BIOGRAPHICAL MEMOIRS

Sir Alan Hugh Cook. 2 December 1922 – 23 July 2004: Elected FRS 1969

Terry Quinn

Biogr. Mems Fell. R. Soc. 2005 **51**, 87-100, published 1 December 2005

SIR ALAN HUGH COOK

2 December 1922 — 23 July 2004

Biogr. Mems Fell. R. Soc. **51**, 87–100 (2005)

Alan H. Cook

SIR ALAN HUGH COOK

2 December 1922 — 23 July 2004

Elected FRS 1969

BY TERRY QUINN CBE FRS

92 rue Brancas, 92310 Sèvres, France

Alan Cook was a man of many parts, described variously as a physicist with an unusually wide range of interests, a distinguished natural philosopher and a man who was seriously learned. He was all of these. He combined the qualities of a scientist, academic and scholar and was distinguished in all of them.

EARLY LIFE AND EDUCATION

Alan Cook was born in Felsted, Essex, on 2 December 1922, the eldest of six children. His parents, Reginald Thomas Cook OBE and Ethel (*née* Saxon), had met in Workington, where each had their first appointments. His father, who was a customs officer, wrote many articles for Customs and Excise and was keenly interested in the study of political affairs as well as rural manners and customs. Both parents were also active in the Congregational Church in Felsted, and after his father's death, at the relatively early age of 63 years in 1954, his mother held various offices in Essex Congregational Church organizations. She lived much longer than her husband and died in 1986 at the age of 93 years. This early exposure to the church must have had an influence on Alan, who throughout his life maintained a deep Christian faith with an active involvement in church affairs during his years at Cambridge, a practice he continued right through to the time that he eventually became Master of Selwyn College. On his father's side, the family came from near Monmouth, where they were involved in the timber and wood business; his mother's family hailed from Eastbourne, where they conducted a coach-building business.

His early education was in Felsted at the village school from 1927 to 1931. At that time Felsted was a small, compact farming village, although it also had a well-known public school and a brewery. A boy growing up in such a place could not have but been aware of the cycle of the seasons of rural life, the ploughing and threshing with horses and steam power as well as the stars in the clear dark skies at night. Alan often accompanied his father on his duties visiting local industries, particularly the breweries that came under the purview of Customs and Excise, and he inherited his father's interest in country people and things. In 1931, the family moved to Leigh-on-Sea, where Alan went to West Leigh School. Family holidays at that time often took them to Devon as well as to other seaside places in East Anglia. The old historic harbour in Leigh gave him an interest in naval history and during the annual yachting week the harbour was visited by many of the largest ocean-going racing yachts. In 1933 he took the entrance examination to Westcliff High School for Boys, coming top in the competition. There he was strongly influenced not only by the headmaster, Mr H. G. Williams who, as the first headmaster, had launched the school in 1920, but also by other excellent maths, physics and chemistry teachers. His real interest in Earth sciences began with lessons on geology as part of the geography course. In the summers of 1937, 1938 and 1939 he spent the holidays with relatives in Barnstaple, Devon, where he made cycle tours studying the local geology. In December 1939 he sat the Cambridge entrance examinations and was awarded a Major Entrance Scholarship to Corpus Christi College. Early in 1940, Leigh became a restricted area and everyone had to move out: the school moved to Belper in Derbyshire; his father had to stay in London but his mother and the rest of the family moved to stay with the relatives in Barnstaple. Alan spent his last two terms at school as a boarder in Belper enjoying the fine summer of 1940 in the Derbyshire dales. He went up to Cambridge in October 1940 to read natural sciences. Soon afterwards, the family was reunited again and they all came back to Essex, where they found a cottage in Canfield in which they stayed for the rest of the war.

It is clear that in following the classic Cambridge Natural Science Tripos, he would naturally choose geology as the additional experimental subject. His early experiences as a child in the countryside and the holidays in areas of great natural beauty had laid down a deep and abiding interest in geology and the Earth. In his Tripos Part 1 he was awarded the Bacon Prize and the Bishop Green Cup from his college. Also, living in the deep countryside, the dark nights allowing the Milky Way to be clearly visible, had sparked an interest in astronomy. Both of these interests were very much reflected in his later life.

