House of Commons

Science and Technology Committee

Astronomy and Particle Physics

Fourth Report of Session 2010–12

Volume II

Additional written evidence

Ordered by the House of Commons
to be published 28 February, 2 March, 23 March and 27 April 2011

Published on 13 May 2011
by authority of the House of Commons
London: The Stationery Office Limited

The Science and Technology Committee

The Science and Technology Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Government Office for Science and associated public bodies.

Current membership

Andrew Miller (*Labour, Ellesmere Port and Neston*) *(Chair)*
Gavin Barwell (*Conservative, Croydon Central*)
Gregg McClymont (*Labour, Cumbernauld, Kilsyth and Kirkintilloch East*)
Stephen McPartland (*Conservative, Stevenage*)
Stephen Metcalfe (*Conservative, South Basildon and East Thurrock*)
David Morris (*Conservative, Morecambe and Lunesdale*)
Stephen Mosley (*Conservative, City of Chester*)
Pamela Nash (*Labour, Airdrie and Shotts*)
Jonathan Reynolds (*Labour/Co-operative, Stalybridge and Hyde*)
Graham Stringer (*Labour, Blackley and Broughton*)
Roger Williams (*Liberal Democrat, Brecon and Radnorshire*)

Powers

The Committee is one of the departmental Select Committees, the powers of which are set out in House of Commons Standing Orders, principally in SO No.152. These are available on the Internet via www.parliament.uk

Publications

The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at http://www.parliament.uk/science. A list of reports from the Committee in this Parliament is included at the back of this volume.

The Reports of the Committee, the formal minutes relating to that report, oral evidence taken and some or all written evidence are available in printed volume(s).

Additional written evidence may be published on the internet only.

Committee staff

The current staff of the Committee are: Glenn McKee (Clerk); Ed Beale (Second Clerk); Farrah Bhatti (Committee Specialist); Xameerah Malik (Committee Specialist); Andy Boyd (Senior Committee Assistant); Julie Storey (Committee Assistant); Pam Morris (Committee Assistant); and Becky Jones (Media Officer).

Contacts

All correspondence should be addressed to the Clerk of the Science and Technology Committee, Committee Office, 7 Millbank, London SW1P 3JA. The telephone number for general inquiries is: 020 7219 2793; the Committee's e-mail address is: scitechcom@parliament.uk

List of additional written evidence

(published in Volume II on the Committee's website www.parliament.uk/science)

Written evidence

Written evidence submitted by the University of York (APP 01)

1. I am a serving Head of a Physics Department in a UK university. I have also served on many national (STFC and EPSRC) advisory bodies, serve on review panels for many international funding agencies (Germany, Belgium, the USA, Australia etc) and have been a member of several international panels producing reports (European Science Foundation and the OECD Global Science Forum).

2. The present inquiry is established to investigate the impact of STFC operations and financial cut backs on astronomy and particle physics. The STFC in fact supports three areas of research activity, astronomy, particle physics and nuclear physics. All three have suffered in recent years and it is unclear why the committee's deliberations should be restricted to just two of these areas.

3. The level of support for astronomy, particle physics and nuclear physics should reflect both the level of academic activity that the UK judges appropriate for these subjects, but must also recognize that these are some of the most attractive areas of physics to young people and are what often encourages young people to pursue science at school and to take degree level courses. Hence they provide the pull to bring talented young people in to form the science workforce that the country needs in the future.

4. In addition to this, nuclear physics has many practical applications in power generation (around 20% of the electricity in use around you at the moment), medical applications (more than a quarter of readers of this will receive a nuclear based medical intervention in their lifetime), in industry (standards, oil exploration, smoke alarms etc) and in defense (a prime responsibility of Government). As numerous reports (both industry and government sponsored) have revealed in recent years, there are looming skills shortages in the power (nuclear rebuild) medical (operation of new radiation equipment in hospitals) and defense (aging workforce resulting in crucial skills loss). These other strategic needs for the country need to be recognized and balanced in the support provided for nuclear physics, for it is through the university research activities in this area that many of the skilled people needed for these areas come.

5. As a recent survey sponsored by the Research Councils of a number of European countries (including STFC) reveals, the funding on nuclear physics in the UK is at a level of one tenth of that in our competitor countries (http://www.nupnet-eu.org/wps/portal/nupnet-report-2010.html).

Professor Brian Fulton
Physics Department
University of York

6 February 2011

Written evidence submitted by Professor George Efstathious, Director, Kavli Institute for Cosmology, University of Cambridge (APP 03)

1. I am a Professor of Astrophysics at Cambridge University and a Fellow of the Royal Society. I was a member of the Particle Physics and Astronomy Council between 2000–04. I am in receipt of STFC and UK Space Agency research grants.

2. In this short submission, I wish to concentrate on your question (3), in particular the engagement of the Executive and the Chief Executive Officer with the academic community. I will also express concerns about the composition and role of STFC Council.

3. There is little doubt that the academic community has lost confidence in the CEO of STFC. Last year, I coordinated a petition with several other senior academics calling for Professor Keith Mason's resignation. The petition was initiated on 24 February 2010 and closed on the 1 March 2010. We did not publicise the petition on blogs or web mail forums, nor did we lobby petitioners. Yet in that short time interval the petition was signed by 916 researchers, including 18 Fellows of the Royal Society and 162 University Professors. This represents about half the university-based academic community in Particle Physics, Nuclear Physics and Astronomy in the UK. I believe that many more would have signed had we publicised the petition. The petition was submitted to the Chair of STFC, Michael Sterling, in July 2010.

4. There are many reasons behind the loss of confidence expressed in the petition. STFC has had two major science prioritisation exercises in its short lifetime (with variable levels of consultation). These have led to a drastic reduction in the breadth of research in Astronomy, Particle and Nuclear Physics, the closure or withdrawal from many facilities and projects, and has left these subjects particularly poorly placed to absorb further cuts. The widespread view in the academic community is that the research programmes in these subjects is now dangerously narrow (and considerably narrower than in major European countries). There was, therefore, little confidence in allowing the CEO to lead a CSR bid on behalf of STFC. Within the astronomy community, there has been dissatisfaction with the way that STFC has handled relations with international organisations, in particular, Gemini and the European Southern Observatory. In 2008, STFC announced an intention to withdraw from Gemini, *without any consultation with the academic community at all*. This was presented

aggressively to the Gemini Board by STFC and led to the temporary expulsion of the UK from the Gemini consortium (disrupting science programmes). The legal disputes between STFC and both Gemini *and ESO* have damaged the UK's reputation as a partner in major international collaborations.

5. I am particularly concerned about the composition of STFC Council and the impact that this has had on the governance of STFC. Since it was created, STFC has had many fewer senior academics than the other Research Councils. This was flagged as a major issue in the 2008 Science and Technology Select Committee Report and by the Wakeham Review. I quote from the Wakeham review:

> "The Panel was immediately drawn to the different governance structure that exists in STFC in comparison with other Research Councils, notably a reduced Council membership of 10 individuals, four of whom are not university-based academics, and a further three of whom are from the STFC executive. The Panel was told by STFC that this different structure was deliberately selected to deal with the multiple purposes assigned to STFC. The provision and maintenance of large scale facilities for science in the UK and elsewhere, the provision of grant funding for three sub-disciplines of physics and the planning, operation and development of Science and Innovation campuses at Daresbury and Harwell. Its small size was designed by DIUS to make it dynamic and to facilitate regular meetings. However, when compared to other Research Councils, which have Councils made up of approximately 11 to 17 members representing broad scientific interests from the community operating at the highest level, STFC does stand out for the relative lack of members of the scientific community at the highest level. The structure has not best served the community in several branches of science whose input is one level below Council. The Panel therefore recommends that the DIUS should broaden the membership of STFC Council to include more stakeholders in the science activity, and that the balance between executive presence and non-executive oversight should be redressed. It is argued that this adjustment can be made without detracting from the executive activity in developing the Science and Innovation Campuses.
>
> The Panel recommends to DIUS that the membership of STFC's Council be broadened to include more of the stakeholders in the science activity at the highest level, and to redress the balance between executive presence and non-executive oversight."

and the RCUK response to this recommendation (October 2008):

> "DIUS accepts this recommendation. Details of an open competition to recruit two additional scientists as non-executive members of Council (the maximum permitted by STFC's Royal Charter) will be published shortly."

And from the 2008 Grant/Hazell Organisational Review of STFC:

> "22. Governance issues within the Executive seem to be further compounded by evidence of a lack of shared understanding within the top team concerning the role of Council. In our discussions with senior staff from the STFC Executive the perceived role of Council was articulated to the Panel in terms that ranged from the probity and oversight role of a`board of trustees' to the strategic leadership role of a 'board of directors'. It is the Panel's view that the role of Council is closest to the latter."
>
> "23. The Panel also considered the composition of Council, noting that RCUK recently announced that DIUS intends to recruit two additional scientific members to the Council, in response to a recommendation by the RCUK Review of Physics chaired by Professor Bill Wakeham. Notwithstanding this change, the Panel notes that the Council of STFC differs from that of the other Research Councils in having three members of the Executive on Council. The norm for the other Councils is that the Chief Executive is the only member of Council from the Executive. It is the Panel's view that the case for this distinction has not been convincingly made. There is also clear evidence that the composition of Council has created a negative perception outside of STFC that the Executive has excessive influence within Council."

As a result of these recommendations, two members of the Executive resigned from Council and three University based academics (Professor Martin Barstow, Sir Peter Knight and Professor James Stirling) were appointed to Council in April 2009.

However, following Professor Sterling's appointment as Chair of STFC, three new members of Council were appointed from the non-academic sector (two of whom have no scientific training). Two further Council vacancies have been advertised, one for somebody with a background in the life-sciences and one with expertise in government and parliamentary process. The advert excludes senior academics in astronomy, nuclear and particle physics.

These appointments will again skew STFC so that it looks highly anomalous compared to other Research Councils. Most of the other Research Councils are dominated by "heavyweight" research scientists with strong international reputations.

I have discussed this issue extensively with Professor Michael Sterling who expressed the view that senior academics in receipt of STFC grants have a conflict of interest and should not sit on Council. (This is certainly consistent with the pattern of appointments since Michael Sterling took over as Chair of STFC).

I have also written to Sir Adrian Smith and have spoken to him personally about the composition of STFC Council. Professor Smith replied that he was satisfied with the composition, which reflected the diverse nature

of STFC (facilities, campuses and research). Yet the nature of STFC was clearly known to members of the Wakeham and RCUK reviews.

6. The process of appointing members of Council lacks transparency. According to Adrian Smith, the membership of Council is entirely a matter for the Council. According to Michael Sterling, the process is controlled by BIS. Research scientists, including science members of Council, have no idea how appointments to STFC are decided.

7. It is clear to me that the loss of confidence with STFC Executive, and many of the problems to be explored by your committee, are in large part due to governance issues, including the under-representation of senior scientists on Council. Academic members of Council are necessary: (a) to provide technical and scientific expertise; (b) to develop a coherent scientific strategy for STFC; (c) to advise Council on the impact of decisions on these subjects; (d) to challenge the Executive, when appropriate; (e) to retain the confidence of the academic community.

8. I would be happy to submit supporting documentation.

Professor George Efstathious
Director
Kavli Institute for Cosmology
University of Cambridge

10 February 2011

Supplementary written evidence from Professor George Efstathiou, Director, Kavli Institute for Cosmology, Cambridge (APP 03a)

Dear Mr Miller

I have just listened to your session today and thought that you might like to see the letter that I sent Adrian Smith concerning the composition of STFC Council. The appendix lists the composition of several other research councils as of July 2010. I think you can see that there is a large difference in the composition of STFC compared to the other research councils. STFC has only one research academic in particle physics (James Sterling) and only one research academic in astronomy (Martin Barstow).

I cannot see how Adrian Smith can say that the composition of STFC is similar to that of other research councils.

Yours sincerely

George Efstathiou
Professor of Astrophysics
Director Kavli Institute for Cosmology
Cambridge

16 March 2011

Annex

Letter from Professor George Efstathiou FRS, Director, Kavli Institute for Cosmology, University of Cambridge to Professor Adrian Smith FRS, Department for Business Innovation and Skills

Dear Professor Smith

Earlier this month a group of senior academics, including myself, submitted a petition to Professor Michael Sterling signed by nearly 1,000 scientists expressing a loss of confidence in the CEO of STFC. In fact, there was widespread loss of confidence in STFC in 2008. However, the academic community did not express this in the form of a petition in the hope that the Wakeham Review and the RCUK Structural Review of STFC would lead to changes that might help to restore some confidence.

Our group has met with Professor Sterling twice and we have had some constructive discussions. However, we have reached an impasse on aspects of the governance of STFC, particularly on the composition of STFC Council, which I believe is a critical issue.

The composition of STFC Council is radically different to the composition of the other Research Councils. The composition of STFC Council was flagged as a major issue in the 2008 Science and Technology Select Committee Report and by the Wakeham Review. I quote from the Wakeham review:

> "The Panel was immediately drawn to the different governance structure that exists in STFC in comparison with other Research Councils, notably a reduced Council membership of 10 individuals, four of whom are not university-based academics, and a further three of whom are from the STFC executive. The Panel was told by STFC that this different structure was deliberately selected to deal with the multiple purposes assigned to STFC. The provision and maintenance of large scale facilities for science in the UK and elsewhere, the provision of grant funding for three sub-disciplines of physics and the planning, operation

> and development of a (sic) Science and Innovation campuses at Daresbury and Harwell. Its small size was designed by DIUS to make it dynamic and to facilitate regular meetings. However, when compared to other Research Councils, which have Councils made up of approximately 11 to 17 members representing broad scientific interests from the community operating at the highest level, STFC does stand out for the relative lack of members of the scientific community at the highest level. The structure has not best served the community in several branches of science whose input is one level below Council. The Panel therefore recommends that the DIUS should broaden the membership of STFC Council to include more stakeholders in the science activity, and that the balance between executive presence and non-executive oversight should be redressed. It is argued that this adjustment can be made without detracting from the executive activity in developing the Science and Innovation Campuses.
>
> The Panel recommends to DIUS that the membership of STFC's Council be broadened to include more of the stakeholders in the science activity at the highest level, and to redress the balance between executive presence and non-executive oversight."

and the RCUK response to this recommendation (October 2008):

> "DIUS accepts this recommendation. Details of an open competition to recruit two additional scientists as non-executive members of Council (the maximum permitted by STFC's Royal Charter) will be published shortly."

And from the 2008 Grant/Hazell Organisational Review of STFC:

> "22. Governance issues within the Executive seem to be further compounded by evidence of a lack of shared understanding within the top team concerning the role of Council. In our discussions with senior staff from the STFC Executive the perceived role of Council was articulated to the Panel in terms that ranged from the probity and oversight role of a 'board of trustees' to the strategic leadership role of a 'board of directors'. It is the Panel's view that the role of Council is closest to the latter."
>
> "23. The Panel also considered the composition of Council, noting that RCUK recently announced that DIUS intends to recruit two additional scientific members to the Council, in response to a recommendation by the RCUK Review of Physics chaired by Professor Bill Wakeham. Notwithstanding this change, the Panel notes that the Council of STFC differs from that of the other Research Councils in having three members of the Executive on Council. The norm for the other Councils is that the Chief Executive is the only member of Council from the Executive. It is the Panel's view that the case for this distinction has not been convincingly made.
>
> There is also clear evidence that the composition of Council has created a negative perception outside of STFC that the Executive has excessive influence within Council."

As a result of these recommendations, two members of the Executive resigned from Council and three University based academics (Professor Martin Barstow, Sir Peter Knight and Professor James Stirling) were appointed to Council in April 2009.

However, following Professor Sterling's appointment as Chair of STFC, three new members of Council were appointed from the business community. These appointments have again skewed STFC Council so that it looks highly anomalous compared to other Research Councils (see the annex attached to this letter). Most of the other Research Councils are dominated by "heavyweight" research scientists with strong international reputations. In my conversations with Michael Sterling, he has seemed to be under the mistaken impression that most other Research Councils are dominated by "lay" members, and is particularly concerned that academics in receipt of grants from STFC have a "conflict of interest". I quote verbatim from an email exchange (15 July 2010):

> "Thank you for setting down your views about the membership of STFC Council. We have discussed it a number of times in detail but I regret that I do not share your view. The need for scientific understanding is not limited to active researchers who are funded by the Council, who have an inevitable conflict of interest. The challenge for recruiting future Council members is to persuade those who have that knowledge but are not in receipt of our funding, to accept the challenge that Council membership entails in these difficult times. Your suggestions would be welcome but as you know the process is controlled by BIS."

I accept that STFC Council needs a range of expertise, but I do not accept this oversensitivity to potential conflicts of interest of research scientists on Council. It does not seem to be a significant concern for the other Research Councils. In the case of MRC, they seem happy to have members from MRC Institutes (for whom they presumably pay salaries) as members of Council. Research scientists are regularly asked to sit on panels where we must make cross-disciplinary decisions. In my experience top scientists are highly capable of making objective decisions. This is evidently expected from members of STFC Science Board.

Academic members of Council are necessary: (a) to provide technical and scientific expertise; (b) to develop a coherent scientific strategy for STFC; (c) to advise Council on the impact of decisions on these subjects; (d) to retain the confidence of the academic communities in these subjects (particularly in difficult economic times).

No other Research Council relegates its academic heavyweights to lower level committees.

It is clear to me that the loss of confidence with STFC Executive is in large part due to governance issues, including the under-representation of senior scientists on Council. STFC seemed to take a step in the right direction following the Wakeham Review (with DIUS/BIS approval), but has now taken a step backwards.

I would therefore like answers to the following questions:

[A] The Organisational Review of STFC stated clearly that a Research Council should provide "strategic leadership". How can this be achieved if the best research scientists are excluded from Council?

[B] The Wakeham Review explicitly called for the inclusion of "more of the stakeholders in the science activity at the highest level". DIUS accepted this recommendation and appointed three University based academics to Council. Why is BIS now ignoring the Wakeham Review and skewing Council towards a lay membership?

[C] Why is the composition of STFC Council so different to that of the other Research Councils?

[D] Do you agree with Professor Sterling that University academics in receipt of STFC funds have a conflict of interest and should not sit on Council? If so, why does this restriction not apply to other Research Councils?

[E] If one follows strictly the logic that recipients of STFC funds cannot serve on Council, then why does this not also apply to people from STFC funded industry (eg Astrium, e2v, etc)?

[F] Are you confident, based on your recent experience, that Council members with the scientific expertise to provide "strategic leadership" can be found from the business community?

Finally, you will of course have seen the Royal Academy of Engineering response to your Science and Research Budget review request calling publically for a reduction of funding to fundamental physics and particle physics in particular. Yet Mr Philip Greenish, CEO of the Royal Academy of Engineering is a member of STFC Council and is surely aware of the savage reductions of 35% to science exploitation funding in particle physics, astronomy and nuclear physics since 2008. These reductions go well beyond the "slash and burn" scenario envisaged by the Royal Society and leave these subjects particularly vulnerable going in to a difficult CSR.

So my final question is:

[G] Do you believe that Mr Greenish's continued membership of Council is credible, particularly given the loss of confidence in STFC by the academic community?

Yours sincerely

George Efstathiou

19 July 2011

Annex

MEMBERSHIP OF RESEARCH COUNCILS

NERC

Chairman	Ed Wallis	Chairman WS Atkins
CEO	Prof. Alan Thorpe	(Former Director NEC Centres for Atmospheric Sciences)
Members	Prof Paul Curran	Professor of Physical Geography, Bournemouth
	Prof Huw Davies	Professor of Physics, Institute for Atmospheric Climate Change ETH Zurich
	Mr Rowan Douglas	Managing Director Wills Analytics
	Prof Alastair Fitter	Pro-VC for Research, Univ. York
	Prof Anne Glover	Chief Scientific Advisor, Scotland
	Prof Charles Godfray	Prof of Zoology, Univ. Oxford
	Prof Alex Halliday	Prof of Geochemisty, Univ. Oxford
	Mr Peter Hazell	Chairman Argent Group etc.
	Prof Michael Lockwood	Prof Space Plasma Physics, Energy and Environment, Univ. Southampton
	Prof Thomas Meagher	Prof Plant Biology, Univ. St Andrews
	Prof Julia Slingo	Met Office Chief Scientist
	Prof Andrew Watson	Prof Environmental Sciences, Univ. East Anglia
	Prof Rob Watson	Prof Environmental Sciences, Univ. East Anglia
	Prof Marjorie Wilson	Prof of Igneous Petrogenesis, Univ. Leeds.

13 University + 3 "Lay"

EPSRC

Chairman	John Armitt	CEO Network Rail
CEO	Prof David Delpy	Former Vice Provost Research UCL
	Prof Anne Anderson	Professor of Human ComputerInteraction, Univ. Dundee
Members	Mike Carr	Former Chief Scientific Officer BT
	Prof Brian Collins	Chief Scientific Advisor SfT, Prof of Information Systems Cranfield
	Prof Lynn Gladden	Shell Professor, Univ. Cambridge
	Dr Andrew Herbert	Managing Director, Micros of Cambridge
	Prof Tim Pedley	Prof. Fluid Mechanics, Univ. Cambridge
	Dr Malcolm Roberts	Managing Director Guidance Ltd.
	Prof Roy Sambles	Prof of Experimental Physics, Exeter
	Prof Christopher Snowden	Vice-Chancellor Univ. of Surrey
	Prof Pierre-Louis Viollet	Vice-President R&D Labs.
	Prof Bill Wakeham	Vice Chancellor Univ. Southampton
	Dr Dave Watson	Director IBM Hursley Lab.
	Prof Mark Welland	Prof of Nanotechnology Cambridge and Chief Scientific Advisor MoD
	Prof Robert Winston	Prof of Science and Society Imperial
	Dr Tony Wood	Head of Medicinal Chemistry, Pfizer

11 University + 6 "Lay"

MRC

Chair	Sir John Chisholm	Chair QinetiQ
CEO	Sir Leszek Borysiewicz	Former Deputy Rector Imperial, Principal Faculty of Medicine
Members	Prof Jeffrey Almond	Vice-President Research and Development (Former Head of School of Animal and Microbial Science, University of Reading)
	Prof Michael Arthur	VC Univ. of Leeds (Former Dean of Faculty of Medicine, Southampton)
	Prof Dame Sally Davies	DG Research Dept of Health
	Prof Chris Day	Prof of Liver Medicine Univ. of Newcastle
	Dr Annette Doherty	Pfizer Global Research and Development
	Dr Richard Henderson	MRC Lab of Molecular Biology
	Prof Sir Andrew McMichael	Prof of Molecular Medicine, University of Oxford
	Prof Sally Macintyre	Prof Faculty of Medicine Univ of Glasgow. Hon Director MRC Social and Public Health Unit, Glasgow
	Ms Vivienne Parry	Writer and broadcaster
	Lord Naren Patel	Former consultant obstetrician Ninewells Hospital Dundee, Former President Royal College of Obstetricians and Gynaecologists.
	Prof Michael Schneider	Head of Cardiovascular Science, Imperial College
	Prof Herb Sewell	Prof of Immunology, University of Nottingham

10 academics (including CE0) + 4 "Lay"

STFC

Chair	Prof Mike Sterling	Former VC Birmingham
CEO	Prof Keith Mason	Former Head MSSL
Members	Mrs Gill Ball	Former Finance Director, Birmingham
	Prof Martin Barstow	Head of College of Science Engineering, Leicester
	Prof Keith Burnett	Vice Chancellor, Sheffield
	Mr Marshall Davies	Retired Director Boots
	Mr Philip Greenish	CEO Royal Academy of Engineering
	Dr Michael Healy	Director Navigation Business Division Astrium
	Dr Philip Kaziewicz	Managing Director GI Partners
	Prof Peter Knight	Senior Principal Imperial
	Prof James Sterling	Jacksonian Professor of Physics, Cambridge
	Mr Will Whitehorn	President Virgin Galactic

6 University (including CEO& Chair) + 5 "Lay"

Written evidence submitted by the Science Faculty, Durham University (APP 04)

1. This is a submission from Departments and Institutes within the Science Faculty at Durham University to the inquiry into "Astronomy and Particle Physics in the UK" being undertaken by the Science and Technology Select Committee of the House of Commons. This submission has been compiled on behalf of the Departments and Institutes by the STFC Liaison Group at Durham.

