House of Commons Select Committee on Science and Technology: Inquiry into astronomy and particle physics

Submission from the Royal Astronomical Society

1. In recent years UK astronomy and space science has been in a strong position. One measure of this is the productivity of UK researchers, who between 1999 and 2009 published 18288 papers that received 330311 citations, making us the most highly-cited nation after the USA.

2. The RAS welcomes support for our science from government, for example the decision of BIS to continue the implementation of the Drayson review. This addressed specific issues associated with the Science and Technology Facilities Council (STFC), such as the difficulties posed by changes in exchange rates and Net National Income (NNI) which determine the subscriptions paid by nations for the membership of international projects such as the European Southern Observatory (ESO) and CERN. We further welcome the steps taken to tackle the issue for STFC posed by the costs of domestic facilities used by a number of Research Councils.

3. However, the Comprehensive Spending Review and resulting allocations for the science budget plan for a steep reduction in STFC resource funding for astronomy over the period from 2011 to 2015. The impact of this flat cash settlement will depend on the level of inflation over the same period, but is expected to be of the order of 10-15%. Furthermore, as the cuts resulting from the 2007 CSR are implemented astronomy will see an additional decline in cash terms of around 11% by 2015, with resource funding falling from £81.4m to £72.7m and hence a total loss of purchasing power of 21-26%. This retrenchment threatens to cause irreversible damage to the UK astronomy and space science programme.

Impact of reduced capital funding on UK capability

4. In *capital* terms, STFC and hence UK astronomy faces an even more severe reduction. According to the material supplied by STFC to the Committee, the capital available for each of the financial years from 2012/13 to 2014/15 will be 56% lower than in 2010, declining from £23.27m to £10.57m.

5. This is a change which takes some time to work through the system, in that it affects existing infrastructure, such as the renewal of equipment as well as the ability to participate in new projects including the development of new instrumentation for observatories vital to our national capability.

6. Researchers in universities often bid for funds for small scale laboratory equipment and computers. These count as capital investment and are therefore likely to be seriously affected by the planned cuts.

7. Other areas of concern are magnetohydrodynamics, theoretical astrophysics and cosmology, all of which use High Performance Computing facilities to model different physical problems. This has been an area in which the UK excels and includes facilities in Durham, Leeds, Warwick and St Andrews. The supercomputers that are crucial for this work become obsolete as technology and potential computing performance advance, so periodically researchers need to renew this equipment. Any future applications for grants relating to this research may thus also fall foul of restrictions on capital.

8. Alongside STFC funded research, space scientists receive some funding from the new UK Space Agency. For this group the major capital costs associated with research projects are the spacecraft and its launch vehicle. With the Agency delivery plan not yet published, we are concerned that its budget will not be sufficient to cover its inherited responsibilities.

9. The cut in resource funding means that the UK is about to lose a competitive advantage it enjoyed through participation in facilities across wavelengths, in both hemispheres, on the ground and in space. In combination with the capital cuts, this risks causing long-term damage to the astronomy research base.

Impact of withdrawal from international ground-based facilities (for example the Gemini Observatory and Isaac Newton Group of telescopes) on the UK's research base and international reputation

10. In the near future (in most cases by spring 2012) the UK plans to withdraw from all optical and infrared observatories in the northern hemisphere. These facilities include the Isaac Newton Group (ING) and Liverpool Telescope (LT) on La Palma in the Canary Islands and the UK Infrared Telescope (UKIRT) and Gemini North telescope on Hawaii. The UK will continue to have access to ESO in Chile.

11. These plans result from a prioritisation exercise carried out by STFC in 2009. Despite scientific panels advising against this withdrawal, the research council made these decisions in order to manage a decline in its funding that resulted from the 2007 CSR allocation.

12. The UK is a partner in a number of existing and future space-based observatories, such as the Herschel Space Observatory, Planck, GAIA and the James Webb Space Telescope, all of which observe objects across the whole sky.

13. In addition there a number of flagship radio observatories in the northern hemisphere such as Jodrell Bank and the Multi-Element Radio Linked Interferometer Network (e-MERLIN) and LOw Frequency ARray for radio astronomy (LOFAR) arrays.

14. Once the cuts take effect, UK researchers will be able to use these space-based and radio observatories to study objects in the northern part of the sky but will have no optical and infrared facilities with which to follow up that work. These changes will mean that UK scientists who make discoveries using a space based or radio observatory could then see leadership of this work pass to their peers in other nations.

15. In contrast to the UK, the ESO member states Germany, Italy, France, the Netherlands and Spain all have access to other optical / infrared facilities elsewhere in the northern hemisphere. We are concerned that the decision to rely solely on ESO facilities is moving us from the first to the second division for UK astrophysics (involvement will be comparable to that by Portugal) and that it will further mean that we have much less to bring to any new international partnerships.