It being wartime, after his BA degree he was drafted to do war work. He was sent as a temporary Experimental Officer to the Admiralty Signals Establishment (ASE) at Witley, near Godalming in Surrey, where he was involved in radar research in the Test and Measurement Section. This lasted until the end of the war, when he came back to Cambridge to begin his PhD. His period at the ASE was the subject of an article published in *Notes and Records of the Royal Society* in 2004. In this he recounts certain exploits of himself and his colleagues on 5 June 1944 in last-minute efforts to install jammers in some of the invasion fleet due to go into action the following day. As is well known, there was a severe storm in the Channel on the night of 5 June and this added considerably to the dangers of being close to the Normandy beaches at that time.

On his return to Cambridge, he enrolled for a PhD in the Department of Geodesy and Geophysics, where, under the supervision of E. C. (later Sir Edward) Bullard FRS and B. C. Browne, he undertook a thesis subject on measurements of gravity in the British Isles. At that time there were few staff in the department but among them were Sir Gerald Lennox-Conyngham FRS (the last British Director of the Great Trigonometrical Survey of India, who had started the Cambridge department when he retired), Harold (later Sir Harold) Jeffreys FRS and, of course, Edward Bullard. The three years at ASE had in some ways been equivalent to a postgraduate training for a PhD, and when he was back in Cambridge it was more like a postdoctoral period. He was not alone in this, of course, because many of those whose university careers had been interrupted by the war were far more experienced and mature in all sorts of ways when they came back than the typical undergraduate or new postgraduate. Many look back on those days as a golden age.

In terms of science, the war had given an enormous boost to practically every area. This was true for geophysics, notably in marine geophysics. The end of the war had led to a vast amount of surplus electronic equipment becoming available, which rapidly diffused into university science departments and was soon used to open up new avenues in, among other things, radioastronomy.

On completing his PhD, Alan stayed on in the department as a Research Assistant from 1949 to 1951. Here he continued along the broad lines started in the thesis, taking an increasing interest in all matters related to the Earth's gravity field. This is reflected in the first dozen or so of his published works (1)*. Most of these are accounts of gravity surveys at various places in Britain and Ireland and notes on the estimation of errors and the calculation of gravity from various geological formations. His first paper in the *Proceedings of The Royal Society*, series A, appeared in 1950 and was on the calculation of deflections of the vertical from gravity anomalies (2). This interest in gravity broadened over subsequent years to include what is commonly known as laboratory gravitation, in which the gravitational attraction between laboratory-sized masses is measured, as opposed to the attraction between one laboratory-sized mass and the Earth. The former is much more demanding because the effects are so much smaller. The gravitational attraction between two 1 kg spheres nearly touching is only about 1 part in 10^8 of their weight, namely the attraction towards the centre of the Earth. On the one hand, we attempt to measure their acceleration towards the centre of the Earth (little g) to 1 part in 10^9, and on the other hand we struggle to measure their mutual attraction (big G) to a few parts in 10^5! Throughout his subsequent career Alan always came back in one way or another to these problems he first encountered as a young man. Indeed, his last scientific book was on laboratory gravitational experiments and was published in 1993. In 1949, his Cambridge supervisor Edward Bullard had left Cambridge to become Director of the National Physical Laboratory, and it was he who in 1952 suggested that Alan should come to Teddington.

By this time Alan had, in 1948, married Isabell Weir Adamson, who remained his constant companion until the time of his death more than half a century later.

The National Physical laboratory, 1952–69

The 17 years that Alan spent at the National Physical Laboratory (NPL) in Teddington were the most productive of his scientific life. During this period he fully developed his experimental and theoretical interest in the gravitational field of the Earth, embarked on some optics, practised the techniques of precise measurement and broadened his interests in astronomy, notably the movements of the planets and interstellar microwave emissions. All of this was crowned by his election to Fellowship of the Royal Society in 1969. Bullard stayed on as Director until 1955, when he was replaced by Gordon (later Sir Gordon) Sutherland FRS, who stayed until 1964.

* Numbers in this form refer to the bibliography at the end of the text.

