Sir Ian Axford FRS
1933–2010

Fellow, Honorary Fellow and Chapman Medallist of the RAS, internationally renowned space and astrophysical plasma physicist.

Sir Ian Axford FRS, one of the greatest figures in space and astrophysical plasma research whose work revolutionized our understanding of the magnetosphere, died at his home in Napier, New Zealand on 13 March 2010 after a long illness.

William Ian Axford was born in Dannevirke, New Zealand on 2 January 1933. He attended the University of Canterbury in Christchurch where he earned a double degree, ME (with distinction) and MSc (first class honours, in mathematics). In 1957, having joined the New Zealand Defence Scientific Corps, he went to Britain to study aerodynamics at Manchester and Cambridge, receiving a PhD in applied mathematics in 1960. His research involved topics in magnetohydrodynamics and interstellar gas flow, from which he soon developed an interest in geophysical and astrophysical applications of plasma physics, a research area that was then, in the Space Age after Sputnik, undergoing a vast expansion. Ian joined a group under Colin Hines at the Defence Research Board of Canada in Ottawa. After returning briefly to New Zealand for a stint with the NZ Air Force, in 1963 he moved again to North America and took an academic position at Cornell University, up to Associate Professor of Astrophysics and Professor of Astronomy in 1966. From 1967 to 1974 he was Professor of Physics and Applied Physics at University of California, San Diego.

It was at Ottawa that what is arguably Ian's most important (and certainly his most cited) paper was written: the 1961 "Axford and Hines" paper in *Canadian J.Physics* known to every magnetospheric physicist. Axford and Hines introduced the concept of magnetospheric convection, a vast circulation of plasma driven by interaction with the solar wind as it flows past the Earth, derived its basic properties, and showed that it could account for many observed features of geomagnetic disturbances and the aurora (a list subsequently expanded to include many features observed by spacecraft *in situ*). A paper by James Dungey (another Chapman Medallist and also Gold Medallist of the RAS) published a few months earlier had shown that reconnection of interplanetary and terrestrial magnetic fields could produce such a circulation, and Ian soon accepted that mechanism as a reasonable alternative to the unspecified viscous drag he and Hines had assumed. This led him to investigate the properties of the magnetic reconnection process itself and to propose the fundamental concept (sometimes called the "Axford conjecture") that although reconnection cannot occur unless there is a non-zero electrical resistivity (or some other departure from ideal MHD), the process is governed primarily by large-scale dynamics and boundary conditions, not by the value of the resistivity. Ian's favourite analogy was with viscosity in aerodynamics: the lift of a plane does not depend on the coefficient of viscosity, but if air were non-viscous then planes couldn't fly.

Fundamental contributions

Other topics on which Ian made fundamental contributions include cosmic rays (one of his favourite subjects), both in the solar system and in the galaxy; the ionosphere and in particular the polar wind (outflow from the upper atmosphere analogous to the solar wind from the corona); interaction of the solar wind with the interstellar medium and with comets; and the formation of the solar wind itself.

A major career change for Ian Axford came in 1974 when he accepted the call to become Scientific Member and Director at the Max Planck Institute for Aeronomy (as it was then called) in Katlenburg-Lindau (near Göttingen), Germany, where he remained until his retirement in 2001, except for returning to New Zealand between 1982 and 1985 as Vice-Chancellor of Victoria University in Wellington. The Institute had lost one director by premature death and was about to lose the other two by retirement, so Ian's charge was to redirect and revitalize its research work. He could bring in some new people but mostly had to make do with those already there, and he had a substantial say (but no official authority of decision) in selecting the other directors. As one of the new directors called under his aegis, I had the privilege of working with Ian for some 25 years and observing his remarkable talents of science management. Departing from the traditional structure of a Max Planck institute, with people and resources assigned to separate divisions each headed by a director who determines its research, Ian had all the resources pooled together, to be made available to research projects as needed. In the selection of research topics, available opportunities were to be considered as well as the interests of the participating scientists. The one overriding principle was that the topic be new and address significant questions at the cutting edge of research; the one thing Ian had no use for was continuing routine data collection, which he felt was a task for some outfit other than a Max Planck institute.

Under Ian's leadership, the Institute achieved world renown in areas such as investigations with atmospheric and ionospheric radars and observations of energetic particle spectra and composition in the solar wind and in planetary magnetospheres. It also moved into (for it) completely new areas, investigating comets (in particular the Giotto mission to comet Halley, including the first images of a cometary nucleus) and the Sun. (The name MPI for Aeronomy, obsolete almost since Ian's arrival, was finally changed in 2004 to MPI for Solar System Research.) The principle of available opportunities was not left to chance: either Ian personally or Institute scientists at his instigation played a major role in the genesis of several space missions, particularly Ulysses, Giotto, SOHO/Cluster, and Cassini/Huygens.

Ian was much concerned with the organization of science and was instrumental in restructuring the European Geophysical Society and transforming the EGS (now EGU) annual assembly from an obscure European meeting to its present status of a major international conference rivalled only by the AGU fall meeting. One tool in the transformation was the founding (largely at Ian's initiative) of the Copernicus Society for the Promotion of International Cooperation in Earth and Space Sciences in 1988. He was also a founding member (2003) of the Asia–Oceania Geosciences Society.