2. We appreciate the constraints under which STFC is operating, some of which can be traced back to the £80 million deficit it inherited at its creation. However, we have concerns about the long-term impact of cuts to capital spending, grant and fellowship support on the international competitiveness of Astronomy and Particle Physics Theory research within the UK. If sustained over a period of years, these cuts will also erode the infrastructure necessary to undertake world-leading science in the UK, not only in Astronomy and Particle Physics, but also across the full range of science supported by STFC's facilities. In particular, we believe it is essential that these cuts do not preclude some planning for the next generation of facilities.

3. The Department of Physics at Durham is currently the largest departmental recipient of grant funding from Science and Technology Facilities Council (STFC) with £35 million worth of grants (Durham and Cambridge Universities are the largest recipients of STFC funding with £38.1 million each). STFC funding to the Department supports the world-leading research activities within the UK's national centre for Particle Physics phenomenology, the Institute for Particle Physics Phenomenology (IPPP), and the Astronomy Group, including the Institute for Computational Cosmology (ICC) and the Centre for Advanced Instrumentation (CfAI). STFC funding is also held and STFC-funded facilities are exploited by a number of other research groups in the Departments of Physics, Mathematics, Chemistry and Biology at Durham University.

4. As a major recipient of STFC funding, we have undertaken to constructively engage with the Council, over a period of years, to ensure that they understand our needs and concerns and that likewise we understand the constraints under which they operate. To this end a large number of our academics contribute their time by sitting on STFC committees or advisory bodies. We believe that this engagement has been very positive and has a number of benefits for the wider UK research community, for example, through the establishment of the IPPP and the development by CfAI of novel instrumentation for the European Southern Observatory. Hence we feel that our views are heard within STFC and so we are keen to continue to positively engage with STFC in the future.

5. Nevertheless, we note with concern the impact of reduced funding on blue skies research within both the Particle Physics Theory and Astronomy grant and fellowship programmes. Such reductions reduce the competitiveness of the UK community at recruiting top-quality researchers, and hence impact on the ability of the academic system to both inspire and train the next generation of scientists. In the short term, the effect of these cuts will be less obvious, but the longer-term impact of removing our ability to drive future developments will have more serious consequences on the UK's leadership in these areas.

6. In our opinion, the reduction in grant funding in Astronomy has resulted in our being unable to efficiently exploit the facilities which STFC funds, losing leadership of key science to our international competitors. As grant support represents a small fraction of STFC's budget, even a modest increase in funds going to exploitation grants, £5 million per annum, would significantly improve this situation, and provide a world-leading scientific return on the UK's investment in these facilities.

7. We are also concerned by the planned reductions of capital funding, which will particularly affect a capital-intensive Council such as STFC. This has potentially severe impact on the up-keep of our well-founded laboratories, as well as to the entire Astronomy programme, including instrument development and work on the European Extremely Large Telescope (E-ELT). This is an area where the UK could expect substantial returns on investment and so these reductions appear especially short-sighted.

8. We strongly endorse STFC's decision to put ESO membership at the core of its long term plans for observational astronomy in the UK. Hence, given the financial climate, we accept the need to withdraw from some STFC-funded facilities for observational astronomy and for the community to concentrate on maximizing our exploitation of ESO facilities. In the light of this, we believe that the withdrawal from the Gemini Observatory could have been better organized, but we do not feel that this will have any lasting impact on the UK community's scientific output. The withdrawal of support from the Isaac Newton Telescope Group will have some impact on our instrumentation work in support of E-ELT development, but we are hopeful that these effects can be mitigated.

9. Whilst we broadly support STFC's current priorities for its facilities, in the longer term the withdrawal from participation in, or even planning for, future facilities such as the International Linear Collider, the CCAT submillimetre telescope, the Cerenkov Telescope Array, the New Light Source, the European X-ray Laser Facility (X-FEL) and the Linac Coherent Light Source will pass leadership of new science areas to our international competitors. The cost of early participation and planning is relatively small and the UK needs to have a strategic plan for inclusion in future facilities.

10. We note that the publicity associated with STFC's financial position will undoubtedly have a negative impact on young researchers intending to undertake a PhD, or obtain a job or a fellowship in an STFC-supported area. However, we stress that the purpose of this training is not solely to produce "future astronomers and particle physicists" and we are also hopeful that these cuts and their influence will be short lived. We

welcome STFC's introduction of STEP fellowships and hope that these will be administered in as flexible and efficient way as possible, while keeping studentship numbers at their present level.

11. Finally, we would like to highlight the concerns of those research groups at Durham who are users of STFC-run facilities, but are outside of the Particle Physics and Astronomy communities. We endorse STFC's strong support for Diamond as essential to maintain the UK's leadership in areas of biochemistry, nanoscience and structural chemistry (and to compensate for the future reduction in UK access to ESRF). However, we note that STFC's cuts to other facility operations have already begun to impact the world-leading structural chemistry work at Durham and the structural biology in the School of Biological and Biomedical Sciences. The loss of half the beam-time on the ISIS neutron source over the past ~5 years now limits our research into areas as diverse as the structures and chemistry of new smart materials and the development of Hydrogen energy and storage materials, all areas with significant impact potential.

12. We declare our interests in this matter arising from the funding by STFC of research grants and projects at Durham University and our use of Council-funded facilities to undertake elements of our research.

Professor Ian Smail
Chair of STFC Liaison Group
Durham University and Head of Astronomy

14 February 2011

Written evidence submitted by Prof Don Pollacco, Astrophysics Research Centre, Queens University of Belfast (APP 05)

The delivery plan of the STFC currently envisages a withdrawal from Northern Hemisphere facilities over the next one to two years. While the majority of Astronomers would certainly claim that the highest priority must be to remain in ESO, in a recent survey for STFC ("Ground Based Facilities" chaired by M.Rowan-Robinson) the same Astronomers also expressed the view by a factor of three to one, that we must place Northern Hemisphere telescope access as an extremely high priority. Furthermore, the withdrawal is motived solely by funding and not by science as:

1. While the universe may well be isotropic is true for cosmological projects (eg clusters of galaxies etc) this is not true when studying the local universe or, indeed, rare objects. Examples of this include nearby galaxies (there is nothing to rival the Andromeda Galaxy only visible from the Northern Hemisphere) and rare events such as Gamma Ray Bursters.

2. The UK's leading position in the study of extra-solar planets will also be threatened. Here not only are the brightest examples only visible in the northern sky but NASA's Kepler mission is currently surveying a single patch of sky *only visible from northern latitude's*. Kepler will find the first (few) examples of Earth like planets and only those with facilities in the northern hemisphere will be in a position to study them. Withdrawal from Northern Hemisphere sites will effectively end our contribution in this exciting area.

3. The UK is currently leading in the detection of large planets around bright stars thanks largely to the UK's SuperWASP experiment (Canary Islands) and followup observations from the Liverpool Telescope and William Herschel Telescope of the Isaac Newton Group (both facilities on La Palma, Canary Islands).

4. Instrumentation. The current facilities are ideal for groups to develop technology in challenging environments. So for example at the WHT, some of the most important scientific advances have stemmed from instrumental developments from small institutes (eg SARON, PNS, UltraCAM etc) each of these have been transformational in their respective subject areas (each opening a new window on their science areas). These developments would be difficult or impossible in the ESO environment.

5. Surveys. The UK has invested significant money in surveys some of which are only of the northern sky (eg the radio LOFAR survey which although a Dutch led project now has significant UK investment through our Universities). Further more, the interpretation of space data and in particular that from our ESA investment is at risk. The best example of this is the GAIA mission (to be launched in 2012) which will map the entire sky and is scientifically aimed at understanding our galaxy's structure and evolution (the northern sky will be important to reach this aim).

6. Investment. Since the 1980's has the UK, through SERC, PPARC and now STFC, has been investing £2 million/yr in the observatory infrastructure. The scientific importance of staying in the north has not lessened in this time.

Vested interests. I am the manager of the SuperWASP experiment on La Palma and have made significant use of the telescopes in the Canary Islands (and ESO for that matter).

Prof Don Pollacco
Astrophysics Research Centre
Queens University of Belfast

14 February 2011

Written evidence submitted by John Beckman (FRAS), CSIC Research Professor in Astrophysics, Instituto de Astrofísica de Canarias (APP 06)

1. As a British physicist who has been working within the Spanish astronomical community for over 25 years, I would like to address the points raised by the Parliamentary Science and Technology Committee in so far as they relate to the future of, the Isaac Newton Group of Telescopes (ING) on La Palma.

2. First I declare my scientific interest in the continuation of the ING as an operating facility. I have supervised 15 PhD theses whose main observational component was produced on the WHT or the INT, (the two principal telescopes of the ING) and a further five with some input from these telescopes, and I am the PI on the GHaFaS project, which maintains a Fabry-Perot interferometric spectrometer on the WHT, with which we are obtaining significant new results.

3(a) The first point on which the Committee wishes to be informed relates to the impact of reduced capital funding on UK capability. Here we can say that as a mature observational facility, with no new UK telescopes being proposed, the impact of reduced capital funding will be very small. In this sense we are talking about a working observatory with proven telescopes of high quality and instrumentation which works well, and which will require no major capital input into the foreseeable future. The only item of spending envisaged is the multi-object wide field spectrograph suggested by the Director as a means of matching in the Northern Hemisphere the highly successful 2dF and similar surveys performed by UK astronomers in the southern hemisphere and which have had a huge impact on world astronomy. The ING is well placed to play a similar role for relatively low outlay.

3(b) The second point is the impact of withdrawal from international ground.-based facilities on the UK's research base, and international reputation.

I am in a unique position to comment on this, since I am an active member of the Spanish astronomical community, while retaining British nationality and ample active professional contacts within the UK community. While it is not so easy for me to comment on the impact of a UK withdrawal from the ING on the overall scientific output of UK astronomy, I am in a position to state that a withdrawal would go down exceptionally badly with the Spanish community, and would not serve the interests of Britain's international reputation. In recent years Spain has been making increasing contributions to the ING. One of the permanent instruments on the WHT, the LIRIS cooled IR spectrograph, was conceived and made in Spain, while another instrument in regular use, GHaFaS, a Fabry-Perot spectrograph which is at present the only such instrument on a 4m class telescope, was produced by a collaboration led by Spain. Thus both communities benefit from instrumentation produced by the other. Any sense that Spain is benefitting more that the UK can be dissipated with the knowledge that (as demonstrated with the 10.4m GRANTECAN) Spain is now able to provide fully up to date instrumentation for major telescopes (not so 26 years ago when the WHT was commissioned). This means that the UK can benefit directly by having a major say in future Spanish instrumentation for ING telescopes, without UK outlay. I understand that the Dutch scientific authorities understand well the benefits of retaining their stake in the ING, and would not take well a UK decision to withdraw.

3(c) Talking to my British colleagues in the UK it is my impression that the STFC has not in fact engaged adequately with the research community on this issue, and there is a general welcome, in the circumstances, for this Parliamentary Enquiry. However this is an opinion necessarily obtained at second hand.

3(d) Opportunities for education and outreach. I can state categorically that the UK observatories in the Canary Isles offer unique possibilities for training and outreach activity. They are sufficiently accessible from the UK for student access and use, so that universities can incorporate research-based teaching programmes at all levels even into undergraduate physics degrees, and certainly at Master's degree level. Astronomy and astrophysics has always been an attractive way to win students for science and technology, I have no need to go into any detail here (I was on the staff in Physics at Queen Mary when we initiated one of the earliest modular degrees which included Astrophysics, and the fraction of students who were persuaded to come in via Astrophysics was often above 50%; this is an anecdotic personal example). The Liverpool "robotic" telescope, on La Palma, which explicitly combines research with secondary school teaching, owes part of its success to the relative ease with which technical problems can be resolved when a visit is urgently required. Of the recognized world class observing sites, La Palma is not only the nearest to the UK, but for reasons not in any way connected with astronomy, it is one of the least expensive to visit. As a measure of its role in wider outreach, within the past three months I have participated in two BBC TV films on astronomical themes which were made in the islands. This resource has perhaps not received its merited degree of recognition, and it shows clarity of perception on the part of the Parliamentary Committee that we are encouraged to comment on this point.

I append to these specific comments some more general arguments which I believe to be significant.

4. The first comment is based on a figure produced in 2005 by Helmut Abt, for 28 years Editor in Chief of the Astrophysical Journal, universally recognized as one of the world's two or three leading journals in the field. He explained that over 80% of major discoveries in astronomy during the past 50 years, (derived with a minor degree of subjectivity from the published record of his journal) had been made with small telescopes. Asked to explain this apparently surprising statistic Dr Abt gave his considered view that it was because on large telescopes the observing time is subject to such tight competition, than not only can observers not obtain

enough time to mount many major projects, but they are constrained to propose safe bets, in order to ensure that the observations give rise to a publication and so obtain further time and funding. In an age when telescopes with optical apertures less than 8m are considered small, the UK would be well advised to take heed, and not to pump absolutely all of its funding into the support of large telescopes.

4. The La Palma observatory is at a world-class site, recently narrowly beaten out by a Chilean site for the placement of the future 42 m E-ELT, the world's largest optical/infrared telescope, and (bear in mind that the host institution, ESO, has been dedicated for over 50 years to placing telescopes in Chile). Its telescopes, and notably the 4.2m William Herschel Telescope,(WHT) have been well designed, and thanks to refined instrumentation have kept pace with many of the advances made at observatories with telescopes in the 8 and 10 m classes. However compared with these latter telescopes even the WHT will not, in the medium term, be able to compete directly. Fortunately British astronomy can be very well served by the WHT without calling on it to carry out programmes better placed on larger instruments. This is because within the last year the 10.4m Spanish GCT, currently the largest single optical/infrared telescope in the world has been commissioned and has come into active use. One of the key roles for the WHT into the future should be to run programmes with implications for related programmes on the GTC, such as photometric studies preparatory to spectroscopic studies, and experimental work on diffraction limited imaging to exploit the full apertures of both for studying objects at high redshift. The greater instrumental flexibility and longer durations of observing runs at the WHT compared to larger telescopes will permit the running of higher risk observations, which if successful could be transformed for use on larger telescopes such as the GTC in the north and the VLT in the south. The instrumental flexibility mentioned means that new techniques can be readily tested on WHT, techniques which would imply very long lead times or impossibility on eight or 10m class instruments. The flexibility means that a variety of instruments could be in situ for regular use. The possibility to schedule longer runs implies that powerful surveys (analogous to 2dF on the AAT) could be envisaged and brought about. It leaves open the possibility that the telescope could, for a significant time, be devoted largely to such a survey. One of the most successful astronomical projects of all time, the Sloan Digital Sky survey, was performed on a 2.5m telescope. Indeed this causes me to wonder whether even the 2.5m Isaac Newton telescope might not be converted to a single purpose instrument, implying very low running costs indeed, with possibly impressive rewards in impact and utility.

5. It is not obvious that time on northern hemisphere telescopes will be so easy to come by for the British astronomical community in the coming decade. Retaining the operation of the ING, with whatever may be deemed suitable streamlining measures to economize on its operating costs, would be of major value in these circumstances.

John Beckman
Research Professor in Astrophysics
Instituto de Astrofísica de Canarias

14 February 2011

Written evidence submitted by the Association for Astronomy Education (AAE) (APP 07)

VIEWS ON OUTREACH AND INSPIRING THE NEXT GENERATION

1. The Association for Astronomy Education has as its mission the promotion of good teaching of Astronomy at all levels in schools, and engagement of the general public. We are a national UK organisation with about 100 members (individual and corporate). The work we do heavily relies on the good will of volunteers, and at the same time a few individual members hold, or have held, awards from funding bodies, such as STFC (and formerly PPARC) and the Institute of Physics, to help fund specific astronomy related events and activities. The awards have helped to promote different aspects of space and astronomy not only to schools but also to a wider public audience. STFC has been the single most important source of funding because of the specific nature of their award schemes.

2. We note with disappointment that the Science Centre Award Scheme has been withdrawn and the upper limit of the Small Award Scheme has been reduced to £10,000. However a Schools Grant Scheme has been added for projects up to £500. This is plainly inadequate. There is very little that can be done with such a budget other than to provide a one-off activity or buy a modest piece of equipment. While the Large Award Scheme offers funding from £10,000–£100,000, there is more emphasis on research, with strong links to the STFC scientific research community. This places non-university applicants for educational Large Awards funding in direct competition with research groups.

3. One of the AAE's prime areas of practical help has been in providing teacher training workshops. Individual members participate in many aspects of public engagement through open evenings at observatories, lectures to outside groups, and special days for astronomy such as "Your Universe" held at University College London. With funding being cut in the area of public engagement, it will become increasingly difficult to afford to provide these. The recent BBC programme (Stargazing LIVE) has brought awareness of astronomy to the public and it would be a great pity to see such activities wither for want of additional support.

4. Outreach activities bring forefront science and astronomy into the classroom, offering exciting glimpses into research into astronomy and cosmology. This can be inspirational in recruiting teenagers into science in a way that the delivery of the National Curriculum and the exam syllabuses cannot always achieve. Equally important is engaging the general public's untapped enthusiasm for science. Cuts in the funding of such outreach will have a serious impact on this, as it is not something that schools can somehow magically replace or provide for themselves.

5. It is especially disappointing that STFC has reduced its production of posters and leaflets on various activities and research topics in both astronomy and particle physics. It is a false economy if the goal is to get schools and the public engaged with its activities. At my university observatory, we relied very much on being able to offer a wide variety of informative and well-designed posters to our school visitors and to visitors on public evenings. Instead, visitors to STFC's website are now encouraged to download a pdf file of the various leaflets. I doubt seriously if even one person in a hundred, who might eagerly take up a well-printed folded poster presented on a table, would take the time and trouble to locate, download and print out a poster offering.

Dr. Mike Dworetsky
President
Association for Astronomy Education

14 February 2011

Written evidence submitted by Professor Mike Barlow, University College London (APP 08)

1. The current STFC Chief Executive has been reported to have made comments at a number of venues to the effect that "there are too many astronomers in the UK" and that "UK astronomy was over-funded during the decade beginning 2000". The data that I have gathered below, on the numbers of professional astronomers in ten advanced economies, show that there is no basis in fact for the first of these statements. I suggest that a proper comparison of funding levels per astronomer for ground-based and spaceborne research in each of these ten countries would show that there is no basis in fact for the second of these statements either.

2. The table below lists the numbers of professional astronomers in each of ten advanced industrial economies who are members of the International Astronomical Association (IAU). Members of the IAU normally hold long-term positions at universities or research establishments and are nominated by the subscribing body for each country. IAU assignment to a particular country is by residence, not by country of birth.

3. The table also lists the population and 2009 GDP (in US$) of each country, while its final two columns list the number of IAU members per million population and the number of IAU members per trillion $ of GDP. These two ratios are plotted in Fig.1.

This comparison shows the UK to be in the middle of the distributions for both the number of astronomers per million residents and per trillion $ GDP, with five countries above the UK and 4 below.

4. A comparison is also needed between the amount of research funding per IAU astronomer in each of the ten countries. Because each country has different funding mechanisms and funding bodies (eg there are at least four significant funding agencies in the US), I suggest that it is appropriate and within the current terms of reference for the Science and Technology Committee to commission such a comparative study.

