basic, curiosity-driven research in line with the overall growth in R&D investment.

Specific points raised by the Committee

The effectiveness of public spending on R&D, including through mechanisms such as the Industrial Strategy Challenge Fund:

17. In astronomy, space science and geophysics, the UK has an extremely efficient research base. In these disciplines, the UK is ranked second or third globally in citation impact, with only Germany and the United States performing better[1].

18. Both of those nations have significantly higher levels of government R&D investment. The US invests 0.68% and Germany 0.94% of GDP in this area[2], compared with 0.52% by the UK, so in recent times our scientists delivered a strong research output, at least in the disciplines represented by the RAS, for a relatively low level of investment.

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[1] https://www.scimagojr.com/countryrank.php

[2] https://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=sdg_09_10&language=en

19. This is no reason for complacency. Astronomy and space science projects can take a decade or longer to complete, so their recent successes in part result from the funding landscape of the 2000s, before the current constraints were in place. The leading position of the UK may as a result decline in the near future.

Individual research disciplines, research councils and cross-disciplinary schemes:

20. The pattern of new investment so far is particularly challenging for curiosity-driven 'blue skies' research in disciplines like astronomy and space science. The tendency is for spending to target specific goals, such as those set out in the Industrial Strategy Challenge Fund. This approach by its very nature severely constrains support for some curiosity-driven areas that depend on bids for grant funding judged primarily on the basis of scientific excellence, peer-reviewed by researchers in the field of interest.

21. Astronomers and geophysicists are as creative as their peers elsewhere, and have for example made connections with the 'AI and Data Economy' grand challenge in the ISCF. Nonetheless this is problematic for many UK researchers, whose work is world class, but simply does not align with the new funding streams.

22. Similar issues arise with the growth in investment through the Global Challenges Research Fund. Projects supported through this route depend on compliance with Official Development Assistance (ODA) rules, and with the exception of a few excellent examples such as those in sub-Saharan Africa related to the Square Kilometre Array, the majority of programmes in astronomy and space science are unlikely to qualify.

23. Where bids do take place, researchers comment that they need to be prepared on short timescales, require a lot of preparation and if successful the resulting grants need to be spent in a short period of time. This fails to recognise the work profile typical in scientific research, where outcomes are realised on timescales of years (and longer).

24. In geophysics, GCRF has in contrast been more beneficial and researchers are more easily able to align projects to the ODA guidelines. Examples cited include work in Ethiopia on deformation of the Earth's crust, work in Santiago on active faulting, and in Nicaragua on active volcanism. Geoscientists see positives about GCRF including the ability to fund overseas collaborators properly, and to engage stakeholders directly in the research.

25. Other areas of geophysics are less suited to these funding streams, so these resources should not be seen as effective substitutes for those lost elsewhere. The Industrial Strategy is also missing important targets where geophysics expertise is important, such as in realising the potential of geothermal energy.

26. Despite the increase in public R&D investment, the core resource funding for the disciplines represented by the RAS has withered. Our researchers in astronomy and

geophysics are largely supported by the Science and Technology Facilities Council and the Natural Environment Research Council respectively, organisations with budgets that received ‘flat cash’ or slow growth since 2010.

27. Taking inflation into account, this represents a decline in purchasing power in the core programme of at least 20% in the last eight years, further constrained in the case of STFC by the growing cost of subscriptions to international projects.

28. STFC recognised this in its 2018 annual report, which stated: “*There was a significant loss of volume in the core programme between 2010 and 2015 due [to] the effects of inflation. During this period STFC lost 32% of the volume of the programme, were unable to take advantage of some new opportunities and participated in fewer new high priority projects across the programme.*”[3]

29. Both STFC- and NERC-funded researchers note the lack of resources to properly exploit capital investment in new facilities. (The STFC report commented that ISIS and CLF have operated below capacity since 2010 as a result.) Government capital investment in and subscriptions to world-leading projects like the Square Kilometre Array and European Southern Observatory are welcome, but this must be accompanied by resource funding sufficient for UK scientists to exploit these facilities.

30. The decline in real term funding also hits the UK ability to support and exploit our considerable investments in European Space Agency space missions and those where we have bi- or multi-lateral involvement (e.g. with NASA, JAXA etc.). This is particularly important in planetary and exo-planetary sciences, where the UK has acknowledged expertise and leadership both in mission design and instrument building, and in the interpretation of the data returned.