Among the many honours awarded to Ian Axford, in addition to the Chapman Medal, may be mentioned the John Adam Fleming Medal of the American Geophysical Union (1972), election as Fellow of the Royal Society (1986), election as foreign associate of the National Academy of Sciences of the United States, and having Asteroid 5097 named after him (1993). Although he spent most of his career abroad, he was well appreciated in New Zealand, where he was frequently compared to another great New

Zealand scientist, Ernest Rutherford. He was elected Honorary Fellow of the Royal Society of New Zealand (1993), received the Rutherford Medal (New Zealand's highest scientific award) in 1994, was named New Zealander of the Year in 1995, and was knighted in 1996. An exchange fellowship programme of the government was named in his honour the Ian Axford (New Zealand) Fellowships in Public Policy.

Cricket and Soviet history

As well as his scientific interests, Ian played cricket for Cambridge in 1959, enjoyed music, and investigated the genealogy of the Axford family, tracing his ancestry to a branch in Wiltshire and identifying an independent branch in Cornwall/Devon. In the last decade of his life he began working together with Tamara Breus, already known by him and by many of us for her work as scientist at the Space Research Institute (IKI) in Moscow, on aspects of the history of the Soviet Union, to which Tamara, born in Georgia just prior to the outbreak of World War II, could contribute from personal experience. Under the pen-name "Tatiana" the two published "*In Soso's Web (Scenes from Russian Life 1)*" (Copernicus GmbH, 2004), intended as the first volume of a trilogy. Sadly, Ian's health did not allow him to continue participating in this work; the extensive materials he had accumulated have been deposited at the Hoover Institution Archives at Stanford University as the W Ian Axford collection.

Sir Ian Axford was always soft-spoken and calm, whether dealing with intriguing questions of physics or tortuous issues of policy. He was adept at seeing the essential aspects of a scientific problem; his conference presentations as well as personal discussions were always illuminating. The influence of his published work continues to shape research to this day. With the passing of Ian Axford, the field of magnetospheric and astrophysical plasma physics has lost one of its founding fathers.

Vytenis M Vasyliūnas

Tim Hawarden
1943–2009

Fellow of the RAS, infrared astronomer, galaxy observer, innovator in passive cooling technology and outreach enthusiast.

Timothy G Hawarden was born (on 24 December 1943) and raised in South Africa, where he showed through his early hobbies a love of innovation and scientific exploration and an interest in astronomy. He graduated in 1966 from the University of Natal in Pietermaritzburg with a BSc in Physics and Applied Mathematics, going on to gain an MSc in Astronomy and a PhD from the University of Cape Town on the topic of old open clusters. He then became Computer Systems Manager and Deputy Head of the Photometry Department of the South African Astronomical Observatory in Cape Town. He was instrumental in the choice to site the present, now major, observatory at Sutherland.

In 1975 he transferred briefly to the Royal Observatory Edinburgh, before taking up a position at the UK Schmidt Telescope in Australia, where he had a major influence on the huge success of the SRC/SERC Southern Sky Survey. It was at this stage of his career that his love of galaxies first became clearly established. He was the first to identify clearly a class of galaxies with extraordinarily high neutral hydrogen to total mass ratio, linking them to galaxies with very faint optical extensions discovered on Sky Survey plates.

It was in Australia that his first wife, Kit, gave birth to their daughter Kate, and a son Sam followed in 1979 after they had returned to Scotland.

Passive cooling

Tim went back to the ROE in May 1978, where he worked as a member and then as Head of the UK Schmidt Unit. During this time he developed his interest in infrared astronomy and from 1981 he worked in the UK group that supported the operation in Hawaii of the 4 m UK Infrared Telescope UKIRT, becoming Head of the Edinburgh "Home End" section. Here, while working on ideas for ISO, already far advanced in design as a cryogenically cooled space telescope, he started to develop the concept of "passive cooling". He then transferred from Edinburgh to the Joint Astronomy Centre (JAC) Hawaii in October 1987, where for 13 years he ably supported visiting astronomers from the UK and internationally in their use of UKIRT. He continued to promote the passive cooling concept, doing calculations at not much more than back-of-envelope level which turned out to be spot-on when eventually checked by NASA. The importance of this innovative work has just been recognized by the award to Tim from NASA of their Exceptional Technology Achievement Medal, for which the citation reads: "For the breakthrough concepts that made possible the James Webb Space Telescope and its successors." These are the highest awards made by NASA. Tim was aware of his nomination but sadly did not live to hear of its confirmation.

At a time when major evaluations of the future of 4 m telescopes in the era of the next generation 8 m telescopes was taking place, Tim became Project Scientist for the UKIRT Upgrades Programme. With a team led by Project Manager Donald Pettie they achieved image quality down to about 0.2 arcsec. In 2001 Tim relocated to Edinburgh as the UK ATC's Project Scientist for Extremely Large Telescopes, analysing and advising on requirements for the instrument designs and novel technologies needed to enable the next generation of ground-based 30–60 m telescopes achieve their scientific potential. Tim rapidly became the mainstay of the ROE Visitor Centre's Meet an Astronomer programme, through which he enthralled hundreds of visiting schoolchildren with tales of astronomy and astronomers – an activity he continued for several years well into retirement. His numerous non-technical scientific publications covered a wide range of topics from exotic-sounding objects such as the Cartwheel Galaxy and cometary globules to fundamental photometry and standards, but those on hydrogen-rich, or dusty, or barred spiral galaxies or any combinations thereof would probably have been closest to his heart.

In 2006 he retired to spend more time with his beloved second wife Frances, to whom he was not only husband but also best friend and devoted carer. Tim Hawarden was not just a fine scientist, he was a personality, a presence, an inspiring colleague and wonderful friend. He died suddenly at home in Merchiston, Edinburgh on 10 November 2009. He will be greatly missed and very fondly remembered.

Andy Longmore