

UK Engagement with Space: response from the Royal Astronomical Society

1. This is the official response from the Royal Astronomical Society (RAS) to the House of Lords Committee on UK Engagement with Space inquiry.
2. The RAS represents more than 4,000 astronomers and geophysicists, in the UK and around the world, 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. Space is a central area of interest for the Society, so we are pleased to be able to respond to this inquiry, and would be delighted to give oral evidence to the Committee to explore this further.

Executive Summary

4. In our response we emphasise the importance of the complete space 'ecosystem', with a synergy between work in academia and industry. UK space science is extremely strong by international standards, ranked fourth in the world in citation indices, and vital for the success of the industry as a whole.
5. The likelihood of a challenging settlement for the Science and Technology Facilities Council, which in the last few years benefited from some growth despite inflation, and the turmoil in the United States with possible deep cuts to NASA, represent serious threats to UK space science. We urge the UK government to recognise the value of sustained investment in our sector, given its clear benefits for industry and for the economy as a whole, and to use its influence to try to persuade the US administration to change course.
6. If this effort is unsuccessful, then the UK should work with European and other partners to deepen cooperation, including the recruitment of at least some of the talented people in the US space sector who will be put out of work.
7. A ten year funding settlement for basic research along the lines of those proposed for other areas of science, continued association to Horizon Europe, and resources to return stability to the higher education sector would be enormously helpful for the development of academic space and astronomy research.
8. In space debris and space weather, we draw the attention of Committee members to the strength of the UK in academic research in these areas. We also note the emerging concern about the environmental consequences of disposal of satellites through burning them up in the upper atmosphere of the Earth. This requires adequately funded research to explore both the atmospheric impact and possible mitigations, including alternative disposal methods.

9. Space law and regulation is not fit for purpose in the domain of protecting ground- and space-based astronomy, a key 'space activity', from the impact of large satellite constellations in Low Earth Orbit.
10. Space and astronomy remain continue to inspire young people in particular to enter the sector, and science and engineering more generally, as well as the wider economy. There are ongoing issues in the diversity of recruitment and the academic workforce. The proportion of women on courses and in more junior workplace roles stuck at a little under a third for some years now, and lower representation at more senior levels. Alongside this, people from some minority ethnic groups are barely represented in space science and astronomy at all.
11. Despite our concerns, in the coming decades there will be enormous opportunities to help us answer some of the fundamental questions about the universe we live in, such as the presence or absence of extraterrestrial life. If the UK wishes to retain its leading position in space science and astronomy, then it should allocate the resources to participate in at least some of these extraordinary projects.

Questions set out in the inquiry:

The opportunities and challenges relating to the UK space sector, including:

- *Where the UK's space sector has comparative strengths.*
12. UK space science, the area of the space sector closest to the interest of the RAS, is an area of significant strength, and a vital part of the space industry ecosystem. Our most recent demographics and research interests survey indicates that in 2023 more than 1800 people worked in astronomy and solar system science in universities, a doubling since the 1990s¹.
 13. This workforce is highly productive, and the UK is ranked fourth in the world on the basis of international citation indices in space and planetary science. UK space scientists also play a leading role in building instruments for, and scientific exploitation of data from, many high profile international space missions, for example JWST, Gaia, BepiColombo and JUICE. We expect to see this continue into the future with projects like the Habitable Worlds Observatory set to launch later this century.
 14. The UK is also home to a strong scientific publishing industry, with the journal Monthly Notices of the Royal Astronomical Society, one of the world's leading primary research journals, covering many aspects of astronomy and space science. This 200-year old journal earned £3.4 million in 2024², and is also a significant UK

¹"The Demographics and Research Interests of the UK Astronomy and Geophysics Communities 2023", S. McWhinnie, 2023. <https://ras.ac.uk/ras-policy/community-demographics/demographic-survey-2023>

² Royal Astronomical Society annual report, in preparation

export, with authors around the world choosing the journal for peer review and dissemination of their research.