16. The decision to pull out from and certainly the abruptness of the withdrawal from the Gemini Observatory in 2007 has also undoubtedly had a negative impact on the reputation of the UK as a reliable international partner and may hinder our ability to join future collaborations.

17. In consultation with our Fellowship, we have established that there are a number of areas like stellar astrophysics, studies of gamma ray bursts and searches for planets around other stars that will be badly affected by the planned cut in provision. This work, where the UK is in a world-leading position, is particularly dependent on access to a suite of telescopes in both hemispheres.

18. Further support for this perspective comes from the STFC Ground-Based Facilities Review led by former RAS President Professor Michael Rowan-Robinson which reported in 2009. His panel surveyed the UK astronomy community and evaluated different observatories operating at optical, infrared, submillimetre and radio wavelengths. The Review accepted that withdrawal from Gemini was inevitable, but backed continuing UKIRT operation and instrument development and urged STFC to find solutions for UK access to large telescopes elsewhere in the northern hemisphere.

19. The Review panel also supported continued involvement in the ING, in particular citing the use of the William Herschel Telescope (WHT) to support follow-up work and provide a test-bed for instrument development. A continuing presence on La Palma could allow the UK to negotiate access to the Gran Telescopio Canarias (GTC), a telescope with a 10-m mirror operated by Spain, Mexico and the US, that is yet to come into full operation.

20. In addition, the 2010 report by ASTRONET (which brings together national agencies, including STFC, to develop a pan-European approach to astronomy) described a range of scientific programmes that could be carried out on the WHT in the years ahead, in part complementing the work of new space-based observatories.

21. Measures of the productivity of different observatories also support continued involvement in the ING telescopes. In a paper in 'Astronomische Nachrichten' in 2008 Trimble and Ceja evaluated astronomical facilities around the world. The table below compares publications resulting from the 4-m mirror William Herschel Telescope (WHT) and 2-m mirror Isaac Newton Telescope (INT) and two other similar instruments.

Publications and citations resulting from medium-sized telescopes

Telescope	**Papers (from 2001-3)**	**Resulting citations (from 2002-6)**
Isaac Newton Group	246	2962
Kitt Peak National Observatory 4-m telescope	79	1244
Cerro Tololo Inter-American Observatory 4-m telescope	96	1198

22. It can be seen that the ING compares favourably with the other facilities. Given this productivity, it is unsurprising that it is highly regarded by the research community and that consultation for this RAS submission elicited strong support for continued UK involvement in La Palma.

23. Current operational costs for the ING site are around €3.5m (£2.9m) per annum, with €1.3m (£1.08m) of this paid by the UK. This budget has already been pared to a minimum and funds only a limited operation. A more realistic UK contribution for full operations is around €1.5m (£1.26m) per annum. To remain competitive in the future the observatory needs to develop new instruments such as the new wide-field multi-object spectrometer which is now under consideration. A sensible figure for the annual UK budget requirement is €2.5m (£2.1m) per annum. Without an investment of this kind to recover access to northern hemisphere facilities we fear that UK astronomy will be internationally uncompetitive.

Whether the Science and Technology Facilities Council (STFC) has sufficiently engaged with its research community in these two areas on its strategic direction and impacts of budget reductions

24. There is a consensus that STFC has made real efforts to improve its engagement with the research community from 2009 onward. The prioritisation exercises that informed recent funding decisions drew on the advice of research scientists organised into thematic panels, although in key respects they did not follow this advice.

25. Senior representatives from STFC are also regularly invited to attend the Astronomy Forum, the body convened by the RAS made up of heads of astronomy and space science research groups across UK universities.

26. The astronomical community sees the origins of the STFC crisis as dating from its formation in 2007. At that time decisions on programmes and grants resulting from a budget shortfall of some £80m were announced with little or no consultation.

27. Examples of community tension at that point included political and media campaigns such as the petition to Downing Street which attracted almost 20,000 signatures urging the then Government to mitigate this shortfall. In April 2008 the House of Commons Innovation, Universities, Skills and Science Committee (which covered the work of the present Science and Technology Committee at that time) found weaknesses in STFC management, communications and its peer review system. The Committee recommended substantial and urgent changes to the Research Council to restore confidence in its operation and to give it the leadership it needed.

28. Despite welcome changes, there is however still concern that at the most senior level, STFC does not act as an advocate for science in the way that it might. This came across starkly in the Select Committee hearing on the Research Council budget allocations, where the STFC Chief Executive Officer made statements which require clarification as they left a misleading impression.

29. Firstly, the Society disputes the assertion that there had been a planned over investment in astronomy following the UK accession to ESO in 2002. This is in contrast to the recollection of the scientific community and not supported by any documentary evidence that we are aware of. On the contrary, areas like grant funding (at least measured by the number of postdoctoral research associates hired) have seen a 50% decline since 2006 and are now lower than in the year 2000.