Professor Mike Barlow
Professor of Astrophysics
Dept of Physics & Astronomy
University College London

14 February 2011

Declaration of Interest:

I am a professional astronomer employed by University College London

Table 1

	IAU Members	*Pop.*	*2009 GDP[1] US$*	*IAU Members per mn Pop.*	*$tr GDP*
Australia:	258	22.5m	849bn	11.5	304
Japan:	597	127m	4.308tr	4.7	139
Netherlands:	205	16.6m	658bn	12.3	312
Spain:	303	46m	1.364tr	6.6	222
Sweden:	112	9.3m	338bn	12.0	331
USA:	2573	309m	14.256tr	8.3	180
France:	695	63m	2.108tr	11.0	330
Germany[2]	530	82m	2.806tr	6.5	189
Italy:	567	60m	1.740tr	9.5	326

	IAU Members	*Pop.*	*2009 GDP[1] US$*	*IAU Members per mn Pop.*	*$tr GDP*
UK:	521	62m	2.139tr	8.4	244
Totals:	6361	797m	30.566tr	8.0	208

Data sources:

IAU Membership: http://www.iau.org/administration/membership/national/

Population: www.google.com/publicdata

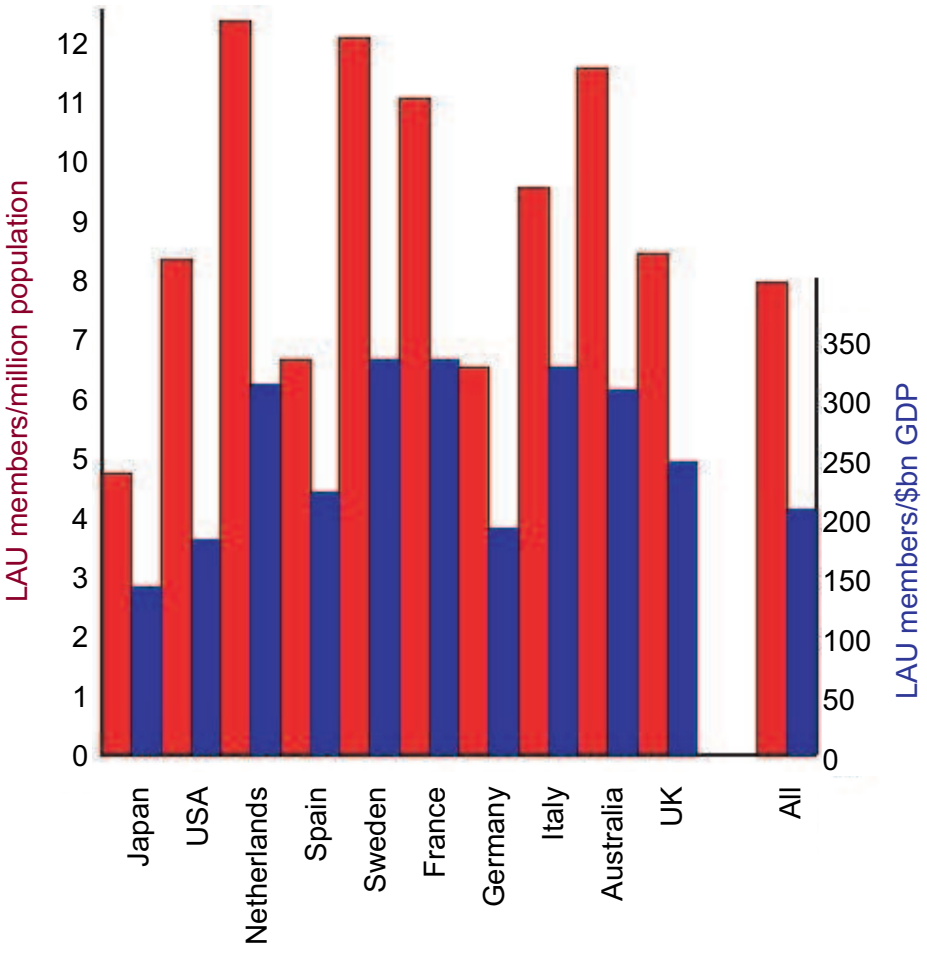
GDP[1]: Wikipedia

Notes

[1] PPP = Purchasing Power Parity.

[2] The incorporation in 1990 of the former East Germany (population 16m) added very few IAU astronomers to Germany's total.

Figure 1



Written evidence submitted by Daresbury Laboratory Section of Prospect (APP 09)

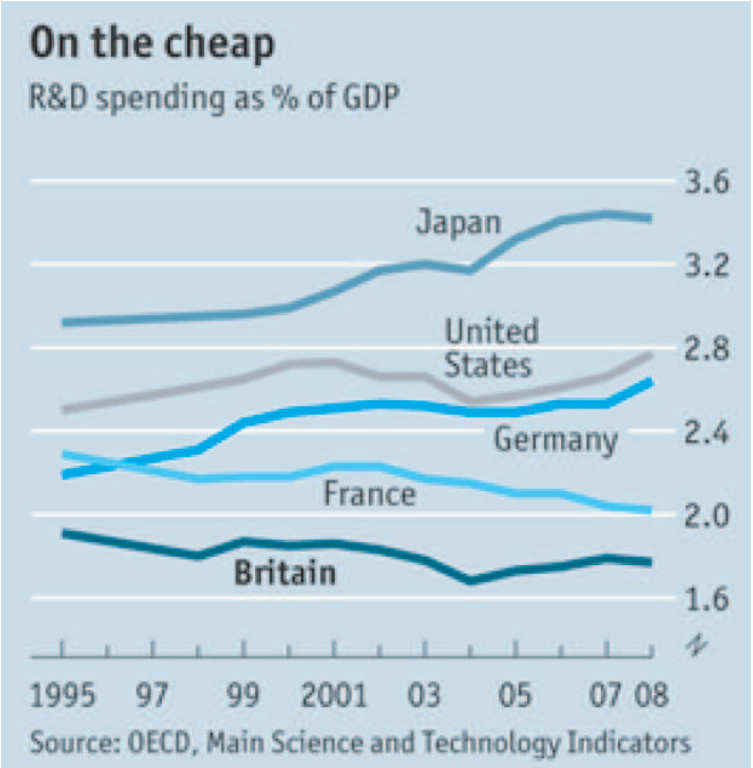
CAPITAL FUNDING FOR ASTRONOMY AND PARTICLE PHYSICS

The Prospect Section Committee at Daresbury Laboratory wish to communicate the following points to the Select Committee:

The UK has a reputation for being the lowest spender on research and development as a function of GDP when compared to the other major world economies. The graph compiled by the OECD clearly illustrates this point.

This reputation extends to collaborations with counterparts overseas who are often reluctant to engage with UK-based groups because we have a poor record on delivery due to the funding constraints under which the UK's science infrastructure works, and the un-ending uncertainty over mid-to-long-term funding for big

projects. These factors combine to cause significant damage to the UK's ability to do "big science" and to collaborate in world projects.



Within STFC, capital is extremely limited, but there are apparently significant funds for restructuring. This is completely the wrong scenario under which to carry out cutting-edge science, and it sends the wrong message to stakeholders, both internal and external. The most important internal stakeholder is of course the staff, and as a consequence of the continued uncertainty over the future of big science, morale within STFC is lower than ever, and continues to fall as we move towards what is expected to be a wide-spread redundancy programme. This will further reduce the UK's credibility overseas, and further limit our ability both to compete at the cutting edge, and to collaborate with the rest of the world.

One of the first casualties as resources fall is outreach because it is a "soft option". Outreach is generally "tagged on" to a person's responsibilities, and as resources dwindle and pressure increases to get more things done more quickly, the "day job" has to take priority and secondary duties such as outreach fall by the wayside. Consequently, a feedback loop is created whereby the next generation of scientists are not being drawn out of the university population, so again reducing our ability to compete with the rest of the world. STFC's staff work in some of the key areas that fuel young people's interest in science. They may stay with these areas or move on to other areas of science, but without the showcase areas of astronomy and particle physics, they might not become interested in science at all. STFC staff have a vital role to play in inspiring an interest in science and involving young people in it as they progress through education.

There is an apparent failure of the "*dipole model*" which seeks to focus all of the UK's major scientific infrastructure at the Harwell and Daresbury campuses. While Daresbury is losing capabilities with the forthcoming closure in March of the last two on-site user facilities (NCESS and MEIS) and de-commissioning infrastructure (such as the SRS synchrotron radiation source), all of the recent expansions have been focussed on the Harwell campus. Examples include Target Station 2 (TS2) on the ISIS neutron source, expansion of the Diamond Light Source (DLS) capabilities through delivery of the third phase of experimental beamlines, and the establishment of the UK space agency.

It should be noted that DLS have in previous phases of their beamline installation placed a significant amount of overseas orders for equipment and capabilities which are available within the UK, from the STFC and high-tech UK businesses. This must not be allowed to happen in the forthcoming phase III work as it will be completely indefensible if UK science funding from the large facilities capital fund is being spent overseas when the STFC is making its staff redundant and undergoing costly restructuring and UK companies are struggling to survive.

With a delay of three to five years on the UK's next accelerator-based light source (NLS), the NLS design team (most of whom are based at Daresbury) are struggling to find work, and we risk losing this talent to overseas facilities. In addition, the NLS prototype machine (ALICE) at Daresbury is experiencing severe cuts in its capital funding, which severely limits the operational usage of the machine. ALICE is a unique machine:

it is one of only four machines in the world which is capable of accelerating a particle beam, exploiting it to produce radiation in the UK's only operating free-electron laser, then decelerating the beam and recovering the energy. Daresbury is becoming reliant on this machine to retain its core skills, and retain the UK's ability to build the NLS, yet this machine is drastically under-funded, and struggling to achieve its full potential.

The EMMA accelerator is unique triumph of UK technical achievement, a world-first particle accelerator showcasing UK science, engineering and skills world-wide. It offers a technology that will save lives by supporting hadron therapy to treat otherwise inoperable cancerous tumours, and opens the door to safer, cleaner, cheaper power generation supporting thorium-fuelled reactors. This machine is also suffering from a lack of capital to realise its full potential, and suffers indirectly due to its reliance on the ALICE machine which is also suffering.

In the construction of ALICE and EMMA, Daresbury staff pushed UK companies into areas that demanded new skills and capabilities to help them build world-leading machines. UK companies are now able to reap the benefits of this as they compete in a competitive global marketplace.[1]

To redress the imbalance between the Harwell and Daresbury campuses, it has been proposed that an accelerator research centre be established at Daresbury. The aim is to build on the technical successes so far achieved on the ALICE accelerator, and to continue R&D for the NLS and future accelerator projects. This venture will require significant capital input, but we are already being told that capital is limited, and we will have to compete for what little is available. This is at odds with other Government-stated priorities such as healthcare, energy security and border security, all of which can benefit directly from the advances being made in particle accelerator technology at Daresbury Laboratory. Furthermore, senior STFC management have stated that there will be no new money available for the establishment of this centre. Their focus is on commercial partnerships based on market opportunities with short-term payback periods, even though particle accelerators are national research tools with payback periods which typically run to decades. This mindset is an unrealistic baseline for the creation of the accelerator centre.

This funding approach has been evident in reviews carried out by senior STFC management for other business cases such as the establishment of an engineering technology centre (ETC) as a capability within STFC. This is essential to on-going underpinning research in the field of particle accelerators as the engineering solutions must match the challenging requirements of the physicists who design the machines, and the harsh environments in which the equipment is required to function.

A huge amount of work has been undertaken within STFC in the preparation of business cases for two major technology centres. The Hartree centre is planned to be a world-leading centre-of-excellence in computational science and engineering (CSE). This institute would be based at Daresbury, and would expand the current CSE group and its capabilities by forging stronger links with the academic community, following a similar model to the successful Cockcroft Institute of accelerator science already at Daresbury. The Detector Systems centre is planned to focus the STFC's expertise in detector technology (for applications within space science, security, medical imaging etc.) whilst at the same time strengthening links to academic and industrial groups with similar expertise. The Hartree business case has passed all project gateway reviews with either green or amber status, but has been held at the Minister's desk pending approval for access to the LFCF. Given the cost and effort already invested in this case, it would be a criminal act not to fund this centre. The case for the detector systems centre is less advanced, but the need is real.

The current funding scenario is also pressurising a newly-established capability at Daresbury, which appears to "tick all the boxes" in terms of external collaboration and innovation, but is now threatened. The I-TAC (Innovation Technology Access Centre) seeks to provide laboratory space and access to specialists and capabilities at Daresbury for start-up and small/medium high-tech companies, and has recently won an award for this. However, it seems that its funding may now be withdrawn just as its customer base is building and its reputation growing.

Daresbury Laboratory provides essential support to the local economy, and as its programs suffer due to restrictions in capital, or indeed are cancelled altogether, so the local economy suffers too.

It is clear that the STFC senior management have not made the case in a sufficiently robust fashion to DBIS for an appropriate level of capital funding required by STFC to even maintain the UK's current level of technical expertise, let alone advancing our capabilities. They are also failing to represent the interests of STFC's staff, and in particular, the scientific staff who are the STFC's biggest asset, many of whom are now looking for job opportunities elsewhere.

Lee Jones
Section Chair
Prospect (Daresbury Laboratory)

14 February 2011

[1] For example: TESLA Engineering delivered focussing magnets with high-quality field over a large physical aperture; VG Scienta & Kurt J Lesker delivered precision vacuum chambers with integral beam position monitors; Q-Par Angus delivered a specialist 1.3 GHz RF distribution system which included hybrid devices to control the split and phase of the RF power in each of the 19 accelerating cavities in EMMA.

Written evidence submitted by Heads of Nuclear Physics Research Groups in UK (APP 10)

1. We are writing as the Heads of the Nuclear Physics Research groups in the UK. Between us we have a wide range of experience of research funding at both national and international level.

2. The present inquiry is established to investigate the impact on STFC operations in astronomy and particle physics arising from reduced funding, particularly capital spending. The STFC in fact supports three areas of research activity: astronomy, nuclear physics and particle physics. All three have suffered in recent years and it is unclear why the committee's deliberations should be restricted to just two of these areas. Nuclear physics will also suffer from the reduction in capital spending. Funding for nuclear physics research was already critically low, before the present round of reductions.

3. The level of support for astronomy, nuclear physics and particle physics should reflect the level of academic activity that the UK judges appropriate for these subjects. It must also recognize that these are some of the most attractive areas of physics to young people and are what often encourages young people to pursue science at school and to take degree level courses. They provide the attraction that brings talented young people into science. These people are then the science (and engineering) workforce that the country needs in the future.

4. Nuclear physics has many practical applications in power generation (around 20% of the electricity in use around you at the moment with a likely increase following new build), medical applications (imaging and therapy are both areas were nuclear physics understanding and research is vital), in security (nuclear techniques are widely using for detecting special nuclear materials and other radioactive substances being moved covertly) and in defense (a prime responsibility of Government). As numerous reports (both industry and government sponsored) have revealed in recent years, there are looming skills shortages in the power, medical and defense sectors. There is a strategic need for the country to recognize that the balance in the support of research needs to provide for nuclear physics, for it is through the university research activities in this area that many of the skilled people needed are first attracted.

5. As a recent survey sponsored by the Research Councils of a number of European countries (including STFC) reveals, the funding on nuclear physics in the UK is at a level of one tenth of that in our competitor countries (http://www.nupnet-eu.org/wps/portal/nupnet-report-2010.html)

P J Nolan and *P A Butler*
University of Liverpool

J Tostevin and *W Catford*
University of Surrey

J Billowes and *N Walets*
University of Manchester

A Bruce
University of Brighton

R Wadsworth
University of York

M Freer
University of Birmingham

P Woods
University of Edinburgh

J Smith
University of the West of Scotland

G Rosner
University of Glasgow

J Simpson
Daresbury Laboratory

15 February 2011

Written evidence submitted by Professor David Carter, Professor of Observational Astronomy, Liverpool John Moores University (APP 13)

Declaration of Interest

1. Liverpool John Moores University owns and operates the Liverpool Telescope on La Palma in the Canary Islands. I was project scientist for this telescope from 1996 to 2005, and have retained a rôle in the operational phase of the project.

2. I am Deputy Principal Investigator for WEAVE, which is a proposal for a new wide-field spectrograph for the William Herschel Telescope, also on La Palma, designed principally to support the GAIA satellite to be launched by the European Space Agency. If the WEAVE project is approved by the funding agencies, I will maintain a rôle in its design and construction.

3. I am a member of the Projects Peer Review Panel (PPRP), a peer-review committee of STFC.

4. I am Principal Investigator of the Treasury Survey of the Coma cluster of galaxies, on the Hubble Space Telescope.

The Impact of Reduced Capital Funding on UK Capability

5. Reduced capital funding will make it much more difficult to exploit successfully the international subscriptions, which are now more protected than before. The STFC Projects Peer Review panel is heaviliy oversubscribed with innovative experiments and technology in all areas of its remit, but in my experience in particular in ground based astronomy. Reduced capital funding will make this situation far worse.

The Impact of Withdrawal from International Ground-based Facilities on the UK's Research Base and International Reputation

6. This has several consequences, the loss of access for observational opportunities in the Northern Hemisphere, the lack of opportunities for technical innovation in UK universities, and the removal of support for the ESA space missions such as GAIA in which the UK has invested heavily.

7. If the UK were to withdraw from the island sites, ground based astronomy would be exclusively concentrated in the facilities provided by the European Southern Observatory (ESO) in Chile. The Northern sky contains many unique and important astronomical targets, in my own research areas I point to the nearest large galaxy, the Andromeda nebula, and the nearest rich cluster of galaxies, the Coma cluster. It is embarassing for me as the PI of the major Hubble Space Telescope programme on the Coma cluster, to have to rely on overseas collaborators for the necessary complementary terrestrial observations.

8. Without the island sites, astronomy technological development, as well as observing facilities, are concentrated in the hands of ESO. ESO's programme is heavily managed from the top down, and gives little opportunity for the kind of rapid technical developments to exploit emerging scientific opportunities in which the UK university sector excels. Examples of this are the RINGO polarimeter, developed by my own university for the Liverpool Telescope on La Palma, the RISE rapid readout camera, designed for measuring transits of extrasolar planets in front of their parent stars, and largely designed by Queens University Belfast, and the UltraCAM fast camera, built by the University of Sheffield for the William Herschel Telescope, also on La Palma.

9. La Palma provides the opportunities and the environment to give the UK university community facilities and opportunities in areas of UK leadership. The William Herschel Telescope will provide the needed support to ESA space missions such as GAIA, and further into the future EUCLID. The Liverpool Telescope provides leadership in the rapidly expanding areas of time variable and transient astronomy, facilities which are not provided otherwise in either hemisphere. The Wide Angle Search for Planets (WASP), an initiative of Queens University Belfast is a major contributor to the science of extrasolar planets.

10. Within the context of the ASTRONET framework, La Palma provides the infrastructure for a unique venture in European co-operation at one of the best astronomical sites in the world. It does not have or need the restrictive top-down management structure of ESO, and can allow natural collaborations to develop and ideas to flourish. Finally, through collaboration with Spain, La Palma can provide access to the time on 10 metre telescopes in the north, which the UK lost when it pulled out of the Gemini partnership.

Whether the Science and Technology Facilities Council (STFC) has Sufficiently Engaged with its Research Community in these Two Areas

11. My experience is that STFC engages a lot with a small fraction of the research community, and engages very little with the majority. Funnily enough, having been on the outside for 35 years, in the last 18 months I seem to have become part of the small fraction. My suggestion is that STFC goes to greater lengths to ensure that advisory committee membership turns over regularly, that the same people don't keep reappearing on one committee after another, and that the workload or the opportunities, whichever way you want to look at it, are more evenly distributed.

Opportunities for, and Threats to, Outreach

12. Our institutional sumbission covers this in some detail, I would only add that the availability of the different UK facilities and international facilities on La Palma provide an opportunity for a collaborative approach which could generate the resources to make a very substantial contribution in this area.

13. The clear leaders in outreach are NASA, and we need to look at how they approach this. An example is that every major allocation of time on the Hubble Space Telescope to US scientists comes with the opportunity to bid for additional Education and Public Outreach (E/PO) funds to bring the science to a wider community. ESA don't do this, and the STFC awards are only loosely tied to research.

Professor David Carter
Professor of Observational Astronomy
Liverpool John Moores University

15 February 2011

Written evidence submitted by ESERO UK, National STEM Centre, University of York (APP 14)

Submission to Science and Technology Committee Inquiry into astronomy and particle physics in the UK.

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

Context

1. Astronomy and Space are among the areas that most stimulate young people about science and technology. As such, they have an important role not just in creating the future generations of astronomers and particle physicists, but all scientists, engineers and technologists.

2. It is essential that this is an ongoing process—any "gap" in the promotion of STEM subjects in schools and universities will to lead to a skills shortage in future years. This is likely to have a knock-on effect since this will also decrease the number of motivated (and motivational) specialist teachers. This is a downward spiral that would be difficult to halt.

3. The Space industry is also a major contributor to the UK economy, with a turnover of about £7.5 billion in 2008–09 with strong growth even in times of economic difficulty (see "The Size and Health of the UK Space Industry").[2] To retain this level of growth obviously requires a continuing supply of suitably qualified and motivated employees (especially graduates from suitable STEM disciplines).

4. Because of the recognition of the importance of astronomy and space education and outreach to both these areas, considerable effort in the UK goes into developing and promoting space-based educational resources. STFC is a major contributor to this effort.

ESERO-UK

5. We represent one important aspect of that work—ESERO-UK (European Space Education Resource Office—also known as the UK Space Education Office). ESERO-UK which is based at the National STEM Centre at the University of York has the following aims: (1) Share good practice, and space-related teaching and learning resources, with teachers and college lecturers. (2) Be the first point of contact for the education and space communities when seeking information about space education and careers. (3) Raise the profile of the education work of the European Space Agency (ESA), the UK Space Agency and the wider UK space community with schools and colleges. ESERO-UK is funded by ESA and DfE.

6. Much of the work of ESERO-UK is carried out through a network of "Space Ambassadors" located throughout the UK. These ambassadors are all actively involved in space education and outreach and discover and promote the best resources. The work of the ambassadors is funded in part directly from ESERO-UK and in part by their own organisations (which vary from university research groups, through to schools and science visitor centres).

7. It should be noted that this is a somewhat different model to ESEROs in other parts of Europe where the role has been to *develop* resources. The wealth of existing resources in the UK makes that less important, but coordination and dissemination is essential if the return on investment in developing the resources is to be maximised.

8. Extensive evaluation of ESERO-UK is a significant part of the project.

[2] http://www.ukspaceagency.bis.gov.uk/assets/pdf/SandH2010.pdf

9. Still in its early stages, ESERO-UK will become an important focus for space education throughout the UK. The organisational structure of the ESERO-UK project is being considered by ESA as a potential model for similar organisations in France and Germany.

The Role of STFC in ESERO-UK

10. STFC has fully supported the setting up of ESERO-UK and was instrumental in defining its aims.

11. STFC and the UK Space Agency have been instrumental in obtaining funding from both DfE and ESA. In addition, some of the Ambassadors are funded as STFC "Science and Society" Fellows.

12. However, future funding from ESA for all ESEROs will be conditional on support from the individual member states.

13. ESERO-UK, therefore, is an example of how the current outreach and education strategy of STFC is making use of existing resources to maximise its impact. It is clearly important that such work (or similar enhancements informed by the results of in-depth evaluation) be able to continue into the future.

Declaration of Interests

14 As mentioned in paragraph 11 STFC has funded some of the individuals working within the ESERO-UK project.

A D Clements
ESERO-UK Manager

A Newsam
ESERO-UK Space Ambassador

15 February 2011

Written evidence submitted by Dr Sandra Voss, Science Director, The Observatory Science Centre, Herstmonceux (APP 15)

1. Introduction

1.1 The Observatory Science Centre in Herstmonceux, East Sussex offers a unique visitor experience. Situated at the former home of The Royal Greenwich Observatory, the hands-on exhibits aim to give everyone the opportunity to experience first-hand, science and technology through specially designed equipment. With the added bonus of exploring historic telescopes and domes, The Observatory offers an enthralling and atmospheric visit.