The Standards Division of the NPL in the early 1950s was much involved in the preparatory work that would lead to the redefinition of the metre in 1960. At the time, the metre was still defined as the distance between lines on the platinum–iridium metre bar adopted by the first General Conference on Weights and Measures in 1889 and kept at the International Bureau of Weights and Measures (BIPM) in Sèvres. Michelson had measured the wavelength of a cadmium line in terms of the metre at the BIPM in the 1890s, but it was a difficult and time-consuming operation owing to the absence of a suitable light source with an emission line narrow enough to give a reasonable coherence length. When Alan joined the Standards Division in 1952, the Superintendent was Harry Barrell, who with J. H. Sears had performed in 1932 a precise determination of the wavelength of cadmium red light in terms of the UK copy of the international prototype of the metre. It was not until after World War II, when isotope separation became feasible, that suitable discharge lamps could be manufactured to give light with narrow, well-separated emission lines and the fine details of their hyperfine structure had been understood. Optical interferometry and the delicate instruments that allowed a line scale to be compared with an optical wavelength were important parts of the Division's work. Alan became involved in this with Dick Rowley and together they worked on interference spectroscopy and the development of photoelectric methods for the precise measurement of wavelength profiles. Rowley had also recently joined the Division and subsequently took charge of this work with the introduction of laser interferometry to length measurement in the 1960s. Alan also continued his interest in the measurement of the Earth's gravity (3–5).

The Standards Division also had responsibility for standards of mass, pressure and temperature. It was the second of these that also attracted his attention when he joined the Division in 1952. This concerned the problem of the density of mercury. This is a key quantity required for pressure measurement, which in turn was needed for a definition of the temperature of the boiling point of water, one of the defining fixed points of the international practical temperature scale, something that was of considerable practical use at the NPL for thermometer calibration. Over the next 10 years, in parallel with many other activities, he performed a measurement of the density of mercury (6, 12) that had an uncertainty between five and ten times smaller than the previous best measurements performed at the BIPM some 50 years earlier and in Spain in the 1930s. The highest accuracy pressure measurements, near one atmosphere pressure, were made by measuring the height of a column of mercury; the limiting uncertainty was the then uncertainty in the density of the mercury. Surprisingly, this is still true, and the uncertainties of today's best pressure measurements are still limited by the uncertainty in the density of mercury based on measurements made by Cook at the NPL in the 1950s. Because there are small variations in density due to the natural variations in the isotopic content of mercury depending on its source, samples of the mercury used by Cook have been carefully preserved in several national metrology laboratories around the world. The method used by Cook was very simple: he made a cube of tungsten carbide about 9 cm in length on a side, weighing about 10 kg in air and 200 g when immersed in mercury. From a knowledge of the volume of the cube and the difference in weight in air and in mercury, the density of mercury can be found. He also performed a measurement in which he constructed a hollow cube from plates of fused quartz and weighed the cube first empty and then full of mercury. This was designed to eliminate suspected errors at the surface of the tungsten carbide cube. The uncertainty of the final result in both configurations was about 1 part per million (p.p.m.), and the difference between the two was well below 1 p.p.m. As in all metrological experiments of this sort, the principle of the measurement is simple but the accuracy of the result depends on taking extreme pains to eliminate the multitude of small sources of error inherent in any practical measurement. These measurements of the density of mercury have also been used for quite a different purpose. The kilogram is the last base unit of the international system of units that is defined by a material artefact, the international prototype of the kilogram kept at the BIPM. The problem is that in the absence of any method of linking the mass of the international prototype to fundamental or atomic constants, it is impossible to know whether or not its mass is changing in the long term. It turns out that the smallest limit that we can put on the drift of the international prototype is from the consistency of Cook's measurements in the 1950s of the density of mercury (made in terms of the then NPL mass standards traceable to the BIPM prototype) with measurements of the volt made much more recently using an absolute electrometer in which a given voltage attracted a pool of mercury and lifted it upwards by a small amount. The resulting limit was set by the uncertainty of Cook's density measurements, namely about 1 p.p.m. New work based on the so-called watt balance should soon overtake this, but the influence of Cook's measurements of the density of mercury has been very significant over 50 years.