- *How the UK's space sector's growth can be supported.*

15. Government support for basic, curiosity-driven academic research in astronomy and space science is essential for the UK to continue to be seen as a leading space power.
16. In recent days UK Research and Innovation, and the Science and Technology Facilities Council (STFC), one of the two main funders of space science, received settlements which we are advised are at best equivalent to flat cash (the move away from 'over profiling' complicates comparisons), after several years of increases, albeit affected by high inflation, which followed more than a decade of austerity budgets. These settlements will be challenging for academic research in space and astronomy³⁴.
17. Even before the announcement, there was a delay of around four months in sending out decisions on applications for grants from STFC, and the letters eventually sent contained the ominous reference to the need to make "difficult decisions" and a "lower than anticipated" success rate. The situation was described in detail by the report from the chair of the STFC Astronomy Grants Panel sent in March⁵.
18. The direct result of this is fewer funded postdoctoral research associates (an estimated drop from 80 to 60 moving from the 2023 to 2024 grants rounds), the lifeblood of innovative science, many of whom will later take their skills into private industry and the wider economy as a whole. A number may choose to seek positions in other countries with a strong research base in a new "brain drain".
19. The Society welcomes the increase in the UK Space Agency budget of around 10%, assuming that space science is a concomitant beneficiary, which covers different aspects to STFC of the development of missions, and the ongoing financial support for UK association to the Horizon Europe programme.
20. Given the geopolitical turmoil at present, the Society urges the Government to continue to maintain and grow its investment in science, including in basic research, to support the space industry as a whole.
21. The Government should also act to tackle the funding crisis in higher education institutions, many of whose staff are essential for delivering research in space science, and whose jobs are under threat as a result of insufficient tuition fee income.

³ "DSIT allocations confirm strong overall settlement, but tight UKRI finances", CaSE rapid analysis, and private communication

<https://www.sciencecampaign.org.uk/analysis-and-publications/detail/dsit-allocations-confirm-strong-overall-settlement-but-tight-ukri-finances/>

⁴ Ministers confirm UK Research and Innovation budget will fall <https://www.researchprofessionalnews.com/rr-news-uk-research-councils-2025-4-ministers-confirm-uk-research-and-innovation-budget-will-fall/>

⁵ "AGP Chairs report, March 2025"

22. We in addition note the importance of continued membership of Horizon Europe and future EU Framework Programmes, which have delivered substantial benefits to UK space science and astronomy since their inception.
23. Looking forward, the indication is that the next spending review settlement will be for four years, which will allow some longer term planning by space research groups, and is a positive change from the one year settlements of recent years.
24. Given the long timescale for projects in space science to come to fruition, the Government should extend its manifesto commitment to ten year settlements for other areas of science to this field, and thus give greater certainty to research groups and their industrial partners.
- *How the UK may capitalise on new space technologies, such as nuclear engines, space-based solar power, in-space manufacturing, resource extraction, active debris removal, in-orbit servicing and artificial intelligence.*
25. The RAS is broadly supportive of the development of new space technologies, and we strongly support efforts to mitigate and remove artificial space debris. A cautionary note on some of these, for example large constellations of satellites, is that they have a detrimental impact on the science of astronomy at both optical and radio wavelengths.
26. One positive example here relates to astronomy and space science as disciplines that generate large volumes of data. Machine learning is a key tool here, as is the development of AI more generally, with applications for space projects in general, as well as the wider economy. One example of this is the UKRI AI Centre for Doctoral Training in Decision Making for Complex Systems, with an explicit link to astronomy as well as other sciences⁶.
- *Opportunities, challenges, and potential for growth in the different sub-sectors operating in the space sector, including:*
 - *Space manufacturing;*
27. In our sector, continued support for space science and the development of missions will allow the UK to manufacture space-based instruments. This will build on a strong legacy in this area, including in recent years the James Webb Space Telescope (JWST), the BepiColombo mission to Mercury and the JUICE mission to Jupiter's moons, and the Gaia and Euclid observatories.

Existing international partnerships that the UK is involved in, and the potential for future partnerships with both state and commercial actors.