1.2 Following the closure of The Royal Greenwich Observatory at Herstmonceux in 1990, Science Projects Ltd took over the lease of the buildings and opened the Science Centre. With all the historic telescopes still in place and crying out to be brought back to life a heritage lottery grant was secured and alongside an exhibition telling the story of the Royal Greenwich Observatory the telescopes and domes were refurbished. Using these instruments which were formerly at the cutting edge of International research, The Centre was now ready to effectively engage the public and bring astronomy back to Herstmonceux.

2. Visitors

2.1 The Centre attracts approximately 60,000 visitors per year from all walks of life and all ages. Family groups make up the majority of visitors but one-third of this number is from schools, both primary and secondary. A number of visiting school groups, as well as scouting and guiding groups, come along for twilight evenings when they take advantage of being able to look through the telescopes (weather permitting). Specialist groups (U3A, Astronomical Societies, Rotary Club etc) hire The Centre for private evenings or come along during the day and book private telescope tours.

3. Events and Activities

3.1 The Centre offers a broad range of astronomy and other science related activities. There are over 100 fully interactive hands-on exhibits based around permanent themes of Light and Colour, Earth and Beyond, Forces, Astronomy and Time. Two other temporary exhibitions are interchanged during the year providing a fresh feel to The Centre and presenting returning visitors a different experience. Guided telescope tours are conducted during the day and at busier times fun, interactive science shows are also regularly performed.

3.2 There is a full programme of special events and seasonal activities planned every year which includes children's workshops, drop-in activity areas, Open Evenings when the public can gain access to the historic telescopes, Themed evenings (usually based around astronomical events such as meteor showers etc), evening astronomy courses and the annual Astronomy Festival.

3.3 Scouting and Guiding groups can carry out specific badge work activities and businesses can take part in corporate Team Challenge days. Specialised workshops have been developed for schools and are part of the wide range of activities offered to schools during their visit to The Centre.

4. Funding

4.1 As an educational charity with no core funding, The Centre has relied on and been grateful to funding bodies such as STFC (and formerly PPARC) to help fund specific astronomy related events and activities. In the past we have been successful with applications through either the Small Awards Scheme or the more specific Science Centre Award Scheme which was rolled out in 2005.

4.2 The awards have helped to promote different aspects of space and astronomy not only to schools but also to a wider public audience. STFC have always been approached for funding because of the specific nature of their award schemes. By definition, this narrows the number of applicants and therefore increases the chances of receiving grants.

4.3 Initially when the Centre first applied to the PPARC Small Award Scheme, funding could be gained for projects requiring £500–£15,000. The Centre successfully secured a £5,000 award to help fund "Einstein looks over a Festival of Physics." This enabled the Centre to host a Family Fun Evening and a mobile Physics cart. The introduction of the more specific Science Centre Award Scheme which offered £500–£25,000 gave an even better opportunity to fund larger projects and in 2006 the Centre was awarded just over £17,000 to fund a "Solar Physics Experience." This helped to develop a workshop for KS4 students which otherwise would not have been possible to fund and which has given The Centre an excellent opportunity to engage older students in more diverse areas of astronomy. This in turn offers students a chance to work with specialised equipment not necessarily available in school. This workshop is still being taken up by schools and will remain part of The Centre's educational package in future years. In preparation for International Year of Astronomy another application was made through the Science Centre Award Scheme in 2008. By this time the upper limit of the fund had been reduced to £20,000. The Centre was fortunate to secure £10,000 to help fund a wide range of events throughout the year. In the current economic climate this funding was extremely valuable and helped to ensure visitor number was maintained during 2009 when it was clear that other visitor attractions were suffering.

4.4 Looking to fund further projects this year (2011) it was noted with disappointment that the Science Centre Award Scheme had been withdrawn and the upper limit of the Small Award Scheme has been reduced to £10,000. However a Schools Grant Scheme has been added for projects up to £500. While the Large Award Scheme offers funding from £10,000–£100,000 there is more emphasis on research with strong links to the STFC scientific research community. Science Centre projects would be competing with University research departments. The funding procedure is also more complicated with a two stage process.

5. Conclusion

5.1 Science Centres are valuable gateways, bridging the gap between formal and informal learning, making science exciting and above all fun. As the former home of the Royal Greenwich Observatory there is a strong emphasis on astronomy, a subject that is perceived by many as boring or too difficult. However, by offering events and activities which make astronomy more accessible in a relaxed, informal setting, Centres such as The Observatory Science Centre are able to help inspire the next generation as well as foster further interest in those who are merely curious about the night sky. On Open Evenings or twilight group visits, when the public/schools/cubs/scouts/brownies etc can view through the historic telescopes, often the greatest measure of success is how many "wows" you hear and the best compliment is when people come back. From evaluation forms and word of mouth feedback The Centre does attract many repeat visitors.

5.2 With funding being cut in this area of public engagement and outreach it will become increasingly more difficult to offer activities over and above those that are already part of the annual programme. Development of specific workshops for targeted Key Stages takes time and money and without a broader spectrum of granting bodies that offer a reasonable amount of funds, this area will suffer. Teachers are often constrained by time and money.

5.3 This has a knock on effect of what they can achieve in terms of practical activities to supplement their subject matter. Science Centres can certainly help by providing a hub from which schools can access a wider variety of specialised equipment and practical activities. These activities could also be shared with the wider public and specific interest groups such as astronomical societies or scouting and guiding groups.

5.4 In 2010 following the BBC Wonders of the Solar System series The Centre attracted nearly 400 people on one event alone—"An Evening with the Planets." The success of this programme has now been carried on through the recent BBC programme, Stargazing LIVE. These programmes have certainly brought awareness to the public (gauged by the enormous success overall and our own success on a cloudy night when 170 people

came to The Centre). It would be a real pity if this enthusiasm is not encouraged with more not less funding being given to public engagement in astronomy either through Science Centres, planetariums or other outreach bodies.

Dr Sandra Voss
Science Director
The Observatory Science Centre
Herstmonceux

15 February 2011

Written evidence submitted by the Chair and Vice-Chair of STFC's Ground Based Facilities Review panel (APP 16)

We are writing to offer views on Point 1 in your inquiry:

The 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

We write as the Chair and Vice-Chair of the Ground Based Facilities Review (GBFR) panel, which was set up by the STFC in 2009 to recommend priorities for astronomical facilities. The panel consisted of Michael Rowan-Robinson (Imperial College London, Chair), Rob Fender (University of Southampton), Melvin Hoare (University of Leeds), Rob Ivison (Royal Observatory, Edinburgh)**,** Rob Kennicutt (University of Cambridge, Vice-chair), Richard McMahon (University of Cambridge), and Don Pollacco (Queen's University, Belfast). The Panel's recommendations were broadly accepted by Science Committee and STFC. A key part of the GBFR panel's work was a poll of the UK astronomy community on the priorities it attached to different facilities. The poll also included a number of strategic questions. A copy of the final GBFR report can be found at http://astro.ic.ac.uk/~mrr/gbfrev/GBFRFinal13.pdf

We list here some of the main recommendations from the Executive Summary, with a comment on whether STFC's 2011–15 Delivery Plan (DP) incorporates them.

1. The Panel emphasised the importance of the UK's subscription to the European Southern Observatory (ESO) and,placed this as its highest priority.
   Comment: The DP supports the ESO subscription.
2. The Panel placed very high priority on UK participation in both the European Extremely Large Telescope (E-ELT) and the Square Kilometre Array (SKA). There was very strong, and almost exactly equal, community support for both projects. We agreed that both are of equal scientific priority, and recommended that both should go ahead, and that the UK should seek a leading role in both. Comment: The DP makes no specific mention of E-ELT or SKA, though support for E-ELT is presumably implicit in the continuing support for ESO. Keith Mason in his evidence to the Select Committee says that he hopes that E-ELT will still go ahead.
   Comment: We would like to have heard a stronger commitment from STFC to these two key projects.
3. On UK membership of the Gemini Partnership, we noted that there is strong community support for, and a convincing scientific case for, continued access to a one or more eight metre telescopes in the northern hemisphere. However the GBFR panel found that the level of community support for Gemini, and its cost-effectiveness, is insufficient to justify continuing involvement in the GeminiPartnership at the present level.
   Comment: STFC has announced UK withdrawal from Gemini.
4. In order to mitigate some of the northern hemisphere access resulting from withdrawal from Gemini the Panel recommended that STFC should investigate options for securing of order 40 open-access UK nights per year on one or more northern eight metre telescopes.
   Comment: we are not aware of any effort by STFC to implement this recommendation. Loss of access to northern facilities is one of the most serious negative impacts of withdrawal from Gemini.
5. In addition the Panel made a very strong case for continuing UK involvement in the William Herschel Telescope (WHT) on La Palma for at least the next five years.
   Comment: we are concerned that STFC is moving to close the UK's La Palma activities at the earliest opportunity. We accept that the foundation of the UK's future lies with ESO and the southern hemisphere, but there is a heavy past UK investment in northern hemisphere surveys with space telescopes such as Spitzer and Herschel, and with ground-based instruments such as UKIDSS and SCUBA2. We therefore believe there is a strong case for access to 4 metre (WHT) and 8 metre telescopes in the northern hemisphere for the next several years (our Panel's recommendation was to 2016).
6. The Panel also made recommendations on strategy for radio, submillimetre, and near infrared astronomy.
   Comment: Rather than comment on these in detail, we note that we are not aware of immediate deviations from our recommendations in these areas.

7. The Panel took the view that the university grants line is of very high priority for the future of ground-based astronomy, both for exploitation of our facilities investments and for independent theoretical work that paves the way to new observational ideas.
Comment: The DP states that the grants line will be protected.

In appendices below we give GBFR's table of priorities for different UK ground-based facilities, and GBFR's schedule for its proposed decadal plan.

We conclude this submission by quoting the concluding remarks from the GBFR review:

"The next decade will be an exciting one for astronomy, and ground-based astronomy will be at the forefront of new developments. Ground-based astronomy has reached a level of maturity such that the next facilities, from ALMA onwards, will be massive international collaborations, with a scope and cost comparable to large space missions or accelerators. In its response to our questionnaire, the UK community showed that it is ready for this challenge and is committed to moving in this direction. We have set out strategies for the different ground-based observational wavebands that continue and complete exploitation of past UK investment in ground-based facilities and their instrumentation, while at the same time preparing the way for the facilities of the future. While some additional funding will be needed to deliver the major UK role in construction of E-ELT and SKA that we are recommending, most of what we recommend can be delivered within the present ground-based astronomy funding level. The power of these facilities is such that observing runs may be measured in minutes rather than nights. The impact on public interest in science and as a stimulus to UK advanced technology will be immense."

Prof Michael Rowan-Robinson
Imperial College London

Prof Robert Kennicutt
University of Cambridge

16 February 2011

Table 1

PANEL'S FINAL PRIORITY LIST FOR UK-FUNDED FACILITIES:

	High cost(>£5 million/ yr)	*Medium cost(£1–4 million/yr)*	*Lower cost(<£1 million/ yr)*
Very high priority	ESO subscription (VLT, ALMA, VISTA etc) SKA, E-ELT	ELT instruments	
High priority		N.Hemisphere 8 metre access JCMT to 2014 WFMOS on Subaru e-Merlin to 2014 UKIRT(if UPF) to 2014 LSST (UK Role)	WHT to 2017 LOFAR running costs SuperWASP to 2012 Wide field units Alma Regional Cent. MROI CCAT
Medium high priority	25% share in Gemini partnership	MOS on WHT	MROI beam-combnr
Good science but lower priority			INT JIVE LT Gemini support

APPENDIX

GBFC'S SCHEDULE FOR PROPOSED DECADAL PLAN

2009–14

The ground-based programme will contribute to STFC's short-term funding problems in two ways: the completion of payment of the ESO joining fee in 2012 will save £10 million per year thereafter and replacement of the current Gemini agreement (£5 million) with the purchase of 40 northern 8 metre nights (£2 million) will save a further £3 million per year. Only small savings can be made in the period 2009–12 without disproportionate damage to the programme, but over a five-year period the ground-based programme would contribute its pro rata share of savings, even with a start-up of funding for the build of E-ELT in 2012.

2014–17

The proposed closure date for JCMT, e-Merlin and UKIRT of 2014 has been partially dictated by the need for funding to open for E-ELT and SKA. For each facility a good scientific case can be made for extending them further, but the case for involvement in E-ELT and SKA is stronger, and choices have to be made. The telescope that we identify as most valuable for support of GAIA (2014–17) is the WHT and so we recommend keeping the WHT open to 2017, but with no recommendation on new funding for instrumentation. If the start of the construction phase of SKA were to be delayed, then the case for extending JCMT, UKIRT and e-Merlin beyond 2014 should be looked at again.

2017–20

Towards the end of the decade, the UK ground-based programme will be realized mainly through ESO (VLT, ALMA, E-ELT, and other smaller ESO telescopes) and SKA. In addition we propose a small UK involvement in CCAT. Other opportunities may arise through ESO, for example LSST, or through bilateral partnerships, for example PanSTARSS4.

Written evidence submitted by Professor Gerry Gilmore, UK Principal Investigator, Gaia mission (APP 18)

1. I respond re your enquiry regarding the impact of withdrawal from international ground-based facilities (eg Gemini Observatory, Isaac Newton Group of telescopes) on the UK's research base, and opportunities for public outreach and inspiration of young scientists.

2 . I comment as UK Principal Investigator for the European Space Agency Gaia mission. Gaia is ESA's premier astrophysics mission of the next decade, due for launch in mid-2013. Gaia is a revolutionary satellite, which will provide the first ever 4-dimensional study of the Milky Way Galaxy, determining both where stars are in space, and—uniquely—how they are moving. Gaia science will quantify how the Milky Way Galaxy formed and assembled, create the first detailed map of how Dark Matter is distributed, quantify stellar evolution, determine the orbits of all near-Earth Objects, discovering all those in potentially dangerous earth-crossing orbits, make contributions to cosmology and fundamental physics, and very much more. It will be a revolution.

3. Gaia's data processing requirements in the UK are funded by the UK Space Agency. Much of Gaia was built by UK industry.

4. A crucial aspect of space astrophysics, especially as related to quantitative studies of the whole Milky Way, is that the whole sky, north and south (as seen by us) is studied. Unique aspects are available only in the south—eg the centre of the Milky Way, or only in the north—eg the tidal debris of the Sagittarius galaxy, with which the Milky Way is currently merging, and whose orbit defines the distribution of Dark Matter in the Galactic halo.

5. Astrophysical studies of Dark Matter are the essential complement to interpretation of the (anticipated) results from the LHC at CERN. Cosmological results from Gaia, especially precision calibration of the cosmological distance scale, are not only of high intrinsic interest, but are the essential complement to other cosmological studies, such as the Planck satellite mission currently in operation. Gaia addresses the big cosmological questions.

6. One of the many ways in which Gaia data will contribute is through discoveries of transient events—especially SuperNovae, the prime cosmological distance calibrators. These objects, being transient, require rapid ground-based follow-up, before they disappear for ever.

7. The UK, through the Cambridge Gaia data centre, has sole responsibility for the discovery and public release of Gaia transient discoveries. It is an example of UK leadership of an exceptionally high-profile international project.

8. Transient objects are found in both hemispheres, north and south, and so naturally require follow-up capabilities in both hemispheres. Access to the Isaac Newton Group is crucial.

9. A particular strength in follow up is automated telescopes, which can respond quickly. The UK's involvement in the Liverpool Telescope, and the Faulkes telescopes, is of special importance here.

10. In addition to the manifest science impact, there is a huge potential for motivating the young. Linking the Gaia real-time science discoveries to school access to remote robotic telescopes means that school children can, and will, be able to make unique science discoveries as a natural aspect of their school lessons. Since Gaia will discover new interesting objects every few minutes, schools can schedule time well in advance, knowing there will be unique new discoveries which they will be the first to confirm and follow-up. School students can learn for themselves the excitement of real original science.

11. This project is feasible provided that access to telescopes is provided. If not, the Gaia educational potential will be lost to UK schools—very major preparatory efforts for this are underway elsewhere, particularly in France and Poland, in collaboration with the UK Gaia team. Astronomy manifestly has the

highest public profile of all sciences, and correspondingly has an obligation to deliver real science, beyond pretty images. The opportunity exists, and only requires that the capability exists.

12. STFC's focus on superb facilities delivered through ESO is manifestly sensible for the biggest projects. Scientific and educational/outreach requirements show that it is also essential to maintain breadth of access, both geographically and in scale of facility. This is particularly important noting the synergy between STFC major astronomical facilities, the UK's investments in the European Space Agency, and the astrophysics-particle physics complementary approaches to understanding the nature of reality, through CERN/LHC and the astrophysical dynamics from Gaia.

13. UK science has excellence, and breadth. It will maintain this through balanced access to a range of facilities, appropriate to the range of technical requirements across the scientific spectrum.

Professor Gerry Gilmore
UK Principal Investigator, Gaia mission

Professor of Experimental Philosophy
Institute of Astronomy

16 February 2011

Written evidence submitted by Professor Paul Crowther, University of Sheffield (APP 19)

Thank you for the opportunity to provide input to the Science & Technology Committee inquiry into astronomy and particle physics. I am writing in a personal capacity as a research active academic within the astrophysics group of the Department of Physics & Astronomy at the University of Sheffield.

I declare that our astrophysics research group are in receipt of several research grants from STFC, including support for PhD studentship training, visiting academics and travel & subsistence for observing at telescopes. I have previously served as chair of the UK Gemini National Time Allocation Committee (NTAC), a sub-chair of the European Southern Observatory (ESO) Observing Programme Committee (OPC), and currently serve on the STFC UK Steering Committee for the proposed European Extremely Large Telescope (E-ELT).

Historical Context

1. The 2005 *International Perceptions of UK Research in Physics and Astronomy* (sponsored by EPSRC/ PPARC/IoP/RAS) noted the "positive outlook" of those involved with research at all levels and advocated maintaining a healthy balance between large investments in international facilities and national spending for exploitation. The UK astronomical observing community was singled out as needing "building up" to recoup the investment in VLT, ALMA and Gemini.

2. The CSR 07 settlement for the newly created STFC led to a disproportionate and precipitous reduction in funding of exploitation grants for UK astronomy, set out in the 2008 *Science Budget Allocations* report by the Innovation, Universities, Science & Skills committee. In addition, UK led astronomy projects (eg CLOVER) were terminated at short notice, with plans to withdraw from all non-European Southern Observatory (ESO) ground-based facilities in 2012.

3. There is a common perception that the growth in UK astronomy leading up to CSR 07 was spiraling out of control. Indeed this may have contributed to the poor STFC settlement for astronomy; reinforced by claims of a 40% expansion in UK astronomy academic numbers from 2005 to 2007 by STFC's Chief Executive at the 27 Feb 2008 evidence session of the Innovations, Universities and Skills Committee. In reality, growth was only 4% based on PPARC/STFC's studentship quota exercise statistics over this timescale. In addition, the IoP *Survey of Academic Appointments in Physics* showed that the UK astronomy academic community grew by 14% in the five years leading up to 2008, directly in proportion to the expansion of physics departments, and indeed the entire Higher Education sector over this timescale. In summary, no evidence supports the impression that UK astronomy was experiencing unsustainable growth in the last decade.

4. The SR10 settlement for the STFC was at the high end of the research community's expectations, for which credit should be given to STFC's spending review team (both scientists and management) and BIS staff. In addition, it is important to acknowledge that BIS were able to maintain the UK's subscription for ESO, permitting continued access to the top priority UK ground-based telescopes (VLT, ALMA) throughout SR10. Communication between the scientific community and STFC management is now much improved, in part due to regular policy discussions with senior academic staff through the Astronomy Forum, chaired by the RAS President.

5. BIS are to be commended for following through with STFC structural changes proposed by Lord Drayson in 2010, enabling resolutions to the issues of currency fluctuation relating to subscriptions, and the tensioning between funds for the operation of national facilities used by other Research Councils and facilities/exploitation directly relevant for STFC's user communities.

THE IMPACT OF REDUCED CAPITAL FUNDING ON UK CAPABILITY

6. Uncertainties in long-term capital funding for STFC will make future planning very difficult. Of particular concern to UK astronomy is the next major ground-based optical/infrared telescope project for Europe, the European Extremely Large Telescope (E-ELT). UK groups are taking a leading role in the R&D effort for E-ELT instrumentation, while UK industry also stands to benefit from construction; however such benefits are predicated on UK capital investment in E-ELT.

7. The relatively poor settlement for UKSA raises concerns about the level of support for UK space science and its future health. At the time of writing, there are no details of the planned UKSA expenditure on post-launch support for space science missions, which is of direct relevance to the capability of UK astronomy (eg GAIA mission).

THE 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

8. The UK competitiveness in astrophysics and space science—second only to the US according to Thomson Reuters—arises in large part from the multi-wavelength, multi-hemisphere, ground-based and space-based facilities. Over the course of a few years, the UK leadership in ground-based astronomy within Europe—strategically built up over decades—has been eroded, and will shortly become a distinct disadvantage following the withdrawal from non-ESO telescopes.

9. As recently as the 2007–08 STFC Delivery Plan, equal priority to ESO (southern hemisphere) and Gemini (both hemispheres) were planned for the UK, contrary to evidence to the S&T Committee from STFC's Chief Executive on 19 January 2011. Advice from STFC's advisory panels and ground-based review panel noted that access to a northern hemisphere telescope beyond 2012 was of high priority, in part due to international space-based facilities for which the UK plays a leading role (eg Herschel, Swift). Withdrawal from Gemini will reduce UK access to 8m telescopes by—40%, which will be further compounded by a 25% reduction in access to VLT by UK astronomers over a two year timeframe, as partial compensation for the late delivery of the VISTA telescope to ESO.

10. The forthcoming withdrawal from island sites (La Palma, Hawaii) will greatly reduce opportunities for UK-led innovative instrumentation development. For example, ULTRACAM was the first visiting instrument at ESO's Very Large Telescope, which was only made possible having initially been commissioned at the Isaac Newton Group on La Palma.