While working on his density measurements, Cook also pursued his interest in gravity experiments (7). This was not only because of his earlier interest in gravity surveys but also because the other essential quantity needed for accurate pressure measurement is a correspondingly accurate value for the local acceleration due to gravity, g. He very quickly started a project for the accurate measurement of g (9). Traditionally, such measurements had been made with pendulums, but wartime developments in electronics and timing made it possible to conceive of a direct measurement of g by simply measuring the downward acceleration of a falling body. Although such a measurement seems trivially simple, in fact to obtain the high accuracy required to make it useful, the measurement is extremely difficult. Today, for example, one of the limiting uncertainties comes from the recoil of the floor at the instant the falling body is released. Because the position of the falling object is measured with an optical interferometer, one mirror of which must somehow be attached to the floor, even today this poses a serious problem. In addition, it is not easy to release a body without giving it some residual rotation. Timing circuits have to be very fast because falling bodies in the Earth's gravitational field actually accelerate quite quickly. Cook's apparatus included many clever ways of avoiding some of these problems, the most important of which was to throw the falling body upwards and measure its trajectory up and down. He also chose as the falling body a sphere of glass that focused a beam of light as it passed pairs of slits at the lower and upper ends of the trajectory. This reduces many of the otherwise difficult systematic effects, particularly those due to timing and rotation of the falling body as well as residual air drag. His result, published in 1967 (16), was a landmark in the measurement of g and although its accuracy was soon overtaken by other measurements at the BIPM and at the US National Bureau of Standards (now the National Institute of Science and Technology), he demonstrated how best to perform these sorts of measurements. The uncertainty he gave in 1965 was about 1 part in 10^7. These days the uncertainty of the current generation of absolute gravimeters is about 3 parts in 10^9. The interest in accurate measurements of g continues unabated because of the importance of gravity surveys for geophysics, for oil and mineral prospecting and for important studies of the precursor effects of earthquakes and the determination of the geoid, to mention only a few of its applications.

Encouraged by Bullard, Cook continued his interest in the broader aspects of geodesy and geophysics. During the 1950s and 1960s he published many papers on the Earth's gravity field

(10). When the first artificial Earth satellites were launched it became clear that these could be used as a new source of information on the gravitational potential of the Earth. His first paper on this subject (8) was entitled 'Determination of the Earth's gravitational potential from observation of Sputnik 2', which appeared in the *Geophysical Journal of the Royal Astronomical Society* in 1958. Over the next 10 years he produced a succession of papers on dynamical geodesy and celestial mechanics (11, 13, 14) with applications of surface gravity measurements to the determination of the geoid and related theoretical studies. He studied the theory of the motion of satellites and general applications to the study of the Earth's gravity. He also became interested in the fundamental constants of astronomy.

While a Visiting Fellow at the Joint Institute for Laboratory Astrophysics in Boulder (Colorado, USA) in 1965, he came across the early news of the discovery in Berkeley of new, apparently anomalous, emissions of microwave radiation from the hydroxyl radical in interstellar space. This marked the beginning of a long-standing interest in this subject; he was the first to suggest, in a letter to *Nature* in 1966 (15), that it was maser radiation emitted in a narrow beam. He wrote several papers on this topic and in 1977 published a textbook entitled *Celestial masers* (20).

In 1966, on the retirement of Harry Barrell, Alan had been promoted to Superintendent of what had by then been renamed the Quantum Metrology Division of the NPL. Soon afterwards, however, he became attracted back to academia and accepted the professorship of geophysics at the University of Edinburgh. He left the NPL to move to Edinburgh in September 1969, the same year in which he was elected a Fellow of the Royal Society.

University of Edinburgh, 1969–72

His task at Edinburgh was to set up a new Department of Geophysics, the only one in the country besides Cambridge that was independent of any other department. He was very quickly able to recruit three lecturers and start a course at Scottish second-year level. They worked in close cooperation with the Global Seismology Unit of the Institute of Geological Sciences, then headed by Dr P. L. Willmore (a fellow research student at Cambridge), and with the International Seismology Centre headed by Dr E. P. Arnold. Alan soon began to become involved in wider university affairs, an indication of what was to follow later at Cambridge, when he took the chair of the Steering Committee of the School of Artificial Intelligence. He did, however, continue to broaden his interests in astronomy and celestial mechanics with a study of the dynamical properties of the Moon and the planets, with particular interest in the inferences that may be drawn about their internal constitutions. He also developed a new analytical theory of the librations of the Moon, using a computer to do the algebra. However, his time at Edinburgh was short and in October 1972 he left to take up the Jacksonian Professorship of Natural Philosophy at Cambridge.