⁶ UKRI AI Centre for Doctoral Training in Decision Making for Complex Systems <https://www.ai-decisions-cdt.ac.uk/>

28. We note later the geopolitical issues arising from US policy on science and how this may threaten our previously secure trans-Atlantic partnerships. There are wider concerns about some alternative national partners, but at the very least the UK should work to offset this risk, by deepening its relationship with other European countries through ESA and individual bilateral programmes, and explore further cooperation with India and Australasia.

The importance of the provision of a safe operating environment in space, and how the UK can contribute to this, in particular regarding space weather and space debris.

29. Taking space weather first, RAS Fellows were instrumental in the work that led to this being added to the National Risk Register in 2012.
30. The UK has a vibrant and diverse scientific community in this area, covering solar physics, heliospheric physics and the terrestrial magnetosphere and ionosphere. These communities are represented by the UK Solar Physics (UKSP) and Magnetosphere Ionosphere Solar Terrestrial (MIST) groupings, both affiliated to and supported by the RAS, with strengths in observational programmes, numerical simulations, data analysis techniques, including machine learning, and theoretical work.
31. Both of these two research communities have many young, thriving and active researchers. The funding landscape is somewhat fractured, however, with ground based assets largely supported by NERC while space based assets are largely supported by STFC and UKSA.
32. This research activity led to the relatively newly established Met Office Space Weather Operations Centre (MOSWOC), the success of which has been recognised through the award of the RAS Group Achievement award for Geophysics. MOSWOC also received major support from the UKRI multi research council Space Weather Instrumentation, Measurement, Modelling and Risk programme.
33. The UK space weather community in addition makes significant contributions to ESA's Space Situational Awareness programme. It is also important to note that this will also support future ESA exploration programmes for crewed spaceflight to the Moon and Mars. Accurate space weather forecasting is also essential for the controlled deorbiting of defunct spacecraft from Low Earth Orbit (LEO), as the variable density of the thermosphere (a higher layer of the Earth's atmosphere), which responds to space weather events, can interfere with plans to ensure debris is brought down over uninhabited areas.
34. In the area of space debris, the UK has expertise in this area at institutions such as the Astronautics Research Group at the University of Southampton, and in the UK Space Agency. A significant concern is that collisions in Earth orbit will increase the number of pieces of debris, and lead to a cascade of similar events. This so-called Kessler syndrome could render the incredibly valuable resource of near-Earth space

uneconomic to exploit, through shortened satellite lifetimes, litigation for damage done, and the increased cost and difficulty of planning missions, including crewed spacecraft travelling to the Moon and Mars.

35. Notwithstanding our earlier point about removal of debris from orbit, there is now an additional concern about the environmental impact of material re-entering the Earth's atmosphere, particularly given the huge increase in the number of satellites in recent years (fivefold since 2019 and potentially a hundredfold or more by the 2030s). Space operators are expected to plan for passive or active removal of satellites at the end of their lives, and the usual route is to dispose of them by burn up in the atmosphere.
36. A number of studies are now working on whether this approach will interfere with the chemistry of the upper atmosphere, for example through ablating metals (where they are stripped off re-entering satellites by the heat of re-entry) causing harm to the ozone layer. This is an area the Committee and the Government should investigate with some urgency, to better understand the consequences of the rush to develop LEO.

The development of international space law and regulation.

37. The RAS interests in international space law and regulation centre on protecting astronomy from the impact of satellite constellations (large numbers working for a specific purpose) in Low Earth Orbit, and the recognition of our science as a 'space activity'.
38. The two main international organisations covering this are the International Telecommunications Union (ITU), with OfCom the UK affiliate, and the United Nations Office of Outer Space Affairs (UNOOSA), where the UK engages through the UN Committee on the Peaceful Uses of Outer Space (UN COPUOS).
39. Satellites interfere with astronomy at radio wavelengths through downlink transmissions and unintended emissions from onboard electronics. Beyond a narrow band protected by the ITU for radio astronomy, the radio spectrum needed for our science is open to a wide range of users. Historically it was possible to locate radio observatories at sites far from interference to enable observations across the spectrum, but the advent of large satellite constellations with global coverage makes this much more challenging, and international law and regulation does not take this change into account.
40. In visible light, satellites shine by reflecting sunlight, thus damaging astronomical observations through interfering with images. As with radio astronomy, the global reach of satellite communications networks means there are no longer sites where telescopes can be sited free of interference. International space law offers little protection in this regard, so we welcome the decision by UN COPUOS (the RAS is one

of the advisors to the UK delegation) to discuss this is in its Science and Technology Subcommittee, supported by a group of countries including our own⁷.