11. Flip-flopping over Gemini membership by STFC management between late 2007 and early 2008 certainly damaged the international reputation of the UK. Following the initial ejection from the partnership in January 2008, as the then chair of the UK Gemini National Time Allocation Committee, I consulted first hand with non-UK Gemini Board members in order to establish how this action had occurred. Replies included "*I'm afraid the STFC's actions have been baffling to all"* and "*it was really seen as not serious by the other partners and almost rude and arrogant."* Even following the UK's readmittance into the partnership, STFC's Chief Executive denied STFC responsibility during the NAM Community Forum on 3 Apr 2008: *"I tear my hair out about Gemini frankly, and this is a case where you were all had, and you were all had by the Gemini Board."*

12. Prior to the transfer of post launch support for space missions to UKSA, a second example of the damage to UK's international reputation arose from STFC's planned withdrawal from support to Cassini in late 2009. In a letter to The Times in February 2010, the PI of Cassini's magnetometer instrument Prof Michele Dougherty noted: *"the STFC is breaking obligations to international partners and undermining the UK's future position in multinational space projects."*

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

13. STFC was slow to put in place advisory structures, having prematurely wound up advisory bodies to the predecessor PPARC organization. Administratively, despite the new post-Drayson arrangements for operating national facilities, changes to Science Board and its advisory committees have not yet been made. Consequently, scientific panels for astrophysics and space science (NUAP and FUAP) are too far removed from the decision making process. The dissolution of Science Board would cut out a now unnecessary layer of committee structure, and greatly assist a sense of ownership of STFC's scientific priorities by the respective user communities.

14. Concerns remain about the size and composition of STFC's Council. Following criticism in the 2008 RCUK *Review of Physics* about the low fraction of STFC councillors who were independent academics, additional scientists were appointed to Council. However, only four out of 12 STFC councillors are currently academics. For comparison, academics comprise 8 out of 16 councillors at BBSRC. Indeed, the composition of BBSRC's council ensures that in addition to the Chair and Chief Executive, at least half of the 14 other councillors are appointed for their qualification in science/engineering.

15. In the absence of a visible science strategy for STFC, there are concerns that strategic/political priorities trump scientific priorities. For example, the NUAP advisory panel ranked access to northern ground-based telescopes at a higher scientific priority than the Aurora exploration programme, yet only the latter avoided being cut. The January 2010 report from STFC's Particle Physics, Astronomy & Nuclear Physics (PPAN) committee noted: "*It was recognised that, given the high profile UK commitment to Aurora, to propose withdrawal would have a very high political cost both for STFC within the UK, and for the UK space programme internationally. PPAN did not consider it feasible to achieve a reduction in the planned Aurora subscription*." Aurora subscriptions have since been transferred to the UKSA, preventing the possibility of a subsequent reversal in priorities.

Opportunities for, and Threats to, Outreach and Inspiring the Next Generation of Astronomers and Particle Physicists

16. NUAP and FUAP advisory bodies to STFC's PPAN committee argued that the highest priority should be given to grants (and fellowships), yet these were reduced by STFC in the December 2009 prioritization exercise.

17. Research grant support, as measured by responsive postdoctoral research assistant (PDRA) numbers is at a level of 2–3 of the 2000 baseline, or 50% of the 2006 high-point. For the most recent Astronomy Grants Panel (AGP) 2010 round, 76 PDRA positions were assessed to be world-leading, of which only 56 could be awarded, ie 136% of funded research in astronomy is world class according to the AGP chairman's report. 28 PI's of AGP 2010 grant proposals, myself included, received the following feedback: *"Panel recommended support as requested, as a high priority. Fundable—Unfunded."* This translates into no PDRA support for the next three years, plus no funds either for equipment or travel.

18. STFC also supports PhD studentships and independent fellowships through its education, training and careers committee (ETCC). PhD allocations across STFC's scientific areas have been relatively stable, totalling 256 in 2008 and 2009, with reductions to 235 in 2010 and 220 thereafter, of which 56% are for astronomy and space science. Unfortunately, the sharp fall in PDRA positions, and the withdrawal of independent junior (post-doctoral) STFC fellowships has meant that there is little opportunity for most new PhD graduates to remain within the UK. By way of example, the last three astrophysics PhD students who have completed their studies in our group have taken up post-doctoral positions in Zurich, New York and Heidelberg.

19. Changes set out above reduce the international research competitiveness of UK astronomy and space science with respect to other developed countries and are likely to do long term damage to the attractiveness of the UK for prospective postgraduate students, PDRAs and academics. The future health of UK astrophysics relies upon a critical mass of junior staff being retained within the UK or returning to the UK after time overseas, for which stable funding and access to leading international facilities is crucial.

Paul Crowther
Professor of Astrophysics
University of Sheffield

15 February 2011

Written evidence submitted by Professor Francisco Sanchez, Director, Instituto de Astrofísica de Canarias (APP 20)

This letter is a submission of the Instituto de Astrofísica de Canarias (IAC) in Tenerife, Spain, to form part of your inquiry into Astronomy and Particle Physics in the UK. We particularly wish to comment on points 2 and 4 in your inquiry, on international ground-based facilities and on outreach.

1. The UK and Spain collaborate closely in Astronomy and Particle Physics, including multi-national (ESO, ESA, CERN) and bi-national agreements.

2. This includes the Agreements on Cooperation in Astrophysics, which continue to deliver tremendous scientific benefit to both UK and Spain through the joint operation of several telescope installations on the Roque de los Muchachos Observatory on the Spanish island of La Palma, which is operated by the IAC.

3. Within the Observatory, the UK remains a priority partner for Spain, due to our long history of collaboration, to the leadership shown by the UK and to the quality of our joint facilities.

4. Spain, and the IAC in particular, remain very satisfied with this collaboration and wish to maintain and extend it.

5. The William Herschel Telescope (WHT) plays a key role, and will continue to do so for many years to come. Other facilities include the Isaac Newton Telescope, SuperWASP and the Liverpool Telescope. These facilities have a very strong user base in the UK, as well as in Spain.

6. The Isaac Newton Group, which operates the WHT, is leading an excellent new initiative aimed at adding top-quality instrumentation to the WHT. This is a mainly UK-Spanish-Dutch initiative, fully supported by the IAC. There is very broad support for this initiative from the UK astronomical community.

7. Spain is the majority partner (90%) of the 10 m GTC telescope on La Palma, which is just now coming into full operation.

8. The GTC is the largest single optical telescope in world, and the largest optical telescope in the Northern Hemisphere.

9. The GTC is open to international partners, including the UK. The IAC is very interested in continuing the existing telescope agreement with the UK, which can be re-focused on a joint operation of WHT and the GTC.

10. This would give the UK community unique access to a 10-m optical telescope in the Northern Hemisphere, which will be needed to follow up discoveries to be made with other facilities; such as e-Merlin and LOFAR from the ground and Planck, Herschel, JWST and GAIA from space. All of these have significant UK involvement and some of them are cornerstones to UK astronomy in the next decade.

11. The Canary Island Observatories play a key role in the education of the next generation of researchers, through winter and summer schools, and a successful resident student programme where UK astronomy post-graduates get hands-on experience working at the telescope.

12. Public outreach has always been a priority for both our UK partners and the IAC. Examples of this are live BBC broadcasts from La Palma,and the excellent National Schools Observatory programme, operated by the Liverpool Telescope.

13. We look forward to continued successful collaboration with the UK, through the Research Council as well as through all the Universities involved in the La Palma facilities.

Declaration of interests: The IAC owns and manages the international observatories on La Palma and Tenerife in the Canary Islands. The IAC is a partner in the Isaac Newton Group of Telescopes.

Professor Francisco Sanchez
Director
Instituto de Astrofísica de Canarias

17 February 2011

Written evidence submitted by Far Universe Advisory Panel (FUAP) and Near Universe Advisory Panel (NUAP) (APP 21)

1. We are writing to you as members of the Far Universe Advisory Panel (FUAP) and Near Universe Advisory Panel (NUAP), which are two of the five advisory panels established in March 2009 by the STFC Particle Physics, Astronomy and Nuclear Physics Science Committee, or PPAN. The remits of NUAP and FUAP cover all parts of the astronomy and space science programmes at STFC; from our Solar System to cosmology.

2. Since 2009, FUAP and NUAP have been providing scientific and programmatic advice to PPAN and STFC in general, including working with the astronomy community to help set funding priorities. Our biggest task to date was an extensive community consultation in the second half 2009 as part of the STFC Programmatic Review, that was published on 16 Dec 2009. Since then, FUAP/NUAP, and the community, have had little input into the preparations for the 2010 Comprehensive Spending Review (CSR), nor into the implementation plan of the recent CSR outcome.

3. During the FUAP/NUAP consultation in 2009, one of the key priorities raised by the astronomy and space science communities was the continued stable funding of research grants to our universities, as well as the continued support of our young scientists (both PhD studentships and fellowships). The community gave this issue *highest priority* over any specific astronomical facility, STFC-funded experiment or space mission, and the importance of this prioritization was clearly communicated to PPAN, Science Council and STFC in general.

4. As UK astronomers and space scientists, we must say that this key piece of advice does not appear to have been taken as seriously as hoped, inspiring the chairs of the five PPAN advisory panels (including Bob Nichol and Michele Dougherty as the FUAP and NUAP chairs respectively), to write to Keith Mason, Michael Sterling, Lord Drayson and David Willetts, as well as your committee (on 10 January 2010), to stress the potential impact on our communities of the continuing savage cuts to research grants. To put this into perspective, the number of postdoctoral researchers supported on STFC research grants has halved since 2007, and is now below the number of young researchers supported by such grants in the year 2000. There has also been a similar curtailment of studentships and fellowships, eg, the STFC Postdoctoral Fellowship scheme has been cancelled altogether, resulting in many of our brightest graduating students being forced abroad to continue their careers.

5. That said, we do appreciate the tough priority decisions made by STFC over the last two years given the financial pressures on capital funding, inflation in subscription costs to our major international facilities, and the overheads of merging two research councils (PPARC and CCLRC). However, we feel the management of STFC is more interested in maintaining the funding to large experimental facilities at the expense of

maintaining the research capacity of our university communities. This imbalance is partly recognized in the recent STFC Delivery Plan (20 December 2010), which highlights the need to provide stable grant funding to universities over the coming few years, but unfortunately STFC has set that funding at a level lower than even a decade ago, thus entrenching the savage rounds of multiple grant cuts since 2007.

6. We do feel STFC has not fully acknowledged one of the key parts of our 2009-community consultation, namely the importance for continuing a vibrant research-active community in our universities (students and postdoctoral fellows). The chairs of the five advisory panels to PPAN have all stressed the potential negative social and economic impact of such cuts to physics research in our universities, especially in our ability to train and inspire the next generation of scientists, eg, 90% of physics graduates go on to pursue careers in high-tech, high-added value sectors of the UK economy. Moreover, Astronomy is highly effective in attracting young people into science and our universities.

7. We would therefore ask your committee to stress again the importance of investing in people, as well as facilities, to Parliament and STFC, to ensure we can continue to compete on the world stage; other countries are investing heavily in astronomy (Japan, USA, South Africa, Australia, Brazil), while we are cutting back to levels not seen since last century. The "Brain Drain" is happening again in the UK.

Bob Nichol
University of Portsmouth (FUAP Chair)

Michele Dougherty
Imperial College London (NUAP Chair)

Sarah Bridle
University College London

Emma Bunce
Leicester University

Anthony Challinor
University of Cambridge

Rob Fender
University of Southampton

Ian Franchi
Open University

Tom Hartquist
University of Leeds

Paul O'Brien
University of Leicester

Sarah Matthews
MSSL, University College London

Paul O'Brien
University of Leicester

Don Pollacco
Queen's University Belfast

16 February 2011

References

FUAP & NUAP reports to PPAN discussing the 2009 community consultation carried out as part of the STFC programmatic review:
http://research.icg.port.ac.uk/wikis/fuap/img_pub.php/FUAP-report-PPAN-FINAL.pdf
http://www.stfc.ac.uk/Resources/PDF/MergedNUAPDraftStrat161109.pdf

---

Written evidence submitted by Stephen W. Hawking CH, CBE, FRS (APP 22)

1. I am pleased to be able to make a submission to the select committee about UK funding for particle physics and astronomy. I am sure you all recognise that a healthy science base is necessary for a healthy economy. However, to target funding only using narrow economic criteria is to misunderstand the value to society of science and our Universities. It has been said that not all research and development comes from our Universities, but that all the researchers do. The frontiers of fundamental scientific knowledge, like particle physics and astronomy, have always been an inspiration for the next generation of scientists.

2. The erosion of funding for astronomy and particle physics in recent years has harmed the position and reputation of the UK in the international scientific community and reduced the important educational impact

that it can have upon young people. My own research group has been affected by this funding environment. An accumulation of spending cuts over the last three years, has left STFC awarding one third fewer postdoctoral fellowships in astronomy than average this year. The UK punches significantly above its weight in the competitive world of particle physics and astronomy and has a remarkable history of discoveries and fruitful international collaboration. We are key participants in important international collaborations like the LHC and the current Planck satellite mission. We must ensure that we can support the young people who are poised and able to exploit the new science that comes from projects and telescopes of this sort.

3. The blue skies research pursued by particle physicists and astronomers has had a huge influence upon school students. It is an inspiring shop window for them to glimpse the frontiers of human thinking about the deepest problems of the universe. This creates an enthusiasm for learning about the physics and mathematics that are needed to understand more. In turn, this provides universities with a pool of keen and able students who will diversify into many other areas of pure and applied physics and their associated sciences. Without strong support for subjects like particle physics and astronomy we will suffer the economic and cultural consequences of a lack of students in the physical sciences.

Stephen Hawking
Director of Research
Centre for Theoretical Cosmology
Department of Applied Mathematics and Theoretical Physics
University of Cambridge

15 February 2011

Written evidence submitted by Dr Don Carlos Abrams, Head of Engineering, Isaac Newton Group of Telescopes (APP 23)

Declaration of Interests

1. I, Dr Don Carlos Abrams, declare that I have an interest in the Commons Select Committee inquiry as the Head of Engineering at the Isaac Newton Group of Telescopes (ING) and as an employee of the Science and Technology Facilities Council.

Focus

2. I focus my response on the second issue raised by the Science and Technology Committee. This concerns the 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.

Response

3. The Particle Physics and Astronomy Research Council's (PPARC) *original vision* to provide UK access to ground-based astronomical facilities exclusively via the European Southern Observatory (ESO) was a rational approach given the UK's involvement in Gemini. However this strategic decision was taken without sufficient engagement with the UK astronomical community at a time when the UK's involvement in Gemini was not under threat. Over the past couple of years, the Science and Technology Facilities Council (STFC) rectified the community engagement issue by actively seeking input from its communities. As a result of STFC's consultation exercises it became apparent that the UK's requirement for access to ground-based facilities could not be achieved, in its entirety, through the UK's membership with ESO. Furthermore it has become clear that UK withdrawal from the abovementioned facilities will have a devastating impact on the future scientific output of UK astronomy primarily because a large portion of the sky will be unobservable whilst remaining scientifically important for certain areas of astronomy. This will have a significant impact on the UK's ability to exploit fully certain space missions and large UK-led surveys that are currently underway. Evidently this will be detrimental to the UK's scientific leadership.

4. It's well understood that all facilities have a natural lifespan which is primarily dictated by the benefit-cost ratio. For the telescopes on La Palma, this ratio is particularly attractive when considered in the context of the UK's operational commitment to the ING. It's appreciated that access to the La Palma telescopes did not rank as high as access to some of the other ground-based facilities (STFC's prioritised list). Nevertheless there was a clear indication, from the community, that access to the William Herschel Telescope (WHT) was essential for the future of UK astronomy. This telescope is particularly productive and access to the facility is highly desirable by astronomers worldwide and not just those from the UK. There's a realisation that the funding required for the telescopes of tomorrow, such as the European Extremely Large Telescope (E-ELT) and the Square Kilometre Array (SKA), can only be acquired if the investments in older facilities are relinquished. Whilst this is accepted, it is critical for the future of UK astronomy that the process of withdrawing from telescope A to fund telescope B is thoroughly examined. This is particularly important when telescope A is a highly competitive scientific apparatus with running costs that are, for all intents and purposes, negligible when compared to the costs being invested in the E-ELT and the SKA.

5. The UK's presence on La Palma is governed by a number of international agreements. In these agreements there is an understanding that the facilities on the island will remain operative for a given duration and, of course, partners are entitled to withdraw as per the details in the agreement. Nevertheless, the UK's European reputation will be severely damaged if a unilateral withdrawal is sought without considering plausible alternatives for the future operation of the telescopes. The UK's ING partners have expressed an interest for the continued operation of the ING. This interest is supported by the ASTRONET consortium, which was created by a group of European funding agencies with the remit to establish strategic plans for European astronomy.

6. La Palma is home to a number of UK-owned telescopes that are world renowned. Queen's University Belfast (QUB) is currently installing a follow-up telescope to search for exo-solar planets. This work follows on from QUB's world-renowned planet hunting programme in which 26 planets were identified by the SuperWASP telescope. This is another example of an impressive facility with a high benefit-cost ratio and the ability to develop an outstanding outreach programme. In addition to the search for exo-solar planets the fully autonomous telescope built by Liverpool John Moores University is playing an important role in robotic rapid response astronomy and in delivering astronomy to the classroom through their National School's Observatory programme. Both of these facilities rely heavily on, and greatly benefit from, the UK's presence on La Palma.

7. The UK's Isaac Newton Group of Telescopes is in a distinctive position in that it actively provides a platform for the hands-on training of future UK astronomers. Prospective professional astronomers come to the ING to be trained in the practical aspects of astronomy. Furthermore, young astronomers, with no observing experience, can come to the telescopes and actively perform their own observations. This mode of hands-on observing is becoming rare and is seldom permitted on the larger facilities. The UK's withdrawal from La Palma would significantly reduce these training opportunities for these young scientists.

8. The WHT has a long history of providing a fast-track test-bed environment for new instrumentation. Currently the telescope is being used to demonstrate an advanced observing technique for the future E-ELT. Quiet often the telescope is used to host instruments that are built by UK Universities. This provides an excellent opportunity for engineers and astronomers to work together whilst demonstrating UK leadership in astronomical developments.

Dr Don Carlos Abrams
Head of Engineering
Isaac Newton Group of Telescopes

16 February 2011

Written evidence submitted by Dr. Marc Balcells, Director, Isaac Newton Group of Telescopes (APP 24)

Disclaimer

1. This evidence reflects my personal views and does not constitute the official view of the Isaac Newton Group of telescopes.

Declaration of Interest

1. I am Director of ING, the Isaac Newton Group of Telescopes, an establishment of the Science of Technology Facilities Council (STFC) on La Palma.

2. I was a resident astronomer at the Isaac Newton Group of telescopes in the period 1990–92.

3. My research has benefited for over 20 years from the presence of UK telescopes on La Palma. I have directed or co-directed eight PhD theses, two on UK Universities, based on data from ING telescopes. I currently co-direct a PhD student at a UK University.

4. I am a co-investigator in a large international consortium to study the Coma cluster of galaxies using the Hubble Space Telescope and ground-based observations, led by Prof. D. Carter from Liverpool John-Moores University.

The 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

5. I believe that withdrawal from Hawaii and La Palma will have consequences in three areas, as summarized in the next paragraphs: science (paragraphs 6–11), technology (paragraph 12) and training (paragraph 13). I will focus on La Palma because this is what I know most about.

6. If UK withdraws from Hawaii and La Palma, UK astronomers will have access to only one optical-infrared observatory, located in the Paranal Observatory in Chile. ~40% of the sky is inaccessible from Paranal. This includes the Northern portions of our own Milky Way galaxy. The Gaia satellite, a cornerstone mission of the European Space Agency, promises to unravel the formation history of the Milky Way. Realising the full benefits of the Gaia investment needs ground-based observations of the entire sky. There is a consensus in

Europe that the William Herschel telescope (WHT) on La Palma is the overall best telescope for this endeavour. Without the La Palma telescopes, the UK will miss a unique opportunity to exert international leadership in this exciting field.

7. The part of the Northern sky that remains inaccessible from Chile includes the Andromeda galaxy. UK astronomers, using ING telescopes, led the most important discoveries in the past two decades on the formation of Andromeda. La Palma, now hosting the Spanish-led 10-meter GTC telescope in addition to UK's 4.2-meter William Herschel Telescope (WHT), offers an opportunity to remain leaders in this field, which will be missed if UK leaves La Palma.

8. The Northern sky also hosts the Coma cluster of galaxies, the only giant galaxy cluster that is sufficiently close to be studied in detail. The UK now leads a global collaboration to study Coma. Without ground based optical telescopes in the Northern Hemisphere the UK leadership position in this project will be compromised.

9. La Palma hosts other UK-led astronomical facilities. The novel robotic Liverpool Telescope is ideal for transient astronomy, key for the study of supernovae and gamma-ray bursts. The SuperWASP telescope of the Queens University Belfast is making major contributions to the discovery of extra-Solar planets. Operation of these two telescopes is facilitated by the presence of the ING on La Palma.

10. Consultation with ING's user communities in 2009–10 showed broad support for the continuation of ING. A recent European review of astronomy (ETSRC) sponsored by the main European funding agencies also emphasized the importance of the WHT in the European context, noting that a healthy community will always need mid-size telescopes alongside the larger telescopes. While smaller telescopes need to be closed down or passed on to new owners, the WHT is to many the best 4-metre telescope in the World. Our strategic planning ensures its continuing global competitiveness in the coming decade. The UK will lose out by closing down this facility in 2012.

11. The observatory at La Palma can provide the UK with a convenient platform for the access to the Northern Hemisphere, on a site that is among the best in the World. The observatory is a mature infrastructure that now hosts the Spanish-led GRANTECAN 10-metre telescope. There will be opportunities for the UK to obtain observing time on this larger facility.

12. Technology development for astronomy, in which the UK has an international reputation, will also suffer if ING closes down. The WHT is the only available facility where the adaptive-optics technologies needed for the future E-ELT can be prototyped. This is an area with major contribution from UK labs. Of equal importance for maintaining the strength of the UK technology base, the ING allows University-size teams to deploy with their own instrumentation on the WHT. Such capability, highly valued by UK astronomers, is not available elsewhere and certainly not at ESO. Pulling out of ING would impact technological creativity in UK Universities.

13. The ING contributes to training the next generation of astronomers. Astronomers rarely travel to the Chilean telescopes, which are far away, and where resident astronomers often carry out the observations. But UK astronomers come to ING. They gain a better understanding of telescopes, instrumentation and improve on their observing strategies. Additionally, the ING manages a world-renowned resident student program, providing hands-on training in the science, technology and management aspects of running an observatory. This contributes to educate the next generation of scientists that will manage and exploit the giant telescopes of the future. Without ING, British astronomers would miss an important component of their training.