University of Cambridge

Jacksonian Professor, 1972–90

Alan's time in Cambridge was multifaceted. At the Cavendish Laboratory, which would move to its new site in west Cambridge in 1974, he continued his interests in astronomy and celestial mechanics. With the support from the Science Research Council he was able to establish a small group, called Laboratory Astrophysics, to work on experimental and theoretical aspects of the maser problem mentioned previously. With Dr Bob Butcher, one of his appointments to the Cavendish, he continued a collaboration with the NPL to develop sources for spectroscopy in the submillimetre range in relation to astrophysics. As the new Jacksonian Professor, he of course encountered a considerable challenge in setting up a new group in an experimentally very demanding field in parallel with the existing and, in some cases, long-standing research groups already there such as radio astronomy and many aspects of solid state physics, all being energetically pursued and hungry for resources. He contributed quite significantly to undergraduate teaching in physics. During his time in Cambridge he offered final-year courses in optical physics, geophysics, quantum metrology and advanced quantum theory, displaying the extraordinary range of his knowledge. As head of department he championed the notion of a taught MPhil, which was in fact the precursor of the present final-year course leading to a Master's degree. Partly as a result of the success of these courses, geophysics developed into a major option in the physics course at Cambridge. This opened the way for future physics students to follow in Alan's path. During this time he continued to publish quite extensively on many matters related to gravitation and astronomy, the latter mostly concerned with the Moon and the planets, their constitution and their movement (17, 18). Towards the end of his time at the Cavendish he took up the problem of the measurement of the Newtonian constant of gravitation (19). One of the research students in his group, Clive Speake, now Reader in Experimental Gravitation at the University of Birmingham, actually made, as his thesis topic, a measurement of G with a beam balance. Cook had for a long time collaborated with Professor A. Marussi at the University of Trieste. The plan was to build a large torsion balance in the very tall Grotto Gigante near Trieste. The idea, which was basically sound, was to scale up the experiments that had been done in the past by having a very long torsion fibre, large masses and thus a large, or relatively large, gravitational signal. They would take advantage of the extreme thermal and seismic stability of the cave. Sadly, although the masses were all prepared and measured at the NPL, the early death of Professor Marussi put an end to the project. Cook's final work in experimental gravitation was a test of the inverse-square law performed with Y. T. Chen and A. J. Metherell (21), the experiment being performed in a hut out in the radio astronomy site well outside the city of Cambridge. This was followed up by the book (his last), written jointly with Chen, entitled *Gravitational experiments in the laboratory* (22), a volume still highly valued by experimenters in this field. Among his research students, he was particularly proud of Michael Foale, who subsequently became an astronaut and whose launch into space Alan witnessed in 1992.

In October 1979 Alan succeeded Sir Brian Pippard FRS as Head of the Cavendish Laboratory, a position he held until 1984, a year after he had taken on the Mastership of Selwyn. In addition to running the laboratory, in a period fraught with financial difficulties, he became more and more immersed in university business. He had a significant role in drawing up and sending a formal memorandum to the university drawing attention to the serious deficiencies in its management structure. He became well aware of these deficiencies while Head of Department when he had regularly to deal with the central university authorities. This memorandum had about 200 signatories, including many physicists from the Cavendish. It resulted in 1989 in the establishment of the Wass Syndicate, of which he himself became a member and whose recommendations resulted in major reforms. He became a member of the General Board of the University, a member of the Library Syndicate, Chairman of the Computer

Syndicate, member of the University and Assistants Joint Board and a member of the Faculty Board of Music. One of his important achievements was his successful setting up of the Granta backbone network, which revolutionized communications within the university, including all its departments as well as the 30 or so separate colleges. He was also a Syndic and, from 1988 to 1993, Chairman of the Syndics of Cambridge University Press. This last role he particularly enjoyed because it gave him access to books in almost unlimited quantities. The resulting avalanche of books created something of a problem in his office in the Cavendish and was not unremarked in Selwyn and by his wife at home!

He also had responsibilities outside Cambridge in national scientific affairs. He was a member of the Natural Environment Research Council (NERC) and chairman of the committee with responsibility for oceanography and hydrology. This required many visits to NERC institutes around the country, often beside the sea, a task that he found very congenial. Additional duties included membership of the National Committee for Space Research and of the Geodesy and Geophysics Committee (chairman 1972–76). He was chairman of the Joint SERC/NERC Committee on Climatology, a member of the SERC and chairman of the Astronomy, Space and Radio Board (1984–88). For his numerous services he was knighted in 1988.

On arrival in Cambridge he had been elected a Professorial Fellow of King's College, which he remained until his election as Master of Selwyn 10 years later. While at King's he took a full part in the running of the college, being at one time a Fellowship elector and member of the College Council.

During the period 1977–79 he was President of the Royal Astronomical Society, having earlier occupied many positions in the society since his election in the 1950s. He was also active over many years in International unions, for example the International Astronomical Union and the International Union for Geodesy and Geophysics.