41. Areas affected by this interference include the detection of near-Earth objects and asteroids and comets in general, and transient phenomena such as counterparts to gravitational wave events. There is a risk that satellites blocking these at a crucial point, and data is irrevocably lost.
42. The RAS view is that we continue to strongly support efforts to regulate and put in place guidelines for spacecraft deployment at an international level, but that this must be accompanied by efforts in individual nations, particularly spacefaring powers, which are likely to be developed at a faster pace.
43. In the UK the RAS is represented on the executive board of the Earth Space Sustainability Initiative (ESSI)⁸, developing standards for satellite operators, and we convene a satellite constellation advisory group that includes policy and legal considerations within its remit. We commend these bodies and the UK-based Global Network on Sustainability in Space (GNOSIS) to the Committee as sources of expertise in this area.
44. At a global level, the RAS is a contributing member of the International Astronomical Union Centre for the Protection of the Dark and Quiet Sky from Satellite Constellations (IAU CPS). This brings together scientists and astronomers into four hubs covering policy, industry, community engagement and work on satellite positions and impact mitigation. The IAU CPS is a key body for our sector, and also represented as an observer at UN COPUOS.

The collaboration between academic institutions, government, and commercial space firms in the UK, including but not limited to space research and development and space spin-out and start-up firms.

45. The RAS has many example of these collaborations⁹, and they are also cited in the results of the 2021 Research Excellence Framework. We note that finding an industry partner for knowledge transfer is not always straightforward – a member of our governing council describes a nine month search for one, so far without a positive result.

Education and skills; in particular the skills gap in the UK space sector.

46. In the specific areas of astronomy and space science, the number of students accepting places on undergraduate courses grew from just over 600 in 2005 to nearly 1800 in 2022, demonstrating its continued value as a ‘STEM attractor’. There is no

⁷ See e.g. “ Conference Room Paper on the Protection of Dark and Quiet Skies for science and society” https://www.unoosa.org/res/oosadoc/data/documents/2025/aac_105c_12025crp/aac_105c_12025crp_22rev_3_0_html/AC105_C1_2025_CRP22Rev03E.pdf

⁸ Earth Space Sustainability Institute <https://www.essi.org/>

⁹ See <https://ras.ac.uk/ras-policy/impact-and-industry>

doubt that space is an inspiring discipline, encouraging young people in particular into the sector and into science and engineering as a whole.

47. RAS literature has multiple examples of how these students enter careers in a wide range of applications, using their skills across the downstream and upstream space sector¹⁰.
48. An ongoing area of concern is the lack of diversity in the sector, at all levels from undergraduate students to academics in permanent positions. UCAS data and our 2023 demographics and research interests survey suggests that slightly less than a third of undergraduates in astronomy and space science are women, a proportion essentially unchanged over the fifteen years¹¹.
49. There is also a clear under-representation of people from particular minority ethnic groups. Just 3% of those accepting undergraduate places in 2022 stated that they are Black, and 97% of the British academic workforce in our 2023 survey (dominated by astronomers and space scientists) was White.
50. As noted above, many universities are in a parlous financial position, which presents a possible threat to the supply of students and early career researchers into the space sector.
51. One example of this are solid-Earth geophysicists, who use tools like Earth Observation for their study of our home planet. The supply of relevant geophysics graduates is now so low that the existence of this discipline in the UK faces an existential threat. UCAS data supplied to the RAS indicated 120 places were accepted on undergraduate courses in geophysics in 2022, and several courses have closed in recent years¹².
52. The RAS Early Careers Network¹³, founded in 2020, is an example of our efforts to tackle some of the issues above, at least among those already enrolled on either postgraduate courses or their first research positions. Members of this group prioritise efforts to secure their careers in science, and the value of connecting with employers that can take advantage of their skillset.
53. We suggest that the Government does more along these lines, as there is an expectation that the vast majority of PhD students will leave academia for other occupations, at the same time as private companies in the space sector report ongoing difficulties in recruiting skilled people.