Dr Marc Balcells
Director
Isaac Newton Group of Telescopes

16 February 2011

Written evidence submitted by Professor N. R. Tanvir, University of Leicester (APP 25)

I wish to make some brief remarks on the impact of reductions in funding which began in 2007 and are ongoing.

1. By many measures UK success in astrophysics and space science is second only to the US in recent decades. This has been achieved not by out-spending other comparable nations, but is thanks to our long and proud history of leadership in fundamental science, strategic investment of the funding which was available, and making profitable use of those facilities. One result of this was a "brain-gain" of outstanding foreign scientists coming to the UK to work in these fields. Another result has been the high level of activity in our universities and laboratories, which has inspired many young people into STEM studies, and, one hopes, increased our national self-confidence in these vital areas.

2. One of the characteristics of this successful period has been the access UK astrophysicists have had to a very diverse range of experimental facilities. Many breakthroughs have come about thanks to putting together data from different telescopes and satellites, often operating in different spectral ranges (optical, X-ray, radio etc). There is every reason to expect such a strategy would be even more successful in the future, as we become

able to combine traditional observations using electromagnetic radiation, with new windows, such as gravity waves and neutrino detectors.

3. Of particular interest to me, and a growing field in astrophysics, are the observations of transient phenomena, and in particular exploding objects in space. Events like supernovae and gamma-ray bursts are amongst the most exotic known, and in the latter case are so bright that they can be seen close to the edge of the observable universe. Indeed, in 2009 I led an international group which discovered a gamma-ray burst which was the most distant object known up to that time. Such discoveries are not merely about breaking records, but provide unique information about the universe shortly after the Big Bang when the first stars and galaxies were being formed. This discovery illustrates well the critical requirement for facilities spread both across the electromagnetic spectrum and spread geographically: the burst was discovered in gamma-ray light, and its position found in X-ray imaging by the Swift satellite. We then made observations over the next 48 hours using telescopes on five continents (most importantly Gemini-North in Hawaii and the ESO/VLT in Chile), and finally used the Hubble Space Telescope to search for the galaxy in which the burst occurred. This discovery would not have been possible had we only had the facilities which will be available post-2012.

4. The consequences of the UK's sudden decline in funding for astrophysics and space science, and in particular the planned withdrawal from many facilities, is already being keenly felt. There has been an exodus of young talented scientists to other countries, which despite suffering in the global economic turn-down as did the UK, seem to have recognised the wider importance of maintaining a high level of activity in inspirational, fundamental science. The almost complete lack of access to northern hemisphere optical/infrared telescopes post-2012, is a especially bleak development, since many important sources in the sky are not observable from the south, and particularly the short-lived events I have described can occur unpredictably in the sky. These northern telescopes are complementary to other facilities we are retaining and many new international facilities (eg northern facilities such as LOFAR, all-sky observatories such as the GAIA satellite, gravity wave detectors etc), so I view it as strategically very important that we retain at least some access to them, even if it be at a lower level than a few years ago.

5. It has been argued that by joining ESO in the early 2000's it was inevitable (and even planned) that other, older telescopes would be under pressure to close. I agree with this, and indeed the UK has withdrawn from the AAT and the UK Schmidt Telescope in Australia, and significantly reduced its spending on the WHT in La Palma and UKIRT in Hawaii. However, as far as I am aware, what was never suggested (publicly) or planned was withdrawal from the Gemini telescopes. These are not old facilities, and they remain at the forefront of astronomical research. It is true that the capabilities of Gemini-South (in Chile) do duplicate those of ESO/VLT, and it made sense to reduce our investment there (as we did). However the decision to withdraw from Gemini-North, came out of the blue, was not the result of a community consultation, or any well developed strategic plan. It did considerable damage to our reputation as an international partner, and taken together with the withdrawal from UKIRT and WHT leaves us without any world-class optical/infrared facilities in the northern hemisphere.

6. Subsequent to 2007, various efforts have been made to patch up the damage done by the initial budget cuts to astronomy and some rear-guard attempt to re-engage the community. Unfortunately, of course, in an era of closures and "fire-fighting" this has not been a great success. The ground-rules for grant funding seem to be changing on a yearly basis, and we seem to be evolving to a new system which, whilst intended to save money, looks very likely to produce lower quality science, mainly due to there being less flexibility, and less oversight and peer-review. Indeed, the relatively efficient (and tested) operation that STFC inherited from PPARC seems to have been almost entirely dismantled. That said, I believe the damage to astronomy could be greatly alleviated by some small reinvestment in northern hemisphere optical/infrared telescopes—the highest strategic priority would be to renegotiate some access to the eight meter Gemini-North telescope (eg at the 15–20% level, which is much less than our previous 25% share of both Gemini telescopes). This would require new agreements with international partners, but I would be surprised if they were not receptive to the proposal. The WHT on La Palma, as I've indicated, would also continue to provide an important resource, if some access could be retained. As I've attempted to stress, this is not about keeping old telescopes so we can continue to do more of the same, it is about providing UK scientists with access to a coherent global network of facilities, so they can be at the forefront of the discoveries of the future.

Professor N R Tanvir
University of Leicester

16 February 2011

Declaration of interests: my only interests are as a working scientist who makes use of many of the facilities threatened with withdrawal of funding.

Written evidence submitted by Dr Bryn Jones (APP 26)

Introduction

1.1 I worked for ten years as a research scientist in astrophysics in British universities. I worked more recently as an academic on short-term contracts for nearly five years and was included in the 2008 Research Assessment Exercise. I left academia two years ago.

1.2 Here I make comments on the current state of astronomy and particle physics, but put a strong emphasis on those particular issues where the Committee has requested evidence.

Impact of Reduced Capital Funding on UK Capability

2.1 The Science and Technology Facilities Council (STFC) budget has had a substantial capital expenditure in past years, making it potentially vulnerable to cuts in capital spending. In 2010–11 capital expenditure was £97 million (17% of budget) as opposed to £472 near-cash spending (83%), in a total budget of £569 million.[3] Ignoring spending on space activities that are being transferred to the UK Space Agency, the 2010–11 international subscriptions are:

Item	*Near cash budget (£M)*	*Capital budget (£M)*	*Total (£M)*
ESO subs.	10.9	18.3	29.2
CERN subs.	63.6	32.9	96.5
ILL subs.	10.4	4.1	14.5
ESRF subs.	7.5	3.5	11.0
Total	92.4	58.8	151.2

(The ILL is a neutron source and the ESRF is a synchrotron source: as such they are beyond the scope of the astronomy and particle physics inquiry.)

2.2 A hypothetical cut of 40% to the STFC capital budget would have meant a loss of £39 million pounds to the total STFC budget (a 7% cut to the total), leaving £58 million for annual capital expenditure across all commitments and projects. It would have been impossible to continue funding all international subscriptions without flexibility regarding classifying spending on subscriptions between capital and near cash funding.

2.3 The STFC Delivery Plan provides details of the draft 2011–12 budget. This gives a resource budget (no longer listed as near cash) of £376 million and a capital budget of £100 million.[4] The Plan also includes a depreciation/impairment of £75 million.

The 2011–12 planned international subscriptions are:

Item	*Resource budget (£M)*	*Capital budget (£M)*	*Total (£M)*
ESO subs.	11.6	–	–
CERN subs.	81.8	–	–
ILL subs.	9.8	–	–
ESRF subs.	5.4	–	–
Total	108.6	46.2	154.8

(The breakdown of the capital budget between individual facilities is not given in the appendices to the Delivery Plan.)

2.4 The immediate conclusion from the published budgets is that an effort has been taken to divert spending on international subscriptions between the capital and resource categories. This was necessary to maintain UK participation in the European Southern Observatory (ESO) and CERN. This is a highly welcome outcome. The loss of either ESO or CERN would have ended the international competitiveness of UK particle physics immediately, and of astronomy within several years.

2.5 The settlement for the STFC from the comprehensive spending review must be seen in the light of the considerable cuts in spending over the past few years.

2.6 Given the flexibility that has been given to the STFC, the effect of capital cuts is therefore to reduce total spending, which impacts on funding available for facilities other than ESO and CERN. Other ground-based astronomical facilities, such as Gemini, the Isaac Newton Group telescopes, the James Clerk Maxwell Telescope, the United Kingdom Infrared Telescope and the Jodrell Bank Observatory, provide data for projects of varying degrees of international excellence.

[3] STFC current budget projected from 1 April 2010 taken from http://www.stfc.ac.uk/resources/pdf/stfccurrentbudget.pdf

[4] STFC Delivery Plan 2011–12 to 2014–15 http://www.stfc.ac.uk/resources/pdf/DP2011–15.pdf . See the Plan's Appendix C for the capital budget, Appendix D for the resource budget. The depreciation/impairment is given in the Plan's Appendix A.

Impact of Withdrawal from International Ground-Based Facilities

3.1 Within the past decade the UK has joined the European Southern Observatory, and some smaller, older telescopes have become less competitive internationally as more 8- to 10-metre telescopes have come into operation. Some loss of less-productive old facilities is unavoidable.

3.2 The UK has been a partner in the twin 8-metre Gemini telescopes which provided access to large optical/near-infrared telescopes in both the northern and southern hemispheres. This was originally planned in the 1990s to be the only significant access to 8-metre telescopes for the UK. Accession to the European Southern Observatory within the past several years has provided additional access to world-leading 8-metre-class optical/near infrared telescopes through the Very Large Telescope, though this is only in the southern hemisphere.

3.3 The current plans to withdraw from the Gemini project will leave the UK without access to 8-metre class optical/near-infrared telescopes in the northern hemisphere. This will severely affect some research projects which are constrained to the northern skies (for example, because of the need to study one special object, or because observing targets are taken from prior observations from some other type of facility in the northern hemisphere). A majority of research projects can suffice with southern only facilities, but a minority cannot.

3.4 As for my personal experience, I was a significant user of the Anglo-Australian Observatory in the period 1997–2006. The phased withdrawal of the UK from the observatory meant that British-based scientists lost access to world-leading wide-field spectroscopic facilities. This was disruptive to an international collaboration of which I was a member. I felt this was damaging to the reputation of the UK as an international partner.

3.5 The temporary expulsion of the UK from the Gemini project in January 2008 was personally embarrassing to me at a time when I was attempting to finalise the detailed specification of forthcoming observations for an international collaboration that had been awarded joint UK and Australian Gemini time. The immediate crisis was resolved and the UK was readmitted to Gemini, but is now planning an organised withdrawal.

3.6 The early or hasty withdrawal of the UK from front-rank scientific projects significantly damages the reputation of the UK as an international partner. This might make it less likely that other countries will accept the UK as an international partner in major projects in the future.

3.7 The damage of reputation affects individual scientists as they try to contribute to small- or medium-sized international collaborations between researchers. British scientists are less likely to be accepted into particular research projects if there is a risk that UK subscriptions to facilities may be terminated before the projects have reached their conclusions.

3.8 Careful planning is needed to avoid a possible imbalance between relatively cheap ground-based astronomical facilities and expensive space activities.

3.9 The research community needs to be able to plan future projects knowing at least a few years in advance whether it will have competitive access to observing facilities. Sudden changes of plans are highly damaging.

Engagement of the STFC with the Research Community

4.1 It is evident that some senior figures within STFC management have attempted to increase engagement with parts of the astronomical community in the past two years, for example through online discussions of funding policy.

4.2 Having left academia two years ago, I shall not comment in detail on recent STFC engagement with the research community.

4.3 Engagement between research councils and the research community has largely been restricted to permanent academics. In the case of the Astronomy Forum this involves only the leaders of research groups. Engagement has not extended significantly to researchers on fixed-term contracts at any time in the past decade, either by the STFC or by its predecessor PPARC, even though fixed-term researchers are most strongly affected by funding decisions, most acutely through the availability of funding to employ researchers.

Effect on Outreach

5.1 Astronomy, like space science, particle physics and fundamental theoretical physics, maintains a high profile in society and ignites public interest in science.

5.2 These academic disciplines have a powerful, positive effect on the UK economy through inspiring young people to study STEM subjects. This effect occurs by increasing STEM uptake at *all* educational levels, from GCSE to degree level. Many of these young people subsequently go to work in industry and apply their general STEM skills to activities of direct economic benefit.

5.3 Enthusing young people in science through the media profiles of astronomy and particle physics requires a stream of good news about UK science. It requires a continued British participation in iconic projects, such as the Jodrell Bank Observatory and the Large Hadron Collider.

5.4 Less clear is the extent of the impact on the economy made by people who study to PhD level in astronomy and particle physics.

5.5 Instability in funding produces negative news in the media. This may:

(i) have an adverse effect on enthusing young people about STEM subjects;

(ii) dissuade young people from studying low- and intermediate-level STEM subjects, particularly at GCSE and A-level; and

(iii) dissuade young people from applying for physics degree courses, consequently reducing the numbers of graduates who might later take physics skills into industry and business. In turn, this may affect the financial viability of some physics departments.

Effect on Rresearch Careers and the Next Generation of Researchers

6.1 The current funding cuts have forced a reduction in the grants awarded to support postdoctoral researchers. In the 2010 grants round, recently announced, funding for 56 postdoctoral research assistants (or associates) was approved by the Astronomy Grants Panel.[5] Of these, 42 were on rolling grants, and only 14 on standard (responsive) grants. This was 30% of the total number requested by applicants. This is 35% below the average number supported over the past decade and about 50% lower than the number for 2006 before the STFC recent funding crises errupted.[6]

6.2 A reduction in PDRA positions means that some researchers will have to change their career destinations.

6.3 These cutbacks occur under a situation in which the career system in academic research has been very poor for years. Features of the long-standing careers crisis in academic science include:

(i) There is a strong dependency on short-term contracts with a very large turnover of staff.

(ii) The specialised character of research makes it relatively difficult for researchers to switch between scientific fields.

(iii) The demographics of the research community appear unplanned with regard to numbers of early, mid and senior positions—or if planned, is planned with wholly inaccurate demographic data. The STFC funds large numbers of PhD positions (130 per year in astronomy), a moderate number of PDRA positions and a small number of advanced fellowships. Nearly all long-term jobs in astronomical research in the UK are academic positions funded by universities. My own estimate of the number of astronomy lectureships advertised is four-eight per year in the UK. A small number of university departments operate their STFC rolling grants to provide long-term support jobs; these are few in number.

(iv) The ratio of the number of new PhD studentships each year to the number of long-term jobs advertised each year is a critically important statistic for measuring the state of the career system. It determines the probability that a newly graduated PhD will progress eventually to a long-term post.

(v) My estimate is that the ratio is in the range 1:10 to 1:15.

(vi) There is a strong ageism within the postdoctoral research system: people become more expensive to employ as they get older, and there can be too little money in a grant to fund older, more experienced researchers for the lifetime of the grant.

(vii) A majority of researchers who embark on postdoctoral research careers will be unable to continue in university research in the UK because of the lack of long-term positions. They will have to leave the UK or leave academic research altogether.

(viii) The number of fellowships is too small to offer any protection from the cuts in PDRA positions. Fellowship numbers have been reduced recently.

(ix) There is a potential for employment in industry or business for people within a few years of PhD completion in astronomy and particle physics. However, there are often problems of "over-qualification"or "over-specialisation" for older, more experienced researchers seeking alternative employment. Anecdotal reports state that some potential employers believe, entirely wrongly, that many people with postdoctoral experience expect high salary levels and, if appointed, would leave companies after a short time to look for more lucrative employment elsewhere: they are not employed.

(x) There is no obvious alternative career stream in applied science or in industry for people in mid-career, aged 30 to 45 years. There is even a lack of appropriate careers advice for people in this category.

(xi) There appears to be little appreciation by policy makers of the extent of the long-term problems in the career system in UK academic research in general, and the acute problems in UK astronomy.

6.4 Current higher education funding cutbacks for the 2011–12 financial year and uncertainties in post-2012 university income make it likely that fewer academic positions will be advertised in the medium term.

---

[5] Report by Prof. A Lawrence, Astronomy Grants Panel chair, available at http://pacrowther.staff.shef.ac.uk/AGP2010_report.txt .

[6] See the figures compiled by Prof. P A Crowther published by Prof. A Lawrence at http://andyxl.wordpress.com/2011/02/04/astronomy-grant-history/ .

6.5 Attracting people with PhDs into academic research is not a problem: there is a massive oversupply of outstanding people for the needs of academia. The negative publicity from financial cutbacks is unlikely to cause difficulties of the supply of good people at PhD level. However, there may be mismatches between the supply of talented postdoctoral candidates and short-term posts in individual, precise research areas.

6.6 The reduction in PDRA positions over the past few years may drive particular individuals out of academic research. This could affect significantly who among the current generation of researchers will eventually get academic positions. Random factors play a powerful role in determining who is appointed to permanent jobs in astronomy.

Declaration of Interests

7.1 I am not currently employed in UK science or in any university or by any research council. I am awaiting confirmation of an unpaid visiting fellowship in a British university.

Dr Bryn Jones

16 February 2011

Written evidence submitted by the Gemini UK National Time Allocation Committee (NTAC) (APP 27)

UK Withdrawal from International Ground-Based Facilities

I am a Reader in Cosmology in the School of Physics and Astronomy at the University of Birmingham, supported by a University Research Fellowship from the Royal Society (2005–13). In the past decade I have used most of the 8-metre and 10-metre (8-m and 10-m) class optical/near-infrared telescopes on Earth to further my research. I therefore have a broad perspective on the use of large international ground-based observing facilities.

My co-signatories and I currently comprise the Gemini UK National Time Allocation Committee (NTAC) and therefore have the clearest scientific view of UK demand for observing time on the Gemini North and South (GN and GS) 8-m class telescopes. We are responsible for the twice-yearly peer review of proposals for observing time submitted by members of the UK community. As NTAC Chair I also represent the UK on the International Time Allocation Committee (ITAC) that is responsible for constructing the Gemini science program from the merged science rankings of the respective partners.

Our submission to the House of Commons Science and Technology Committee's inquiry concentrates on the second item listed in the call for evidence:

> *"2. the 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;"*

Our view, as expressed in this submission, may be summarized as follows:

- access to international northern 8-m class telescopes is essential to support the UK's research base;
- the Gemini Observatory has matured into an efficient operation with high global impact;
- withdrawal from Gemini represents poor value for money on the UK's investment to date; and
- the most cost effective and scientifically productive way forward is to remain a member of the Gemini partnership post-2012.

Dr. Graham P Smith
Chair of Gemini UK NTAC, 2010–12

Co-signatories (Members of Gemini UK NTAC):

Dr. Nate Bastian
University of Exeter

Dr. Boris Gaensicke
University of Warwick

Dr. Duncan Farrah
University of Sussex

Dr. Rubina Kotak
Queens University of Belfast

Dr. Russell Smith
Durham University

Dr. Serena Viti
University College London

16 February 2011

Access to International Northern 8-m Class Telescopes is Essential to Support the UK's Research Base

1.1 The global impact of UK astronomy is underwritten by access to multi-wavelength, multi-hemisphere observations from both space and ground. UK astronomers are currently leading key projects with truly global impact that are reliant on ground-based observations of faint objects first identified in space-based observations (see paragraphs A1 & A2). These space-based observations are intrinsically "all-sky". Global leadership therefore requires access to multi-hemisphere ground-based 8-m class telescopes.

1.2 The Gemini/Subaru Exchange Program is playing a key role in sustaining the global impact of the UK's research base (see paragraph A3). This program allows UK astronomers to bid for observing time on Japan's Subaru telescope through the Gemini UK NTAC. The key attraction for UK astronomers is Subaru's wide-field capabilities that are unique among 8-metre class telescopes. This Gemini-enabled access to Subaru is of key strategic importance to UK astronomy, and demonstrates the flexible telescope access available to Gemini partners.

The Gemini Observatory has Matured into an Efficient Operation with High Global Impact

2.1 In the last five years the number of peer-reviewed articles based on Gemini observations has roughly doubled, and the fraction of those lead by a UK astronomer has grown from approximately 10% to 20%. The impact of peer-reviewed articles based on Gemini observations is comparable, on average, with other 8-m class telescopes, ie Magellan, Subaru, and the European Southern Observatory's (ESO's) Very Large Telescopes (VLTs). In individual years the impact of Gemini publications can rival that of the 10-m Keck telescopes (see table in paragraph A4).

2.2 These statistics on the output from the Gemini Observatory confirm that, a decade after science observations began, Gemini has reached maturity as an international scientific facility. This has in part been enabled by the development and refinement of the observatory's system of queue observing, whereby observatory staff perform the observations on behalf of the respective proposal teams when the sky conditions are optimally matched to those required by the science goals.

Withdrawal from Gemini Represents Poor Value for Money on the UK's Investment to date

3.1 The UK's investment in Gemini to date has therefore helped to deliver a state of the art international research facility that offers astronomers the ability to observe in both Northern and Southern hemispheres. The teething problems of the first decade of operation are now resolved, and the coming decade promises great scientific rewards for members of the Gemini partnership. There is therefore a prima facie case that UK withdrawal from Gemini will waste the funds that the UK has invested in bringing the observatory to its current level of operational maturity and scientific productivity/impact.

3.2 UK demand for observing time on the Gemini telescopes is comparable with that for time on other 8-m class telescopes, including ESO's VLTs. Moreover, UK demand surges when new instruments are commissioned—ie installed on the telescopes. We have seen this recently in UK NTAC meetings, with a crop of high quality proposals for observations with the new red-sensitive GMOS-N instrument in late 2010 and with GNIRS in 2011.

3.3 UK withdrawal from Gemini would further undermine value for money for the UK because several instruments in which the UK has invested are not yet available for use by the community. This investment in novel instruments—in particular FLAMINGOS-2 and MCAO—would therefore be wasted. It is also of great significance that ESO has no plans to make instruments comparable with FLAMINGOS-2 and MCAO available to the ESO community, of which the UK is part (see also paragraph A5).

The most Cost Effective and Scientifically Productive way Forward is to Remain a Member of the Gemini Partnership post-2012

4.1 Given the UK's investment to date, and the current operational maturity and scientific impact of Gemini, it is clear that the most cost effective way to sustain the UK's research base in relation to scientific exploitation of space-based discoveries is to remain a member of the Gemini partnership.

4.2 However in the current economic climate, a reduced partner share in the range 10–15% (the UK is currently a 24% partner) would help to reduce the burden on the public purse whilst providing sufficient telescope time for a top slice of world-class UK science to be supported. This assumes that we would have access to both GN and GS, and that the Gemini/Subaru exchange program would continue.