He had long been a regular visitor to the International Centre for Theoretical Physics in Trieste, where he had met Professor Marussi and embarked on the *G* experiment. However, many of his visits were not related to that but to the preparation of programmes and to lecturing at courses held at the Centre. During the year 1981/82 he was Visiting Professor at UCLA and Berkeley, and Green Scholar at the Institute for Geophysics and Planetary Physics at La Jolla, San Diego. There, he and his wife were invited by Sir Edward Bullard's widow to stay at the house to which she and her husband had retired some years previously and where he had died the year before. It was there that Alan came across a whole collection of papers relating to Edmund Halley. Bullard had himself been very interested in the history of science. This chance discovery opened a new phase in Alan's life, the history of science. But meanwhile a new chapter in his life had opened with his election to the Mastership of Selwyn College.

Master of Selwyn College, 1983–93

When Professor Owen Chadwick OM KBE decided, in 1983, to retire as Master of Selwyn College, his successor was to be the first Master elected under a new statute. In the past it had been stipulated that the Master must be in holy orders. This was to be the first Master elected under a new statute in which it merely stated that, in the first instance, such a person be sought but if this search proved unsuccessful, then an election could proceed without restriction. This restriction has now been completely removed, but it was obvious that, to avoid the possibility of a very difficult election, a rather special candidate would have to be found, because the interim statute could easily prove unworkable. The then Vice Master, Alistair (later Sir

Alistair) MacFarlane (FRS 1984), to whom it fell to organize the election, recounts that it seemed to him that three requirements had to be met in the person of the new Master: he should be a devout Anglican, someone who was of some real distinction, and someone who would value the college's life and traditions. After a diligent search through all the university and college lists and a wide consultation, he came to the conclusion that there was only one person in Cambridge who satisfied all the criteria with the personality and character to be acceptable to the fellowship—Alan Cook. There then followed the election, a procedure familiar to readers of C. P. Snow! But in the event he emerged as clearly the best choice for the college, and he was a highly successful and much liked Master for 10 years. He was a popular and successful Master because he combined a fine intellect with a great sweetness of nature. He was truly interested in all aspects of college life, in its traditions, in its fellows, in its students, in its alumni and in all of its staff. His scientific achievements gave him a natural authority, and this was amplified and buttressed by his wide interests and obvious scholarship. He recruited more scientists to the college Fellowship, taking great pains to bring women into the community, through senior and junior academic appointments as well as research students. Selwyn was still an institution that at the time reflected the male-dominated culture of the university. He was a great supporter of the Chapel, preaching on natural science and theology, and of the Chapel choir and of music in the college generally. He enjoyed being a Master, delighted in ceremonial, loved the rhythms and rituals of college life, enjoyed dressing up in summer blazers and winter scarves, in black gowns and in scarlet gowns, in Chapel and in Hall. He conducted meetings with grace and humour, spoke well and to the point on ceremonial occasions, and gave the college the attention, involvement and care it needed. Isabell complemented and supported him with great tact and commitment. One of their lasting memorials is the beauty of the college gardens, which they transformed. His great contribution was to perform the very difficult task of taking the college through a potentially very difficult transition from a special, narrowly conceived foundation to a mainstream college while maintaining its special ethos and traditions.

History of science and final years in Cambridge

The history of science occupied him fully during the last 10 years of his life. As in everything else he touched, his interests were wide and he delved deeply (23–25). In 1997, Alan published *Edmund Halley: charting the heavens and the seas* (26), a biography of Edmund Halley. This was the fruit of research performed over all the years since he had come across the papers at the Bullard house in 1981. It was a scholarly work that was very well received. Although it was his main work as a historian of science, it was certainly not his only one. In 1996 he became Editor of *Notes and Records of the Royal Society of London*, the Society's journal of the history of science. He succeeded Desmond King-Hele FRS in this position. It was a task he obviously enjoyed very much. He contributed not only his knowledge and expertise as Editor but also numerous articles, book reviews and regular editorials to the journal. The last three of his articles appeared in the two issues that were published posthumously in September 2004 and January 2005. The final one (27) was entitled 'A Roman correspondence: George Ent and Cassiano dal Pozzo, 1637–55', in which he presented and commented on his own translations from the Latin of nine letters sent from Ent to dal Pozzo. It was a fine example of the scholarly work at which he was adept.

