

CELEBRATING FOUR CENTURIES OF MODERN ASTRONOMY



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2009 is very much a year of science. Alongside the Darwin celebrations, astronomers also have much to say this year. 2009 marks the 400th anniversary of Galileo Galilei's first use of the telescope to study the night sky, an inspired decision that began a scientific revolution by bolstering the Copernican idea that the Earth moved around the Sun. Under the auspices of the UN, his work and the whole field of modern astronomy is being celebrated worldwide this year as the International Year of Astronomy (IYA2009), with active participation by almost 140 nations.

Astronomers ask the 'big questions' about our origin and fate. This group of scientists tries to establish how our Universe began, how it allows life to exist and how it will end. The field encompasses the entire cosmos, from the visible and familiar planets, stars and galaxies to the dust and gas they formed from. And even this amounts to just 4% of the content of the Universe, with the rest made up of invisible 'dark matter' and the even more mysterious 'dark energy', whose very existence is inferred by the effect they have on their surroundings.

Such questions have a powerful impact on the public, arguably more so than most other sciences. Children, adolescents and adults alike have a large appetite for astronomy and space science and show this by their direct engagement with the subject. Public participation ranges from attendance at lectures and organised events to visits to astronomical attractions like the Royal Observatory Greenwich (more than a million people visited there last year), the National Space Centre in Leicester and the Jodrell Bank radio observatory.

Unlike other sciences, astronomy has thousands of amateurs who work alongside the professional community, organised into hundreds of local societies and clubs. These same groups form the backbone of IYA2009 in the UK, running more than 1000 events over more than 3000 days at venues from universities and observatories to shopping precincts and community centres. IYA2009's UK activities are backed by the Royal Astronomical Society (RAS), the Institute of Physics (IoP) and the Science and Technology Facilities Council (STFC).

In April tens of thousands of people got their first look at the Moon through a telescope in the Spring Moonwatch, with similar weeks taking place in the autumn and for schools. In the same week 'Around the World in 80 Telescopes' saw live webcasts from observatories across the globe and in space. And at the end of July the 'Telescope 400' celebrations take place at Syon House in west London, commemorating the 400th anniversary of Thomas Harriot, the English astronomer whose drawings of the Moon through a telescope predate even those of Galileo.

Earlier this year one in four UK secondary schools were given a telescope, for use by pupils and teachers in after school science clubs. This 'Telescopes for Schools' project recognises that young people are excited by space and astronomy and encouraged into studying Science, Technology, Engineering and Mathematics (STEM) subjects, especially physics and maths, at school and university. IYA2009 has inspired a set of exhibitions too, not just in museums and galleries but in less traditional places. Throughout 2009 'From the Earth to the Universe' will

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bring 50 of the highest quality images of the night sky to venues throughout the UK. Photographer Max Alexander's portraits of contemporary astronomers will begin a similar run in the Royal Albert Hall in September and using a rich collection of objects, the 'Cosmos and Culture' exhibition at the Science Museum will explain how astronomy has shaped the way we see our Universe over thousands of years.

IYA2009 is very much about bringing the achievements of contemporary research in astronomy and space science to a wider audience. British scientists have a great record in these subjects, ranking second only to the US for the number of published research papers. The UK is a world leader in areas such as radio astronomy (like Jodrell Bank and its associated MERLIN array of radio telescopes); theoretical astrophysics and cosmology (with prominent contributors like Lord Rees of Ludlow and Professor Stephen Hawking); the study of planets around other stars (UCL scientist Giovanna Tinetti found the first evidence for water on one of these worlds); imaging technology like the SCUBA camera installed on the James Clerk Maxwell Telescope in Hawaii; and space missions from the earliest X-ray observatories of the 1970s to probes exploring comets and other planets (for example the Cassini-Huygens mission to Saturn).

Our astronomers and space scientists work closely with their counterparts in Europe and across the world. The UK is a key partner in the European Space Agency, the European Organisation for Research in the Southern Hemisphere (ESO – which includes the world's

largest optical telescope and the proposed next generation of giant telescopes), the Atacama Large Millimetre Array and forthcoming Square Kilometre Array radio observatories, the Herschel and Planck space observatories and the Aurora programme centred on the exploration of Mars.

UK astronomers feature prominently as recipients of the most prestigious science prizes. Recent examples include Lord Rees of Ludlow (awarded the Crafoord Prize in 2005 for his work on the large-scale structure of the Universe), Professor Donald Lynden-Bell (who received the Kavli prize in 2008 for his seminal contribution to understanding the nature of quasars – objects powered by material falling into black holes), Professor Stephen Hawking (the 2006 Copley medal for his work on cosmology) and Professor Andy Fabian (the 2008 Dannie Heineman prize).

But does this world-leading research in astronomy deliver a direct benefit to the taxpayer? Yes! Their lives are enriched and their outlook is changed by knowing about the 'Big Bang' or the possibility of life on other planets. In a more direct way the work of solar terrestrial physicists is vital in satellite and communication systems and in understanding the impact of the Sun on our climate.

Then, as mentioned, there's the 'STEM attractor' effect. If the UK is to develop as a knowledge based economy and a scientifically literate society more young people need to study science. Dr Maggie Aderin-Pocock, a senior engineer at EADS Astrium, one of the UK's biggest space companies, was 'turned on' to science by her early exposure to astronomy. (During IYA2009 Dr Aderin-Pocock is leading the 'She is an astronomer' project in the UK,

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which aims to promote the science to girls and encourage them into the £7 billion space industry).

Most recipients of astronomy PhDs move into careers outside the field, but make good use of the training and transferrable skills they acquire during their time in academia. Dr Peter Newman, who now heads an operational research team for the Home Office, draws on experience gained during the first part of his career as an astrophysics postgraduate and postdoctoral researcher. At that time he had to produce research that could stand up to peer review and then had to explain often highly technical subjects to a lay audience (or a grants panel). These abilities have served him well in his current role.

Excellence in applied science depends on support for pure science, as recognised by successive Science Ministers. The UK's reputation in this area has brought in talented people from across the globe and directly assists in our recruitment of overseas students. A vibrant, dynamic, science-led economy depends on continuing to attract and retain the very best researchers in our universities and industry. However, while astronomy research is driven by curiosity it has led to a large number of spin-offs such as the terahertz imaging cameras used at airports; a precision camera, developed for gamma-ray astronomy, now used to screen for radioactive materials in cargo

containers and superconducting tunnel junctions that are used on telescopes to detect low levels of radiation but now used in the DNA identification needed in forensic science and medicine. While these applications were at least partly serendipitous they reinforce the conclusions of the economist Professor Edwin Mansfield [see Research policy 20(1991)1] who estimated a 28% rate of return on basic research (based on the profits from innovations, savings from new processes and benefits to users from new products and processes).

Four centuries after the seminal work of Galileo and Harriot, the UK is undoubtedly a world leader in astronomy and space science. The challenge is to ensure this continues and that we do not lose sight of the benefits of curiosity-driven research. Long-term investment in pure science should be a key part of the quest for a rebalanced economy – IYA2009 should remind everyone of its importance.

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Front Cover Image by Max Alexander
Observing the moon at sunset, at Cardiff Astronomical Society's Spring Moonwatch event in the Brecon Beacons National Park