4.3 Gemini partners are also free to exchange time with other nations independently of the formal time exchange programs. For example, the same developments in ground-based astronomy in the southern hemisphere (eg SKA, LSST, ALMA) that motivate some to argue for concentrating UK optical/near-infrared observing resources on ESO will likely increase the enthusiasm of (for example) Japan to trade Subaru time in exchange for GS time. This would allow us to balance UK 8-metre observing time between the hemispheres, at a cost of £2–3million per year (assuming a 10–15% share of Gemini).

4.4 Replacing UK access to Gemini with (for example) access to the 10-m Gran Telescopio Canarias (GTC) on La Palma would set UK astronomy back a decade. This is because GTC is at a stage of development comparable with the Gemini telescopes a decade ago. Recovery from this setback would take many years, and would require significant financial and intellectual investment from the UK in developing the operation of GTC and the suite of instruments available on GTC.

Declaration of Interests

All signatories to this evidence are regular users of 8-m class telescopes including all of Gemini, VLT, and Subaru.

Additional Supporting Information

A1 As a UK astronomer Professor Nial Tanvir's access to the Gemini-North telescope in Hawaii was essential to his publication in Nature of the most distant known Gamma Ray Burst (http://adsabs.harvard.edu/abs/2009Natur.461.1254T).

A2 UK astronomers lead eight of the eighteen extragalactic/cosmology Key Programs on the Herschel Space Observatory, including the largest Key Program called "HerMES" (PI: Professor Seb Oliver). In 2011A follow-up ground-based observations of galaxies discovered with Herschel accounted for 10% of the total UK demand for Gemini observing time reviewed by the UK NTAC—ie a disproportionately large fraction of the total demand. This large fraction will likely increase in future semesters.

A3 Professor Chris Collins published important results on the evolution of the most massive galaxies in the universe in Nature, based on Subaru observations conducted thanks to the Gemini/Subaru Exchange Program (http://adsabs.harvard.edu/abs/2009Natur.458..603C). More generally, UK demand for observing time on Subaru has recently doubled—the average ranking of these proposals is in the 2nd quartile of all proposals that we receive—ie they are stronger than the average proposal.

A4 The impact of large ground-based telescopes is summarized in the following table. Impact is defined as the number of citations to articles that publish data from each observatory, normalized by the median number of citations earned by articles in the Astronomical Journal. On average over the last five years for which data are available, Gemini has been competitive with comparable 8-m class telescopes, ie VLT, Subaru, and Magellan. In individual years it has matched the performance of the pre-eminent Keck 10-m telescopes (ie 2006).

Telescope	*2005*	*2006*	*2007*	*2008*	*2009*	*Average*
Keck	3.3	3.5	4.2	4.2	4.0	3.8
Gemini	2.5	3.5	3.0	2.9	3.6	3.1
Magellan	2.6	2.4	4.2	2.9	3.6	3.1
Subaru	2.5	2.3	4.6	2.5	3.5	3.1
VLT	2.4	2.9	2.9	2.5	3.5	2.8
HST	2.0	2.4	3.9	2.8	2.8	2.8

Source: Compiled by Gemini Observatory, based on publication lists provided by the respective observatories.

A5 Gemini has a distinctive instrumentation strategy that will deliver technology on GS that ESO has no plans to deliver. Most notably, FLAMINGOS-2 will be the only near-infrared multi-object spectrograph in the southern hemisphere. For example, FLAMINGOS-2 and MOSFIRE on Keck will revolutionize studies of cosmic re-ionization at redshifts of $7<z<10$. Participation in Gemini post-2012 would therefore promise world-leading positions for UK astronomers, for example, directly challenging colleagues in California who have direct access to the Keck telescopes in the northern hemisphere. MCAO will also shortly be a unique facility, because ESO has decided not to offer their Multi-conjugate AO Demonstrator (MAD) to the ESO community. MCAO will deliver near-infrared imaging at a spatial resolution and across fields of view comparable to the new WFC3 camera on the Hubble Space Telescope (HST). Naturally MCAO will not achieve the sensitivity of HST/WFC3, however this unique device will revolutionize ground-based near-infrared astronomy. The scientific potential of access to these instruments on GS is therefore huge and, most importantly, unique in the southern hemisphere.

Written evidence submitted by the School of Physics and Astronomy, University of Manchester (APP 28)

The School of Physics and Astronomy at the University of Manchester is unique in the UK in having both experimental and theoretical groups in all three areas of STFC science: Astronomy, Nuclear Physics and Particle Physics. The School has great strengths in almost all areas of physics research, as evidenced for example by the award of the 2010 Nobel Prize in Physics to two of our professors of Condensed Matter Physics. However the overall health of the School has clearly been impacted by recent crises in the STFC, and we are concerned about the future provision for STFC science.

The Impact of Reduced Capital Funding on UK Capability

1. Astronomy, Nuclear and Particle Physics at UK universities have been in a difficult position since the STFC funding crisis of 2007. Grants and project funding have reduced by a large fraction since that time. Nuclear Physics and Particle Physics have already seen large effects of recent cuts which had severe impact on their programmes. Since Astronomy grants are awarded for three years, about 1/3rd of university astronomy groups still have grants awarded during higher levels of funding. These groups, including the Manchester one, are expecting a significant cut in their funding from next April, purely based on past cuts to budgets.

2. Capital funding pays for equipment and some new projects, and its reduction will greatly affect instrumentation groups, as well as groups with high computing demands. Future projects in all areas, including Nuclear and Particle Physics, will be difficult to fund for STFC, and this will affect instrumentation work in all three areas of STFC science, hitting severely the international competitiveness of the UK.

3. The new STFC Delivery Plan suggests a reduction in support for technology research and development in the Universities, with a concentration of such work in the central laboratories, an idea that is probably a response to reductions in capital funding. However this proposal represents a serious misunderstanding of how new technologies for STFC science are developed, in a collaborative effort involving scientists with many different types of skills. It is essential for retaining world-class research at universities that technology research and development, construction of experiments and their exploitation are closely linked in university groups. Indeed, it is those university groups who have this diversity of skills where most of the expertise and international leadership currently exists. In addition, this policy would further reduce the opportunities for educating undergraduate and postgraduate students in the areas of technology research and development.

4. A viable funding level for university groups is based on grants, overheads and a full economic costing component (fEC) which pays part of staff salaries. As an interim measure (which seems to have become permanent), STFC only pays for 80% of the cost of grants. For the STFC-funded e-Merlin project, STFC and Manchester agreed to include the fEC component in the cost of the project, so that effectively Manchester pays for approximately 40% of the project. The rapid reduction in grants funding has also reduced the fEC funding for the university groups, and the issue of the viability of astronomy, nuclear physics and particle physics groups and of physics departments needs to be considered.

5. Jodrell Bank was a founder member of the European VLBI Network of radio telescopes (EVN), a global network of at least 18 telescopes, stretching from Puerto Rico to Shanghai, and South Africa to Sweden. Most of the telescopes can be connected in real time with bandwidths up to one Gb/s. The strategic importance to Manchester of EVN as technical pathfinders for the Square Kilometer Array (SKA), as a key collaborative venture by the European community developing SKA, and as a global network which may provide some of the longest baselines of the SKA, is recognised by STFC. We consider it important that STFC remains able to continue to fund at a modest cost such items of strategic importance.

The 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

6. To remain competitive internationally, the UK became a member of ESO in 2003. ESO exists to provide observational facilities which the member states cannot afford individually. This includes both the telescopes and their instrumentation. Almost all ESO member states also maintain their own observational facilities, in most cases with 2- to 4-metre telescopes.

7. After joining ESO, the UK had some duplication in facilities, which included Gemini-South (very close to the VLT), and withdrawal from some facilities was expected. Withdrawal from *all* non-ESO ground-based facilities is, however, very damaging. Almost all astronomy today is the result of international collaborations. In these collaborations, our position has become severely weakened because we have no facilities to offer.

8. Of the current ESO members, only Poland, Austria, and Portugal do not have access to optical/infrared telescopes outside of ESO. The UK will be in this situation after 2012, when, in astronomy, STFC will be a facilities council without facilities.

9. Withdrawal entirely from northern hemisphere astronomy leaves us unable to study the outer galaxy, the major galaxies in the Local Group, and more than half of the accessible extra-galactic sky. It also affects STFC-funded space missions, which by nature observe both hemispheres but for which we can only request follow-up observations in the south, and only through ESO.

10. We are also concerned about the impending reduced access to the ESO VLT telescopes for UK astronomers. It is expected to be reduced by approximately 25% per semester over four semesters, or alternatively full loss of access for one semester. This loss of access may especially endanger time-critical PhD projects.

11. Manchester operates the STFC-funded e-Merlin radio array, the UK's major SKA precursor. It is located in the UK and, as such, observes the northern hemisphere. Its unique capabilities have no counterpart in the southern hemisphere. The scientific return on this investment from STFC and Manchester will be limited by the lack of opportunities for ground-based follow-up observations.

12. We suggest that STFC should, in consultation with its community and with UKSA, review the balance between space-based and ground-based astronomy. The two should be treated as complementary rather than as competing. The high cost of space missions makes it essential to maintain a correct balance.

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

13. Communication and engagement have improved much over the past two years. The STFC advisory panels on Astronomy, Nuclear Physics and Particle Physics have provided important reports on priorities, based on extensive consultation with the communities. Regular meetings with the relevant communities for each of the science areas have also been beneficial. We commend STFC for this change in its approach.

14. However, Manchester does not recognise some of the statements made by the STFC Chief Executive in his evidence to the Parliamentary Select Committee. We are not aware of any plan for correcting a "deliberate over-investment in astronomy" or of any public strategy to withdraw from northern hemisphere observational facilities.

15. Also, the proposed move to concentrate technology development in the laboratories, as discussed above and described in the STFC Delivery Plan, was not subject to any consultation with the research community before publication of the Delivery Plan. We believe that there would have been very strong opposition to this proposal, and an open discussion of the issues would have clearly shown that it was misguided.

16. We would welcome more openness on the procedure to appoint a new Chief Executive. We understand this process has started but there has been no advert or recent announcements. Manchester gives great importance to cooperation between STFC and the universities, and would welcome a commitment from the new Chief Executive to continue to work with its community.

Opportunities for, and Threats to, Outreach and Inspiring the Next Generation of Astronomers and Particle Physicists

17. Astronomy, Space and Particle Physics have always had the power to inspire. This was most recently demonstrated by the incredibly successful BBC Stargazing Live broadcast from Jodrell Bank Observatory. In a prime-time slot on BBC2 the programme attracted around three to four million viewers each night over three nights, remarkable for a science subject. The programme enabled us to showcase a wide range of British astronomy and space activity, including the work of Jodrell Bank's Lovell and e-MERLIN telescopes, but also UKIRT, JCMT, ESA, the public-access Faulkes Telescopes, solar physics, the solar system and meteorites, and much more. The outreach work of Manchester particle physicist, Professor Brian Cox, is of course also very well known.

18. The first year of the operation of the Large Hadron Collider (LHC) has received broad coverage in media due to the enormous public interest in the fundamental questions addressed by Particle Physics. Particle Physicists from Manchester are regularly visiting schools and present at public events.

19. The impact of BBC Stargazing Live was clear: there were many positive reviews; telescopes and other astronomical equipment sold out in major retailers; a record-breaking 2.3 million people downloaded the BBC Stargazing Guide; and an estimated 40,000 people attended over 300 linked events nationwide. This programme and others like it, such as Brian Cox's Wonders of the Solar System, will have a lasting legacy in bringing young people into scientific and technological careers, not just in astronomy, space and particle physics.

20. The University of Manchester is currently constructing a new public Discovery Centre at Jodrell Bank Observatory, funded by the Northwest Development Agency, the Northwest European Regional Development Fund and the University. The Centre intends to showcase live science and inspire the scientists of the future. In addition to this, independent economic assessment indicates that this ~£3 million project will generate £26 million of additional economic benefit for the region.

21. STFC and their forerunners should be congratulated for encouraging and supporting outreach through a range of funding opportunities over some years. Indeed, they have maintained much of this support through the recent pressures on funding and have been strongly supportive of the outreach work done at Jodrell Bank. The astronomy, particle physics and nuclear physics communities, including the STFC, have shown a strong commitment to outreach. Indeed, in publishing outreach material regarding the use of ESO facilities (eg press releases), the UK is second only to ESO itself, according to information provided by ESO.

22. However, the positive impact generated by the high-quality outreach work in these areas is put at risk by the regular appearance of stories in the media concerning closure or threats to major STFC-funded facilities. We experienced this ourselves in the 2007–08 STFC funding crisis and we still get asked about this today. For a school student making choices of what to study at university and about their future career, this uncertainty can only have a negative impact on the future of STFC science areas and physics in general.

23. Furthermore, much of the outreach work is done by postgraduate students and early-career researchers. Their enthusiasm and commitment to the subject is infectious and plays a key role in engaging with younger people in particular. The large reduction in funding for postgraduate students and post-doctoral researchers means that fewer people are available for outreach. Also the constant squeeze on funding for research posts and facilities is not only leading these people to leave the UK for jobs elsewhere, but also causes a loss of morale, again with serious consequences for outreach and inspiration.

These points were collated from the community of astronomers, nuclear and particle physicists working in the School of Physics and Astronomy at The University of Manchester.

Professor S J Watts
Head of School
School of Physics and Astronomy
The University of Manchester

16 February 2011

Written evidence submitted by Janet Drew, Professor of Astronomy, and Director of the Centre for Astrophysics Research, STRI, University of Hertfordshire (APP 29)

Comment on: the 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.

I write my remarks having recently completed a task for an EU-funded project, Astronet, that works as a policy forum for European Astronomy, in which I chaired a European panel of astronomers, asked to assess the role for the suite of 2–4 metre aperture optical/infrared telescopes, currently funded by Europe's national agencies, over the next decade—with a view to identifying what their science role might be and the ways in which that might be met when it is widely recognised that running costs need to be "optimised" (ie minimised), in order to safeguard the overall world competitiveness and excellence of our science. We took evidence from the European community of research astronomers, and also from the directors of the telescopes under review.

I enclose a copy of the report of this panel, the *European Telescopes Strategic Review Committee (ETSRC),* with the hardcopy of the letter, and note it is accessible via the following link http://www.astronet-eu.org/IMG/pdf/PlaquetteT2_4m-final.pdf

We reported in the spring of 2010, and the report's relevance to your enquiry is that we considered the standing of both the La Palma telescopes (ING, and Liverpool Telescope) and UKIRT in Hawaii that are UK builds and continue to receive UK funding, alongside telescopes of similar scale associated with and paid for by Germany, Italy, France, the Nordic countries, and Spain. We also considered ESO's La Silla telescopes, and VISTA.

Two things emerged very strongly from this exercise.

First, there continues to be a very broad menu of cutting-edge astronomy that needs access to the 2- and 4-metre class telescopes and that these are typically of three kinds: critical follow-up in both the northern and southern hemisphere on a wide variety of (relatively highly expensive) space observatories, without which the space data could not be exploited adequately; time-domain astronomy needing either rapid access to the sky, or sustained access over months/years; and finally, wide-field astronomy. A technical point to make regarding this last need is that the bigger a telescope's aperture is, the smaller is its natural field of view—so for efficient coverage of large sky areas either for imaging or massive-multiplex spectroscopy, the 2–4m aperture telescopes are irreplaceable. The next generation survey telescopes in planning elsewhere in the world are in this class.

Second, despite the fact that only two members of the 10-strong panel were UK scientists, it became very clear as it deliberated, that the UK's 4-metre class telescopes (William Herschel Telescope, UKIRT, VISTA) are held in particularly high regard, internationally. Indeed there was great concern at the time we were meeting that the signalled intention of STFC was to truncate the unique infrared surveying activity of UKIRT in 2012, sacrificing a world lead, and that also a pull-out from the Isaac Newton Group was envisaged on a similar timescale. Regarding the latter, it has been striking that one of our major recommendations —that Europe

needs to invest in a massive-multiplex wide-field fibre spectrograph to support, especially, the upcoming ESA Gaia mission—is already taking shape. It was clear to us, and the argument is accepted, that the telescope best suited to it is the ING's William Herschel. This project in the planning is pulling in a number of international partners, including France, who now prefer this option over building one for the Canada-France-Hawaii Telescope. What a waste if the UK, who created the William Herschel, could have no part in its further use, with a state-of-the-art instrument. Is all the investment of the past just to be handed over to our European colleagues in a gift of future science leadership?

It never was the case that a pull-out from either the ING or UKIRT was seen as scientifically- justified, and in recent times with the shifting frontiers of our subject (eg the huge international activity searching for and characterising exo-planets which deals in observations of bright stars), this is even less the case. Presently, this concept lies mainly with the current STFC CEO. To the community, "abandoning the island sites" has always appeared to have been about budgets.

Speaking now, as a member of the UK astronomical community—in which I have worked for 30 years—it has long been accepted that the operation models of smaller telescopes needs to change, allowing significant cost reductions, as newer/larger facilities are invested in. On the whole PPARC/STFC middle management have handled this process quite well. And indeed the annual spend on the 2–4m telescopes has dropped dramatically, quite rightly starting from the time the UK became a member of ESO. Necessary adjustments have occurred and will continue—the next steps, towards much more specialisation of role by the 2–4m telescopes, were a part of what was considered and endorsed by the Astronet ETSRC panel. One way to achieve this, in respect of La Palma where there is obvious opportunity, would be to merge the operations of all the night-time telescopes. This has been an obvious way forward for some time, including to some visiting international panels (going back over the decade), but now the spirit to do this is relatively strong, even if the politics remain complex.

Janet Drew
Professor of Astronomy, and Director of the Centre for Astrophysics Research
STRI
University of Hertfordshire

15 February 2011

Written evidence submitted by Professor Carole Mundell and Dr David Shone (APP 30)

Introduction

1. Reduction in capital funding for Astronomy and Particle Physics is a serious issue in itself, but this is one symptom of structural issues within STFC. The formation of STFC from the former Council for the Central Laboratories for the Research Councils (CCLRC) and the Particle Physics and Astronomy Research Councils (PPARC) was a crucial and damaging factor.

2. STFC displays a damaging lack of confidence in the value of fundamental research and is striving to excuse its existence by changing its emphasis and funding priorities to reflect this.

Lack of Openness and Accountability

3. STFC governance is opaque; whereas PPARC was a relatively simple organization focused on research funding, STFC is dominated by its own operations and facilities, with much of its structure serving a community beyond and much larger than PPARC and which is also funded by other research councils. Consequently the creation of STFC introduced layer of decision-making that has an impact (usually detrimental) on funding of Astronomy and Particle Physics but which is not accountable to the research community formerly served by PPARC.

4. A clear example of this was the ad hoc diversion of £24 million from Astronomy and Particle Physics to the Physical and Life Sciences areas to exploit STFC facilities such as Diamond Light Source in 2009.[1] This was presented to the Astronomy and Particle Physics Community as a *fait accompli* by the STFC executive and resulted in significant and immediate cuts to University astronomy research group grants. Together with the still-unexplained £80 million shortfall in the budget arising from the merger of CCLRC and PPARC, this has had a destructive effect in fundamental research.

5. Publication of minutes of STFC Council Meetings ceased in 2010, replaced by distilled "News from Council"; perhaps minutes are available on request, but these are no longer directly accessible and this erodes transparency and accountability.

New Consolidated Grant Scheme

6. STFC intends to introduce a new grant scheme for university researchers; this will replace the Rolling Grant and Standard Grant schemes. Rolling grants have provided departmental research teams with funding for integrated programmes of research, giving a degree of long-term stability as these grants are for five years

but reviewed and renewed—or two-year notice of termination is given—every three years. The Standard Grant scheme provides support to fund post-doctoral research assistance for individual scientists in a department.

7. In 2009, due to a financial crisis apparently precipitated by the sudden removal of £25 million from the research grant line, STFC altered its rules on existing grants that had already been awarded and removed the two-year notice period with immediate effect. This had a catastrophic impact on a number of UK research groups and resulted in young postdoctoral researchers having their contracts terminated prematurely.

8. The new consolidated scheme is to be introduced this year with an application deadline in May. The full application details are yet to be published and the community waits for guidance. On the basis of conversations with members of the committee that conducted the review to produce a new scheme and panel members involved in its implementation, it is clear that some of the original intentions and benefits have been lost and also that this scheme is largely the creation of the STFC executive and bureaucracy, with little or no support from the community it is intended to serve. In particular, the suddenness with which it is being introduced, just months after the initial review published its recommendations, has left no time for full consultation with the community or preparation by STFC staff for a coherent delivery.

9. The scheme is ill considered and is being hurried through by the STFC executive with no obvious good reason other than the claim that it will simplify administration for STFC and reduce effort required by departmental researchers.

The benefit is dubious; it comes at the cost of largely eliminating the opportunity for innovative researchers to strike-out in a new direction, since will result in only incremental development of a departmental research, threatens to remove control from researchers and is likely to cause considerable damage to opportunities for innovative research in the long term.

10. One of the authors (CGM) has benefited from the Standard Grant scheme, receiving funding for postdoctoral assistance that has enabled her to establish a world-class research team that has placed the UK at the forefront of a new field of astrophysics; similar successes might not be readily repeatable under the new scheme.

11. This measure to introduce the new scheme should be suspended immediately; at the very minimum, it should be subjected to review in a new regime under the next STFC Chief Executive, but we be believe that more drastic measures, outlined in our recommendations, are required.

STFC and The National Schools Observatory

12. Professor Keith Mason's response to the select committee (Oral evidence, January 19, Q132–136) on the subject of the National Schools' Observatory (NSO) was somewhat disingenuous; his initial dismissal of the NSO as "a different animal" because "this is not an issue for the research councils because it is an education issue" is wrong. One unique strength of the NSO is its foundation on world leading fundamental research using the Liverpool Telescope, placing it firmly within the STFC remit.

13. The NSO is operated by Liverpool John Moores University as part of the function of the Liverpool Telescope on the Canary island of La Palma. The Liverpool Telescope is funded in part by STFC to provide a unique research capability as the world's largest fully instrumented and autonomous robotic telescope. Evidence of its impact as a premier research facility includes the work conducted by the Liverpool Gamma Ray Burst Team, who have used PPARC and STFC funding, won through rigorous peer review (awarded in 2004, 2007, 2011), to establish a world-leading reputation in the early time automatic robotic follow-up of Gamma Ray Bursts. Evidence of excellence includes publications of results in high-impact journals such as *Nature*[2] and *Science*[3] and independently commissioned perspectives on key results[4,5] and award of the Times Higher Education "Research Project of the Year" 2007 prize[6] for "Measuring Gamma Ray Bursts", work described in the judges citation as "brilliantly innovative discovery into the fundamental nature of the Universe that could have profound impacts in decades ahead". Professor Mason is fully acquainted with the importance of this research, having led a GRB group at MSSL, with whom the Liverpool team both competes and collaborates.

