The case for funding blue-skies astronomy

The government gets surprisingly little credit for the remarkable transformation it has made of science funding policy. With overall funding doubled since 1997, few scientists will want to see a return to the policies of the 1980s and 1990s. However, as discussions begin on the 2007 Comprehensive Spending Review (CSR), there's no time to lose in emphasising the importance of core funding for astronomy and particle physics in the UK.

The *Next Steps* document, released in March, made it clear that the Treasury still sees science as a key driver of the economy. Naturally, the Treasury wants to see a return on this investment in science and *Next Steps* emphasised the importance of knowledge transfer from universities to industry. In this context, some sciences clearly have more immediate applications than others and it is perhaps not surprising that astronomy has not shared the huge funding expansion of, say, life sciences. Overall funding for astronomy has risen modestly since 1997, more or less keeping pace with inflation. The government has not totally neglected astronomy, though, with crucial support for key items such as the UK's joining of the European Southern Observatory and participating in the Aurora programme for exploration of the solar system.

A downside of this cherry-picking approach is that the core programme is generally expected to take a proportionate hit and this can result in the cutting of other front-line projects. Earlier in 2006, the Particle Physics and Astronomy Research Council (PPARC) announced a list of proposed cuts designed to cope with the lasting effects of the government's first CSR, nearly a decade ago. While some of these cuts could be seen as appropriate winding down of projects and facilities reaching the end of their front-line life to make way for new projects, others seemed to be rather important science activities. Among these activities are the underground laboratory search for dark matter (which makes up 85 per cent of the matter in the Universe) and much of the ground-based solar-terrestial physics programme (which is crucial for monitoring the impact of solar particle storms on communications satellites).

The justification for spending money on astronomy, space science and solar system science is subtle and complex. If you want to stimulate applied science you cannot do it by just spending money on applied science, you have to support pure science too. In their work**,** astronomers are driven by science goals and it is no use pretending that this is in the hope of some serendipitous industrial breakthrough. To achieve a dynamic science-led economy we have to support excellence in pure science and we have to support the university researchers who are at the heart of this science. By all objective measures of impact, UK astronomers punch well above their weight internationally. The excellence of UK universities brings a direct benefit to the economy in terms of overseas students who want to study here.

The astronomy and space science community has in fact worked very hard with PPARC over the past decade to improve knowledge transfer to industry and there have been some impressive achievements. Although our research is curiosity-driven it does have many direct links with industry, especially in the areas of astronomical instrumentation and space instrumentation. There are certainly long-term economic benefits derived from astronomical research, and the discipline has produced some impressive short-term benefits, such as commercial applications of terahertz imaging. This new technology of far-infrared detectors, developed first for space astronomy, now screens for chemical and biological hazards, across a spectrum of dangers from weapons and explosives to skin cancer. Other examples are listed below.

However, perhaps the strongest argument for a vibrant astronomy and space science programme is the impact this science has on the wider public and on young people at the crucial stages when they are deciding which subjects to pursue at GCSE and A level. Astronomy has been well served by television documentary makers and broadsheet science journalists, but they are reflecting a very real hunger in the public to hear about these new discoveries and ideas.

- *A precision camera developed for gamma-ray astronomy has been used to screen cargo containers for radioactive materials at airports, border crossings and other security-sensitive areas.*

- *Superconducting tunnel junctions, which are used on telescopes to measure low levels of radiation, are being developed to detect fluorescence from tagged DNA. This will improve DNA identification in medical and forensic techniques such as genetic profiling.*
- *One of the most successful imaging devices of recent decades has been the charge coupled device, developed for astronomy and particle physics and now found in cameras and medical X-ray equipment*
- *Adaptive optics is a technology to compensate for the blurring of starlight by the Earth's atmosphere. It is now being applied in medical optics, where there are two distinct uses. The first is to image the retina in unprecedented detail, opening up the possibility of early detection of disease and abnormalities. The second is to enhance vision. Imaging by micro-channel plate camera a standard technique in X-ray astronomy, has been developed into a sensitive camera for monitoring cancer treatment, and for imaging tumours in the body.*
- *Study of reactions between ions and molecules in the interstellar medium led to the development of a technique to measure trace gases. The same technique is now used as a non-invasive method for clinical diagnosis and therapeutic monitoring (breath testing). It is also finding applications in environmental science (pollution monitoring), health and safety (monitoring breath following exposure to hazardous chemicals) and animal husbandry.*
- *Mathematical techniques, designed for processing observations of the Universe as it was just after the Big Bang, are being applied in forensic and medical fields. Picture enhancement was first developed and applied to astronomical images, but is now used to reconstruct fuzzy police photos of car number plates, and to de-blur images of the human body taken by hospital scanners.*

Michael Rowan-Robinson is Professor of Astrophysics at Imperial College London, and President of the Royal Astronomical Society.