30. Although very different funding systems make international comparisons hard to make, the number of members of the International Astronomical Union is a reasonable measure of research activity in different countries. Adjusted for population size, the UK is very much in the middle of the table, with 8.4 members per million people, compared with 12.3 in the Netherlands and 4.7 in Japan. We also note that in the 5 years leading up to 2008, the UK astronomy community grew by 14%, in line with the overall expansion of higher education. Both these pieces of evidence suggest that the UK does not have too many astronomers.

31. Our second serious concern is around the withdrawal from all northern hemisphere optical and infrared observatories referred to earlier in this submission. The evidence given to the Committee implies that this decision was also planned following ESO accession and is part of a long-term scientific strategy. The RAS notes that when the

UK joined ESO it was recognised that we would scale back our involvement in some facilities (see for example the report by Professor Martin Ward in 2001 in 'Astronomy and Geophysics'), but the plan now being implemented goes far beyond that. The decision to implement a complete withdrawal was made for financial rather than scientific reasons, in contrast to the statement made to the Committee.

32. The Committee may also wish to note that the STFC Council has an unusually low number of members with an academic background, in contrast to the other Research Councils. Given that the scientific advisory panels sit some way below the decision-making committees in STFC, recruiting more scientists to its Council to better reflect the balance of research funded would only lead to a modest increase in its size and we feel would also assist in the overall engagement process.

Opportunities for, and threats to, outreach and inspiring the next generation of astronomers and particle physicists

33. Astronomy is recognised as being an ideal subject for engaging young people and the wider public in science. Evidence for this includes the study by Osborne and Collins published in 2000, which examined the views of pupils and parents on the school curriculum and found that astronomy and space generated 'universal enthusiasm'. Studies that looked at the impact of specific outreach projects in astronomy and space science on school pupils and found a similarly positive effect.

34. At university level, the Institute of Physics surveyed physics students in 2007 and found that 53% of undergraduates saw astronomy as being of 'significant interest' in attracting them to the subject; by the final year this rose to 73%.

35. More generally, astronomy is a popular topic for broadcast and print media, with a good recent example the TV series 'Stargazing Live', which attracted more than 3 million viewers.

36. The Society recognises that in contrast to some other Research Councils, STFC has a good record of promoting public engagement through the Science in Society programme. The long-running small and large awards schemes encourage researchers to engage in outreach programmes that promote the areas of science funded by the research council, although funds available for these have declined. We also strongly support the STFC Science and Society Fellowships that allow active researchers to spend the equivalent of one day a week over the course of a year pursuing public engagement work.

37. Some third sector organisations also fund astronomy outreach, including the RAS, which awarded £180k to 89 projects taking place as part of the International Year of Astronomy 2009 (IYA 2009), but more typically offers around £25k per annum.

38. Activities in astronomy public engagement work often celebrate particular events like the 50th anniversary of human space flight this year (Gagarin 50) or the 400th anniversary of Galileo's use of the telescope in IYA 2009. That year saw almost a million people take part in events run by both research staff and voluntary and community groups.

39. Other work runs over the longer term, such as the National Schools Observatory (NSO) that allows schools to access time on professional observatories via the Internet or the engagement programmes of science centres like the Royal Observatory Greenwich (ROG). The NSO has almost 2000 teachers and 3500 pupils registered as users who typically make 620 observing requests each month. Each year the ROG hosts 14000 school pupils and almost 1.6 million visit the site, making it one of the most popular tourist attractions in the UK.

40. We believe that such a vibrant public engagement programme depends on a vibrant research programme. Although the majority of participants in astronomy engagement programmes and projects will not pursue the subject in higher education, many established scientists in other disciplines cite early exposure to astronomy as a motivating factor for a STEM career. In particular, although it is too early to assess, there is a risk that scaling back research activity and the opportunities that come with it will harm the perception of UK science with young people who may then seek other career paths.

41. On many measures, astronomy is in the midst of a 'golden age'. In the decades ahead, new facilities like the European Extremely Large Telescope and the James Webb Space Telescope are expected to lead to a flood of new discoveries, for example enabling us to see Earth-like planets in orbit around other stars and to detect the first stars that formed after the Big Bang.

42. Cutting-edge research of this kind provides great opportunities to inspire a new generation of scientists and it would be unfortunate if the UK did not continue its involvement in this work.

43. We recognise and applaud the efforts made to limit the cut in the number of STFC-funded PhD studentships in astronomy, which declined by 15% over the last four years but should remain at 122 for this CSR period.

44. One clear area where opportunity is tightening is in postdoctoral posts in astronomy. These have declined by more than 50% since their peak, from around 120 in 2006 to 56 in 2011. The Society is concerned that this will deter the best PhD students and research leaders from remaining in the UK.

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