Family and private life

During the years after his retirement from Selwyn, he and his wife stayed in Cambridge but his researches into the history of science led him and his wife to travel very frequently, notably to Italy and to France to visit libraries and people. Travel had always been a pleasure for them both and during his long professional life he had travelled extensively on business connected either with science directly, which took him very frequently both to Trieste and to the west coast of the USA, or with taking part in meetings of International unions, notably the International Astronomical Union, or, in his later years, on missions concerning the Royal Society or foreign academies. Among the honours he received during his lifetime, one that had given him particular pleasure was his election in 1972 as Socio Straniero of the Accademia Nazionale dei Lincei in Rome.

Throughout his life Alan had been a lover of music, and he and his wife took full advantage of opportunities for concert and opera going not only at home but also on their foreign travels. In his youth he had been a keen amateur actor, an activity he still enjoyed while at the NPL, but this gave way to painting in his later years.

Alan was a kind and gentle man having a warm personality and being very much at home in academic circles, with a refined and perfectly appropriate sense of humour. Throughout his life he had been supported by the strong Christian faith that he had received from his parents. He had a deep affection for the Book of Common Prayer and was latterly Churchwarden of St Edmund's, where that tradition was maintained.

He is survived by his wife, Isabell, and a son and daughter.

Principal appointments, degrees, honours and distinctions

1943–46	Temporary Experimental Officer, Admiralty Signals Establishment, Witley, Surrey
1949–51	Research Assistant, Department of Geodesy and geophysics, Cambridge
1952–69	National Physical Laboratory, Teddington; Superintendent of the Standards (subsequently Quantum Metrology) Division, 1966–69
1983	Fellow of the Royal Astronomical Society (Member of Council 1958–64; Vice-President 1964, 1968–70; President 1977–79)
1967	C. V. Boys Prize, Institute of Physics
1969	Fellow of the Royal Society; Fellow of the Institute of Physics
1970	Fellow of the Royal Society of Edinburgh
1971	Socio Straniero of the Accademia Nazionale dei Lincei of Rome
1969–72	Professor of Geophysics, University of Edinburgh
1972–90	Jacksonian Professor of Natural Philosophy, University of Cambridge; Head of Department of Physics 1979–83
1972–83	Professorial fellow, King's College, Cambridge
1972–78	Chairman, National Committee for Geodesy and Geophysics
1974–80	Member, Natural Environment Research Council (NERC)
1973–80	Member, Measurement Standards Requirement Board, Department of Trade and Industry; member, Astronomy, Space and Radio Board Science and Engineering Research Council (SERC)

1983–84	Member, Solar System Committee, Astronomy, Space and Radio Board, SERC
1983	Chairman, Joint SERC/NREC Committee on Climatology
1984–88	Member, Science and Engineering Research Council; chairman, Astronomy, Space and Radio Board
1988	Knight Bachelor
1983–93	Master of Selwyn College, Cambridge
1977–93	Syndic of the Press, University of Cambridge; Chairman 1988–93
1981–84	Member, General Board, University of Cambridge
1986	Member, Library Syndicate (to 1992); chairman, Council of School of Physical Sciences; Chairman of Computer Syndicate; member, University and Assistants Joint Board (to 1992); member, Faculty Board of Music (to 1992); member, Wass Syndicate
1986–93	Chairman of appointments Committees for Arts Faculty, Fitzwilliam Museum, University Library
1965–66	Visiting Fellow, Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder, Co. USA
1981–82	Visiting Professor, Department of Earth Sciences, University of California at Los Angeles; Visiting Professor, Department of Physics and Earth Sciences, University of California, Berkeley; Green Scholar, Scripps Institute of Oceanography, University of California

Acknowledgements

For help in the preparation of this memoir I am most grateful for help and advice from Professor Mick Brown FRS, Sir Sam Edwards FRS, Professor Archie Howie FRS, Dr Christopher Johnson, Sir Alistair MacFarlane FRS and Dr John Sweet. Isabell Cook also very kindly helped in providing me with a number of documents from her late husband's papers.

The frontispiece photograph was taken in 1969 by Godfrey Argent and is reproduced with permission.

Bibliography

The following publications are those referred to directly in the text. A full bibliography, numbered as in the second column, is available from the Royal Society's Library and online at www.pubs.royalsoc.ac.uk.

(1) (3) 1950 (With B. C. Browne, E. J. McCarthy & D. S. Parasnis) Gravity measurements at York, Newcastle-upon-Tyne, Edinburgh and Aberdeen. *Mon. Not. R. Astron. Soc., Geophys. Suppl.* **6**, 91–108.