Impact of Withdrawal from International Ground-based Facilities

14. The Isaac Newton Group of telescopes occupies a prime site for astronomical research on the island of La Palma. Access to this site for installation of new telescopes is difficult to obtain, with new telescopes often being sited on the adjacent island of Tenerife, with less optimal conditions for astronomy. The UK currently has a valuable presence on La Palma and one which is becoming increasingly sought after by competing nations. It is therefore surprising that STFC seem keen to relinquish this privileged position so lightly. In particular, the integration of the robotic Liverpool Telescope with more traditional but larger aperture telescopes such as the William Herschel Telescope continues to provide a unique observational capability for the rapid optical followup of discoveries by high energy satellites. The work of the Liverpool GRB team and teams at the University of Leicester, Hertfordshire and University College London using the La Palma telescopes continues to produce world leading reseach that exploits expensive satellites in which STFC and now the UKSA continue to invest and regard highly. A strong UK presence on La Palma therefore goes significantly beyond a simple strategy for ground-based astronomy. In short, withdrawal from these facilities and the underpinning infrastructure that has been driven from the UK will impact severely on the UK's competitiveness

in space research as well as ground-based astronomy programmes. Having a small number of large telescopes in the Southern hemisphere alone, as STFC claims is their goal, is therefore a flawed and dangerous strategy.

Impact on Outreach and the Next Generation of Astronomers and Particle Physicists

15. Since the inception of STFC in 2007, the impact on the morale of astronomy and particle physics researchers has continued to deteriorate. Young postdoctoral researchers, if they have managed to keep their jobs despite year-on-year grant budget cuts, have significant concerns about their futures in the UK. STFC funding has proven to be volatile, even for those of us with highly rated world-class science programmes. The continuing struggle to make STFC recognize the importance and value of its own researchers and overall astronomy portfolio leads us to conclude that a long-term future in the UK is unviable if STFC continues in its current form.

The Wider Impact of Fundamental Research in Astronomy and Particle Physics

16. Inevitably, in any discussion of the funding of fundamental science, the issue of the impact and value of the research arises. STFC recognises the importance of addressing this issue—indeed, in the hearing on January 19th the Chair of the Select Committee referred to the leaflet issued by the Royal Astronomical Society which was written in conjunction with STFC. However, this only scratches the surface, and we believe that the leaders of STFC—and even many in the scientific community—fail to appreciate and convey the full impact of fundamental research. There is a tendency to view the impact of this fundamental research as being indirect; "spin-offs" that are somewhat peripheral; while this is often the case (and these are valuable in themselves), *perhaps the greatest value comes from the long-term impact of the research itself.* Brief consideration leads to a more extensive list, tabulated below. This is by no means exhaustive but reflects examples of impact arising directly from fundamental curiosity-driven research as well as from "spin-off" benefits.

17. We have no doubt that others could provide additional examples and we have described examples with an astronomy connection; we have omitted examples from other areas of fundamental physics, such as Electromagnetism and Quantum Mechanics, both of which provide the foundation for modern electronics and information systems, and both of which represent the fundamental "blue-sky" research of their day.

Discovery or Invention	*Scientific Motivation*	*Wider Impact*
Historic (pre-1945)		
Newton's Laws of Motion and Gravitation	Understand the observed motion of the moon and planets	Basis for the whole of mechanical engineering and the mathematical framework (calculus) that is used in all branches of science and engineering as well as other fields such as finance.
Einstein's Special and General Theory of Relativity	Theoretical understanding of motion at or close to the speed of light and in strong gravitational fields; reconciliation of observation and theory relating to measurements of the speed of light and planetary motion	Critical for precise measurement of time and position; GPS navigation systems rely on this to function accurately.
Modern (post 1945)		
Optical Intensity Interferometry and Quantum Optics (Hanbury-Brown-Twiss Effect)	Measurement of diameters of stars using a technique developed for radio astronomy. At first, many physicists did not believe this could work but ultimately it did, changing our understanding of the quantum behavior of light.	Major influence on the development of Quantum Optics, and consequently lasers and fibre-optic communications technology.
Carbon "BuckyBalls" (C_{60} Buckminsterfullerene)—a new form of Carbon	Laboratory simulation of the atmospheres of old, Carbon-rich stars, thought to host long-chain Carbon molecules[7]	Expected to have a long-term radical impact on materials science and nanotechnology. Early applications are in high-performance lubricants, with a consequent saving in energy use[8,9]

Discovery or Invention	*Scientific Motivation*	*Wider Impact*
International Celestial Reference Frame based on Quasars	Discovery and investigation of quasars—the most distant and energetic objects in the universe. Quasars turn out to be sufficiently distant and luminous that they act as a giant grid reference system.	A universal reference frame applicable in precise measurements of position; along with Relativity (mentioned above), this is critical to development of GPS navigation with accuracy to allow a wide range of applications such as blind landings for aircraft and future automatic navigation for ground, air, sea and space travel.
Smoothed-Particle Hydrodynamics	A computational technique for understanding the structure and evolution of stars and other astrophysical phenomena.[10]	Diverse applications in simulation and design of systems across a range of engineering disciplines such as aerospace.[11]

The Authors' Background in Declaration of Interests

18. Jointly, the authors have nearly 50 years experience working in research, higher education and high-technology industry. Both are Physics graduates with PhDs in Radio Astronomy. CGM is a senior university academic; DLS is a senior technologist and business development director in a large multi-national IT company. All views expressed here are the personal views of the authors and not necessarily shared by their employers.

19. As an academic working in astronomy, CGM is eligible to apply for STFC funding and currently holds an STFC standard grant. As an academic staff member at Liverpool John Moores University, CGM has privileged access to the Liverpool Telescope as part of her world-leading research into Gamma Ray Bursts.

20. DLS has no other direct interest other than being married to CGM. Both have an interest in the long-term national economic strength that accrues from vibrant pursuit of fundamental research.

Professor Carole Mundell and *Dr David Shone*

16 February 2011

References

[1] Memorandum submitted by the Royal Astronomical Society (FC 26) 2009, Point #21 http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/memo/spendingcuts/uc2602.htm

[2] Steele et al. 2009, "Ten per cent Optical Polarization from GRB 090102", Nature, 462, 767 http://www.nature.com/nature/journal/v462/n7274/abs/nature08590.html

[3] Mundell et al. 2007, "Early Optical Polarization of a Gamma Ray Burst Afterglow", Science, 5820, 1822 http://www.sciencemag.org/content/315/5820/1822.abstract

[4] Covino 2007 "A closer look at a Gamma Ray Burst", Science, 5820, 1798 Covino (Perspective on the Mundell et al. 2007) http://www.sciencemag.org/content/315/5820/1798.summary

[5] Lyutikov "Gamma Ray Bursts: Magnetism in a Cosmic Blast" Nature, 462, 728 (News and views, perspective on Steele et al. 2009) http://www.nature.com/nature/journal/v462/n7274/full/462728a.html

[6] The link to the associated award of THES Research Project of the Year 2007 for this work is here: http://www.timeshighereducation.co.uk/story.asp?storyCode=310051&sectioncode=26

[7] Kroto, H W, Heath, J R, O'Brien, S C, Curl, R F and Smalley, R E, 1985 "C60: Buckminsterfullerene" *Nature*, 318, 162.

[8] Baughman, R H, Zakhidov, A A, & de Heer, W A, 2002 "Carbon Nanotubes—the Route Toward Applications" *Science,* 297, 787. A copy is available on-line at: http://www.eikos.com/articles/carbnano_routetoapp.pdf

[9] Yadav, B C, and Kumar, R, 2008 "Structures, Properties and Applications of Fullerenes" *International Journal of Nanotechnology and Applications,* 2, 15. http://www.ripublication.com/ijna/ijnav2n1_2.pdf

[10] Gingold, R A, and Monaghan, J J, 1977 "Smoothed particle hydrodynamics—Theory and application to non-spherical stars" *Monthly Notices of the Royal Astronomical Society,* 181, 375.

[11] Applications of Smoothed Particle Hydrodynamics in BAE Systems http://www.baesystems.com/ProductsServices/ss_tes_atc_sph.html

Written evidence submitted by Chris Benn, Isaac Newton Group of Telescopes (APP 31)

DECLARATION OF INTEREST

I am Head of Astronomy at the Isaac Newton Group of Telescopes on La Palma.

1. I comment below on the potential impact of the UK withdrawing from ground-based observatories in the northern hemisphere, with particular reference to the possibility of withdrawal from the Isaac Newton Group of Telescopes.

2. UK withdrawal from most of the ground-based observatories in the northern hemisphere would severely limit the ability of UK astronomers to exploit current and future large international surveys, including those delivered by space missions in which the UK has a stake (eg ESA's Gaia).

3. More generally, while there may be a case for concentrating the most expensive future observatories in the southern hemisphere (usually justified on the grounds that the Universe looks much the same in any direction, on large-enough scales), this should not imply *zero* investment in the north. For example, unique/rare objects and events occur with equal frequency in the two hemispheres. Studies of these rare objects and events often trigger dramatic shifts in our understanding, and UK astronomers need at least some facilities in the north to observe them.

4. The international reputation of UK astrophysics is strong, with a scientific productivity second only to that of the USA. Partly for this reason, UK astronomers play a leading role in many European astronomy collaborations. The observatory on La Palma is a particularly high-profile international collaboration. UK withdrawal from this observatory would send a negative message to our European partners, and would reduce both the UK's visibility on the international stage, and opportunities to take part in future collaborations.

5. The Isaac Newton Group of Telescopes is a crucial training resource for young UK astronomers, providing hands-on experience for the many PhD students who visit each year to collect data for their theses. At larger telescopes (eg at the European Southern Observatory), the observations are typically carried out by observatory staff, rather than visiting scientists, limiting opportunities for hands-on training. In addition to the above training, ING offers four support-astronomer studentships each year, providing young UK astronomers with a unique opportunity to live and work on La Palma for a year, acquiring the skills required to support visiting observers.

6. The William Herschel Telescope at the Isaac Newton Group provides a particularly convenient and popular platform for testing new types of astronomical camera, and therefore fosters technical innovation by UK astronomers. For example, it is currently being used as the main test-bed for a prototype of the most ambitious instrument planned for the European Extremely Large Telescope (E-ELT).

Chris Benn
Head of Astronomy at the Isaac Newton
Group of Telescopes on La Palma

15 February 2011

Written evidence submitted by Dr Gavin Ramsay, Chairman, UK ING Panel for the Allocation of Telescope Time (APP 32)

This submission concern's the future of the UK membership of the Isaac Newton Group (ING) on the island of La Palma in the Canaries. The ING is composed of the William Herschel Telescope (WHT) and the Isaac Newton Telescope (INT). The ING costs the UK around £1.1 million per year. To withdraw from a facility costing a relatively small amount of money would be extremely short sighted and have very negative consequences.

1. The UK currently has an allocation of—100 nights per year on both the WHT and INT. Astronomers who want to use these telescopes for a project have to prepare a competitive case. The panel, of which I chair, then ranks these proposals according to scientific merit. Since many more astronomers want time on the telescopes than there is available, typically only one in three get approved. It is therefore not possible to award telescope time to some research projects which are of high quality.

2. The WHT has a diverse and world class suite of instruments which enables UK astronomers to conduct projects which would not be possible if the UK withdrew from the ING. In particular, ISIS is one of the world's most efficient spectrographs which is used to study objects as diverse as Gamma-ray bursts, Earth impacting asteroids and compact binary systems.

3. All-sky surveys are mapping the sky using a range of strategies and wavebands. The UK has for many years been a world leader in this field. However, for the projects to be successful, followup observations of sources discovered during these surveys are an essential component to their success and their brightness will be well matched to the WHT. In order that the UK is not largely excluded from followup projects of northern sky surveys, my panel considers that access to both the northern and southern hemispheres, is an absolute requirement.

4. Many astrophysical objects vary in their apparent brightness. By studying them in detail we can determine what powers them and understand the underlying physical processes. However, this requires multiple observations of the same source (which can be moderately bright). By their very nature these observations are unlikely to be carried out on an "Extremely Large Telescope", which is likely to be dominated by a relatively small number of multi-national "mega" projects. The UK has international leadership role in "time domain" astrophysics. For it to remain so, access to telescopes such as the WHT and INT is essential.

5. STFC rightly stresses the importance of students and junior post-docs receiving appropriate training. The WHT and INT have proved to be excellent facilities to train students in obtaining scientific observations. These skills are valuable even if the student goes on to a career outside astrophysics. Today, students rarely travel to 8 m telescopes for training and such opportunities will no doubt be even rarer in the ELT era.

6. In short, we believe that access to the WHT and INT remains essential to the broad UK astronomical community to help answer the key science questions of the age.

Dr Gavin Ramsay
Chairman
UK ING Panel for the Allocation of Telescope Time

11 February 2011

Written evidence submitted by the Magnetosphere, Ionosphere and Solar-Terrestrial (MIST) council on behalf of the MIST science community (APP 39)

Executive Summary

MIST council represents the space-based solar-terrestrial physics and space-plasma physics communities who have been hit hard by cuts of the last two or three years. This is ironical for a variety of reasons not least that, in our increasingly technology based society, the science in question, which underpins "space weather" is becoming increasingly relevant to maintaining key functions of ordinary life. Once, such applications were primarily of military interest. Today, the ubiquity and integration of communications and navigation systems means are used by everybody.

Often lumped together with less directly practical disciplines like cosmology or astronomy which has made it look esoteric, the discipline has tended to be deprioritised in peer review on the other hand because of its less "pure" nature. There is a national strategic need for the science that the solar-terrestrial science community produces and the facilities they run. Whilst both the European Commission and the European Space Agency have started organising a more coherent European role in the applied discipline of Space Situational Awareness (SSA), the United Kingdom is rather conspicuously incoherent in its response. On the other hand, British scientists over the past thirty years have done much of the work which has given the "space weather" side of SSA the capability to provide forecasting services.

The council is deeply concerned about the strategic consequences of these effective cuts for UK research. Implications arise across the whole remit of STFC science funding (astronomy, space, particle and nuclear physics) but MIST science has been hit hard. In particular we have grave concerns over the process by which STFC prioritised its science, the lack of strategic planning and implications for future science development. Significant damage to national capability is likely with the UK reduced in stature and its ability to deliver world-class science.

1. The Impact of Reduced Capital Funding on UK Capability

In recent years we have seen the UK start on the one hand a new space agency and on the other *"managed withdrawal"* from five space science missions in which the UK has key leadership roles (*Cassini, Cluster, SOHO, Venus Express and XMM*). The first three of these missions are wholly, or in the case of Cassini partially, missions whose science is central to the MIST community. In practice our European colleagues have had to step in with funds to sustain key UK roles, action which shows how important we are but which at the same time has not helped our image as partners. Each of these missions has recently (November 2010) received an extension from ESA, for which the UK correctly voted. However elsewhere, such a vote means a continued commitment to assist in operations of instruments on the spacecraft and a commitment to exploit the science. Of potentially important economic impact, the UK ability to monitor and, more importantly, characterise *space weather* hazards will be restricted, just at a time when there is growing European interest in this area due to our increasingly space-dependent society.

2. Has the Present System of Cutting Through Peer Review led to Appropriate Prioritisation of Key Minority Groups?

In the past few years following successive rounds of Research Council cuts, there has been a natural tendency to form review panels which prioritise with the aid of community input. An unfortunate aspect of the rather democratic approach is the tendency for smaller communities to lose out as there is a natural tendency to consolidate around larger groups. Without wishing to undermine normal peer review process towards judging

quality, small groups working in key areas of economic or strategic interest do need protection in some form for those factors to be allowed to come into play. One does not want to argue that the community represented by MIST Council should dominate British Astronomy or space science funding. But the community is very effective, and is working at world level in a field with practical applications associated with the nature of our society. The past work of UK scientists has already provided a lot of the intellectual impetus behind world work on the space weather aspect of Satellite Situation Awareness as well as important contributions to other aspects of how Sun and Earth interact. At the point where elsewhere in Europe, the practical use is being developed, the UK has been forced into withdrawal. One cannot operate a stop-start arrangement. There needs be proper planning to match the scale of the community to appropriate career evolution and to national need for not only the specific skills of the community but also as part of the supply for the generic skills such a field naturally produces. Moreover, there is a straightforward need to maintain an appropriate academic workforce level for the purely research aspects of the field. *If we fail to retain our world-leading capabilities within space physics, there will not be a future generation of scientists able to exploit upcoming missions*, such as the Bepi-Colombo mission to Mercury or future planned missions to the Outer Planets. *The prioritisation used in the recent past is not matched to national requirements and represents a failure of process, inclined against smaller communities that may well generate important skills critical for a high-technology society.*

3. Opportunities for, and Threats to, Outreach and Inspiring the Next Generation of Astronomers and Particle Physicists

The effect of *space weather* on modern technologies that we take for granted including power grids, satellite technology and air travel gives an immediate way to link exotic phenomena in space to the everyday experience and so is a natural topic for outreach. However MIST science topics have an immediate appeal. The dynamic nature of the aurora, perhaps only seen regularly in the far north of our islands, is immediately stimulating to school or general public audiences. Similarly, the vibrant and dramatic images of our Sun that are now routinely recorded and disseminated, elicit an immediate response in an audience. Here we have exciting science which can be brought very close to home and which can draw young people into science careers. *MIST council has grave concern for early-career scientists within the UK, and in particular the loss of jobs, skills and training opportunities.* These people are not only often the exemplars that inspire the next generation, but they often are the source of really new ideas and approaches.

Magnetosphere, Ionosphere and Solar-Terrestrial (MIST) council on behalf of the MIST science community

17 February 2011

Written evidence submitted by Research Councils UK (APP 40)

1. Research Councils UK (RCUK) is a strategic partnership set up to champion research supported by the seven UK Research Councils. RCUK was established in 2002 to enable the Councils to work together more effectively to enhance the overall impact and effectiveness of their research, training and innovation activities, contributing to the delivery of the Government's objectives for science and innovation. Further details are available at www.rcuk.ac.uk

2. This evidence is submitted by RCUK and represents its independent views. It does not include, or necessarily reflect the views of the Knowledge and Innovation Group in the Department for Business, Innovation and Skills (BIS). The submission is made on behalf of the following Councils:

- Arts and Humanities Research Council (AHRC)
- Biotechnology and Biological Sciences Research Council (BBSRC)
- Engineering and Physical Sciences Research Council (EPSRC)
- Economic and Social Research Council (ESRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Science and Technology Facilities Council (STFC)

3. RCUK welcomes the opportunity to respond to the Committee's inquiry into "opportunities for, and threats to, outreach and inspiring the next generation of astronomers and particle physicists".

4. The RCUK Public Engagement with Research Programme has a strategic commitment to "inspire young people to help secure and sustain a supply of future researchers to support the research base that is critical to the UK economy by encouraging engagement between young people and researchers". A key aim of the RCUK strategy is to enhance the experience of contemporary research for young people and schools teachers, encouraging more young people from a diversity of backgrounds to pursue relevant studies beyond 16 and follow R&D careers and enabling more to act as informed citizens.

5. RCUK is able to add value in this area using its unique access to cutting-edge research and researchers to work with intermediary organisations involved in the co-ordination, funding and provisions of enrichment activities for students and to increase the role of contemporary research in the school curriculum. RCUK currently engages with the Department for Education and would value the opportunity to do more in this area.

RCUK would welcome the opportunity to work more closely with partners who are delivering extra-curricular activities to encourage them to include contemporary research contexts.

6. RCUK funds a programme of Teacher Continuing Professional Development (CPD) entitled "Bringing Cutting-edge Science into the Classroom", which is designed to help secondary school teachers deliver some of the more challenging aspects of the curriculum in a way that captures and retains the interest of learners. It is also designed to support teachers' development of specialist knowledge and to facilitate links between teachers and contemporary research.

7. The Teacher CPD courses have been developed by the Science Learning Centre Network in conjunction with leading RCUK researchers and are clearly linked to the science curriculum. Astrophysics is one of the twelve course topics and there have been three courses held at CERN. The two learning visit based around the Large Hadron Collider (LHC) in February and March 2010 found that 93% of the participants on the first visit and 100% of the participants on the second visit rated the courses as "very good", with the remainder rating the visits as "good". It was clear from teachers' feedback that they found the visits enjoyable and inspirational. One teacher said that the course was "The best event I have ever attended" and another that it was "Quite possibly the most fantastic training course ever!". Due to the popularity of the previous CERN visits a further course was run in February 2011. However the Government's "rarely cover" policy issued to schools has been a challenge in recruiting teachers to take part in CPD outside of school, where schools have a number of conflicting priorities contemporary science courses are viewed as a luxury. RCUK will be reflecting on the government White Paper[7] and its implications for CPD going forward.

8. Researchers in Residence is one of RCUK's flagship schemes. The scheme has been running for over 15 years and brings together early stage researchers, young people and teachers via exciting and innovative placements in secondary schools and colleges across the UK. Placements last for up to 24 hours contact time, with researchers becoming involved in activities including practical classroom demonstrations, discussions and debates, after school clubs, lunchtime and careers talks or special projects for gifted and talented students. The researchers act as positive role models for young people to expose students to exciting future study and career options and motivate students to improve grades. A recent report from the National Audit Office[8] shows that schools participating in programmes such as Researchers in Residence see an increase in the number of students taking sciences at GCSE. The NAO report also shows that schools participating in the RCUK Researchers in Residence scheme see more of the year group achieving grades A to C grades in A Level maths than those schools not participating in a scheme. RCUK works closely with STEM Ambassadors and is currently exploring a recommendation in the STEM Careers Review[9] to amalgamate the two schemes.

Research Councils UK

16 March 2011

Printed in the United Kingdom by The Stationery Office Limited
05/2011 011082 19585

[7] The Importance of Teaching: The Schools White Paper 2010 (Department for Education) http://www.education.gov.uk/publications/eOrderingDownload/CM-7980.pdf

[8] Department for Education: Educating the next generation of scientists (NAO report, November 2010) http://www.nao.org.uk/publications/1011/young_scientists.aspx

[9] STEM Careers Review—Report to the Gatsby Charitable Foundation (November 2010) http://www.nationalstemcentre.org.uk/res/documents/page/STEM%20CAREERS%20REVIEW%20NOV%202010.pdf