The future of UK space science and civil exploration.

¹⁰ See <https://ras.ac.uk/education-and-careers/careers-booklet-sky-high-and-down-earth>

¹¹ UCAS data purchased by the RAS relating to courses in astronomy

¹² UCAS data purchased by the RAS relating to courses in astronomy

¹³ See <https://ras.ac.uk/education-and-careers/Early-Careers>

54. Astronomers and space scientists are nothing if not ambitious. There are for example Europe-wide plans such as the Astronet science vision¹⁴, and the European Space Agency (ESA) Voyage 2050 planning framework¹⁵. The RAS has to remain neutral in the choice of specific astronomy and space science projects, but we note that there are many inspiring ideas on the table, such as the proposed Habitable Worlds Observatory seeking Earthlike planets around other stars and the idea of a sample return mission to the moons of the outer planets.
55. If the UK seeks to remain at the forefront of space science and exploration, then the Government will need to push for our participation in at least some of these extraordinary projects. The benefits of this are palpable, from driving forward advances in science and engineering to fostering enthusiasm for science in general among young people. We also note that investment in project and mission development needs adequate resources for their exploitation – we should not leave harvesting all the fruits of these capitals investments to other nations.

The impact of space on national security and resilience, for example:

- *The implications of geopolitical developments on the UK's activity in space.*

56. The new US administration appears intent on dismantling much of its science base, including in agencies such as NASA, with immediate cuts to funding, resulting in dismissal of research staff, alongside an outright attack on any further work to diversify its workforce, and an erasure of much its historical record.¹⁶
57. The reported proposals are without parallel in recent history, and include a two thirds cut to the astrophysics budget, a 50% cut to heliophysics, a greater than 50% cut to Earth science, and a 30% cut to planetary science.^{17 18}
58. The consequences could include the closure of the Goddard Space Flight Center, the cancellation of the already assembled Nancy Grace Roman Space Telescope, and ending funding for the Mars Sample Return mission. These are missions with significant ESA and UK involvement and investment.
59. Given the many decades of partnership in space and space science between our two nations, via ESA and more directly, we are concerned that the US is no longer a reliable collaborator.

¹⁴ Astronet: A Planning and Advisory Network for European Astronomy <https://www.astronet-eu.org/>

¹⁵ Voyage 2050: Long-term Planning of the ESA Science Programme <https://www.cosmos.esa.int/web/voyage-2050>

¹⁶ "Confusion and worry as DOGE cuts hit NASA", Science, 27 March 2025 <https://www.science.org/content/article/confusion-and-worry-doge-cuts-hit-nasa>

¹⁷ "Trump White House budget proposal eviscerates science funding at NASA" <https://arstechnica.com/space/2025/04/trump-white-house-budget-proposal-eviscerates-science-funding-at-nasa/>

¹⁸ "AAS Gravely Concerned About Cuts to NASA Science Funding" <https://aas.org/press/aas-statement-nasa-cuts#:~:text=In%20particular%2C%20the%20proposals%20included,30%25%20cut%20to%20planetary%20science.>

60. This could have serious consequences for our space science programme, for example in planned missions that no longer take place, and scientific research collaborations that founder as a result.
61. We urge the UK to use its influence to persuade the US government to change course, and to publicly recommit to support the already planned missions and scientific research programmes that involve international collaboration.
62. If that does not happen, then the UK should work with its other partners in Europe and elsewhere to provide a home for the many talented scientists and engineers in the US who find themselves out of a job, or who choose to leave for a more welcoming environment.