(2) (4) The calculation of deflexions of the vertical from gravity anomalies. *Proc. R. Soc. Lond.* A **204**, 374–395.

(3) (13) 1952 Comparison of the acceleration due to gravity at the National Physical Laboratory, Teddington, the Bureau international des Poids et Mesures, Sèvres, the Physikalische-Technische Bundesanstalt, Brunswick and the Geodetic Institute, Potsdam. *Proc. R. Soc. Lond.* A **213**, 408–424.

(4) (16) 1953 Adjustment of the principal gravity observations in Great Britain. *Mon. Not. R. Astron. Soc., Geophys. Suppl.* **6**, 494–534.

(5) (22) 1955 (With G. D. Garland) A determination of the difference in gravity between the National Physical Laboratory, Teddington, the Dominion Observatory, Ottawa, and the National Bureau of Standards, Washington. *Proc. R. Soc. Lond.* A **229**, 445–458.

(6) (28) 1957 (With N. W. B. Stone) Precise measurements of the density of mercury at 20 °C. I. Absolute displacement method. *Phil. Trans. R. Soc. Lond.* A **250**, 279–323.

(7) (31) 1958 The calibration of gravity meters by comparison with pendulums. *Geophys. J. R. Astron. Soc.* **1**, 18–31.

(8) (32) Determination of the Earth's gravitational potential from observations on Sputnik 2. *Geophys. J. R. Astron. Soc.* **1**, 341–345.

(9) (35) 1959 Preparations for a new absolute measurement of gravity at the National Physical Laboratory, Teddington. *Bull. Géod.* no. 51, pp. 63–71.

(10) (36) The external gravity field of a rotating spheroid to the order of e^3. *Geophys. J. R. Astron. Soc.* **2**, 199–214.

(11) (42) 1961 The comparison of the Earth's gravitational potential derived from satellite observations with gravity observations on the surface. *Geophys. J. R. Astron. Soc.* **5**, 29–33.

(12) (43) Precise measurements of the density of mercury at 20 °C. II. Content method. *Phil. Trans. R. Soc. Lond.* A **254**, 125–154.

(13) (50) 1963 Sources of low order in the external gravity field of the Earth. *Nature* **198,** 1186.

(14) (56) The contribution of satellites to the determination of the Earth's gravitational potential. *Space Sci. Rev.* **2**, 355–437.

(15) (69) 1966 A suggested mechanism for the anomalous excitation of OH microwave emissions from H-II regions. *Nature* **210**, 611–612.

(16) (75) 1967 A new absolute determination of the acceleration due to gravity at the National Physical Laboratory, England. *Phil. Trans. R. Soc. Lond.* A **261**, 211–252.

(17) (106) 1972 The dynamical properties and internal constitutions of the Earth, the Moon and the planets. *Proc. R. Soc. Lond.* A **328**, 301–336.

(18) (108) The masses, densities and moments of inertia of Uranus and Neptune. *Observatory* **92**, 84–85.

(19) (112) 1973 The experimental determination of the constant of gravitation. In *Proc. 1st Int. Conf. on Precision Measurements and Fundamental Constants* (ed. D. N. Langenberg & B. N. Taylor), pp. 475–483. Washington: US Government Printing Office.

(20) (129) 1977 *Celestial masers*. Cambridge University Press.

(21) (158) 1984 (With Y. T. Chen & A. J. F. Metherell) An experimental test of the inverse square law of force at range of 0.1 m. *Proc. R. Soc. Lond.* A **394**, 47–68.

(22) (159) Halley in Istria, 1703; navigator and military engineeer. *J. Navig.* **37**, 1–23.

(23) (192) 1996 The 350th anniversary of the birth of G. W. Leibniz F.R.S. *Notes Rec. R. Soc. Lond.* **50**, 153–163.

(24) (195) 1997 Ladies in the scientific revolution. *Notes Rec. R. Soc. Lond.* **51**, 1–12.

(25) (199) An astronomical patriarch. Anna Cassini: Gio. Domenico Cassini, uno scienzato del Seicento. *Notes Rec. R. Soc. Lond.* **51**, 335–337.

(26) (200) *Edmund Halley: charting the heavens and the seas*. Oxford University Press.

(27) (242) 2005 A Roman correspondence: George Ent and Cassiano dal Pozzo, 1637–55. *Notes Rec. R. Soc.* **59**, 5–23.