31. In parallel to these constraints, the community of potential applicants for STFC funding has grown by 50% since 2010, as universities hire astronomers and space scientists in response to the growth of popular undergraduate programmes. (UCAS data indicate that places accepted on ‘astronomy’ courses grew by 140% in the decade from 2007 to 2017[4].)

32. This description accords with the experience of researchers, who now see an increasingly competitive grants system, and an overall reduction in financial support. For example, the number of STFC postdoctoral research fellowships awarded in 2017 was 40% lower than in 2006, despite applications doubling in the last two decades[5].

33. STFC has taken steps to protect PhD student numbers, which is welcome, though the overall funding situation means their prospects of pursuing a long-term career in their field in the UK are significantly lower than in the past. (The RAS of course

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[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725154/stfc-annual-report-accounts-2017-18-web.pdf

[4] Data purchased by the RAS and the subject of a report to be published later this autumn

[5] Correspondence between the RAS and STFC

recognises that the majority move into other sectors after completing their doctorates, and bring their intellectual training to bear in industry and the wider economy. The Society has documented examples of this impact in a series of publications[6].)

34. The squeeze on grant funding is seen as detrimental to newer research groups in particular. Lacking a track record, there is a view that their bids have an inherent disadvantage and in a tight resource environment are even less likely to succeed. It would be useful to expand programmes for early career researchers, such as the Ernest Rutherford Fellowships and STFC New Applicants Scheme, to address this.

35. An additional point applies in the case of NERC. Its research institutes, including the National Oceanography Centre, which is relevant to geophysics, are preparing for a change of status to independent charitable companies. We are concerned that this is not without cost, and encourage the government to cover the costs without diverting support from any scientific activities.

Pure and applied research

36. In "Industrial Strategy: Building a Britain fit for the future"[7], the UK government set out its ambitions for economic growth and high productivity. This document built on an earlier consultation[8] that rightly identified the low proportion of UK GDP invested in experimental development compared with other OECD states.

37. There seems however to be little more than a notional recognition that curiosity-driven research is a core part of the R&D ecosystem, underpinning and enabling many applications-driven research areas. It is also an area where the UK has modest investment by international standards. In the same consultation document on the industrial strategy, the UK is ranked 25th of 29 OECD countries considered by share of GPD invested in basic research. There is little evidence that this has been 'protected' as described, and there appear so far to be no specific plans to grow this to help meet the 2.4% R&D target.

38. The UKRI Strategic Prospectus[9] recognises the value of science in pushing the 'frontiers of human knowledge and understanding' (a core reason for curiosity-driven research), and that this leads to economic, social and cultural impact (for example citing the transfer of technology from the LIGO gravitational wave observatory to industry and the involvement of companies in the SKA radio observatory). These ambitions will be more effectively delivered if accompanied by growth in investment in core research council programmes.

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[6] See https://ras.ac.uk/ras-policy/impact-and-industry
[7] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730048/industrial-strategy-white-paper-web-ready-a4-version.pdf
[8] https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf
[9] https://www.ukri.org/files/about/ukri-strategy-document-pdf/?pdf=Strategic-Prospectus

39. The reference to the Haldane Principle in the prospectus is welcome, as is the commitment to establish a non-ODA Fund for International Collaboration, assuming this will be open to curiosity-driven research projects.

Phasing of the increase in R&D spending by UKRI over the next few years

40. Astronomy and space science projects in particular are often long term. It can take a decade or longer for results to become apparent, for example from the construction and commissioning of a ground-based observatory, or the design, build, launch and finally arrival of a space probe at its destination. Successes we see today result in part from the funding landscape of the 2000s, before the current constraints were in place. The leading position of the UK may as a result be set to decline in the near future.

41. Given the ongoing constraints on funding for curiosity-driven research, and the likely adverse impact of Brexit on astronomy and geophysics, it would be appropriate for the government to move quickly to address this potentially serious deficit. In the coming Spending Review, the Society recommends that the Government send a positive signal to the research community and our international partners.

42. In curiosity-driven research in subjects like astronomy and geophysics, we therefore call for a commitment to grow UKRI resource funding, assessed by scientific peer review, in line with the move to the 2.4% R&D target.