Editorial: Biographical Memoirs, Volume 69

BY MALCOLM LONGAIR

WELCOME

The outstanding Memoirs in this, Volume 69 of *Biographical Memoirs*, demonstrate yet again the huge variety of personalities involved and the science they pursued. These include a President of the Society (Michael Atiyah), a Nobel Prize winner (Sydney Brenner) and two Foreign Members (Fotis Kafatos and Walter Munk). Without any prompting on the part of the editorial team, certain disciplines are prominently represented in this volume – five mathematicians, four geophysicists and three astrophysicists.

DIVERSITY AND EXTENSIBILITY

What is striking about the Memoirs is their enormous diversity, not only within the disciplines themselves, but also in the interests and intellectual development of those celebrated. The personalities range from exuberant, larger than life figures to the quiet and reclusive, from those who enjoyed playing on the international scene to those who remained close to home for a lifetime.

We pay full tribute to the authors of these excellent Memoirs for encapsulating the personalities of those celebrated. The editorial team is only too aware of the challenge of making innovative science accessible to readers of *Biographical Memoirs*, particularly in highly technical areas. Mathematics can be particularly challenging and yet the authors of the mathematical Memoirs have done wonders in making these accessible. I must confess that my heart sank when I read the referee’s report on the Memoir of Christopher Hooley: ‘Hooley’s field of analytic number theory is notoriously technical even amongst professional number theorists as a whole, let alone the community of pure mathematicians in general.’ But this was followed by the warmest of accolades: ‘it provides the best account I have ever read of many of the overall important ideas and results found by the experts in analytic number theory in the second half of the 20th century.’ Although this subject is very far from my fields of interest and I admit my inability to appreciate the arguments, the author of the Memoir succeeds splendidly in giving the full flavor of the ingenuity involved. This is not an isolated example of the great care and thought which goes into the production of the Memoirs.

There are many examples in this volume of how individuals changed direction in response to new challenges or extended their expertise to produce innovative science. Michael Atiyah’s remarkable distinction as a mathematician was complemented in the second half of his career...
by applying his mathematical innovations to gauge theories of elementary particles. In the resulting inverse process, Yang-Mills equations have turned out to be particularly fruitful for mathematicians. The theories of superspace, supergravity and string theories of fundamental particles were all areas of theoretical physics developed using ideas introduced by Atiyah. The same extensive approach to physical understanding is found in John Nye’s seminal contributions on dislocations in crystals, the complex physics of glacier flows and singular singular phenomena in optics. Alex Dalgarno’s deep understanding of molecular science led to major contributions to the fundamentals of atomic and molecular processes, to the study of terrestrial airglow features and the ozone layer and to pioneering applications of these ideas in molecular astrophysics and cosmology.

Equally engaging are the personalities and enthusiasms of the individuals. Sydney Brenner’s exuberance and wicked sense of humour are splendidly caught in his Memoir. Walter Munk’s omniscient studies of all aspects of oceanography and cognate geophysical studies are all-embracing. Dedication to improving the lives of citizens of developing nations is illustrated by the efforts of Michael Gale and Paul O’Brien. O’Brien’s deeply felt sympathies were symbolised by his burial in his honorary degree gown from the University of Zululand.

I have emphasised the extensive and diverse nature of the scientific activities and personalities of those commemorated in this volume. I would claim that these are essential features of a successful and influential career in science. Too often, the sciences are presented as a series of ‘silos’ without the many interconnections between them. This is not how many of the most important discoveries and inventions have been made. So much of contemporary science is interdisciplinary, resulting in greatly increased capability for carrying out investigations which were never possible before. This will be familiar to readers of Biographical Memoirs, but needs to be emphasized to the general public and particularly young people. The latter are inspired by the idea of opening up new fields for the benefit of all society. They need to be encouraged to take a broad, interdisciplinary approach to their learning, playing to their individual enthusiasms and talents.

Since Biographical Memoirs have been freely available online, there has been an encouraging increase in the number of readers. It is to be hoped that the inspiration of the Memoirs can be communicated to young people by their teachers and seniors. We need to do more to foster these aspirations, but in the meantime, can we impress upon all readers the importance of making it widely known that Biographical Memoirs are free to access and that they are a very good and inspiring read?

**Biographical Memoirs Volume 69**

There are 23 memoirs in this, the second 2020 volume of Biographical Memoirs. The following notes are intended to act as a guide to the different disciplines represented, with brief synopses of the achievements of the Fellows, largely taken from the memoirs’ summaries. These, and previous volumes, can be freely accessed on the Royal Society’s website.

**Astrophysics and Theoretical Physics**

**Alexander (Alex) Dalgarno** made great advances in the quantitative study of fundamental atomic and molecular processes. He made landmark contributions to the understanding of
collisionally induced charge transfer, rotational and vibrational excitation of molecules, spin exchange and ultracold chemistry. Applying these advances to atmospheric science, he greatly expanded the knowledge of terrestrial airglow features and the ozone layer. In molecular astrophysics, he applied that same systematic approach to studies of a range of environments from the early Universe to UV-irradiated interstellar clouds, shocks and supernova ejecta.

Donald Lynden-Bell was one of the most influential and pre-eminent astrophysics of his day. His contributions encompassed general relativity, galactic dynamics, telescope design and observational astronomy. His papers on stellar dynamics led to fundamental insights into the equilibria of elliptical galaxies, the growth of spiral patterns in disc galaxies and the stability of differentially rotating, self-gravitating flows. ‘Violent relaxation’ and ‘the gravothermal catastrophe’ were introduced in pioneering work on the thermodynamics of galaxies and negative heat capacities. His prediction that supermassive black holes may reside in the nuclei of nearby galaxies was confirmed by multiple pieces of independent evidence. His work on accretion discs led to the realization that the infrared excess in T Tauri stars was caused by protostellar discs around these young stars. He was the first to realize the importance of tidal streams as measures of the past history and present-day gravity field of the Galaxy.

David Olive was a theoretical physicist who made seminal contributions to the development of string theory and to our understanding of the structure of quantum field theory. In early work on S-matrix theory, he helped to provide the conceptual framework within which string theory was initially formulated. His work on supersymmetry in string theory made possible the whole idea of superstrings, the natural framework for string theory. Olive’s pioneering insights about the duality between electric and magnetic objects in gauge theories were way ahead of their time; it took two decades before his bold and courageous duality conjectures began to be understood.

Bernard Pagel was for many years the undisputed authority in the United Kingdom on the determination and interpretation of the abundances of the chemical elements in the Universe. His spectroscopic chemical analysis of stellar spectra not only improved methods to give greater reliability, but enable careful interpretation of the observed abundances in terms of nucleosynthetic processes. He pioneered simple analytic models of the chemical evolution of galaxies. He had a long-term interest in the abundances of helium which originates in the Big Bang and which provides major constraints on cosmology.

Cellular and Molecular Biology

Sydney Brenner was an extraordinarily influential and accomplished molecular biologist. He made seminal discoveries in how genetic information is used for protein synthesis, and established \textit{C. elegans} as one of the foremost model organisms for the study of development and neural function. He also pioneered techniques for genome analysis and was instrumental in establishing several outstanding centres of biological research around the world. He was awarded the 2002 Nobel Prize in Physiology or Medicine.

Michael Gale was an internationally well-known crop geneticist with a career devoted mostly to wheat genetics. He brought new knowledge and techniques into plant breeding that made a difference to crop improvement worldwide. His team also provided the worldwide cereal geneticists and breeding communities with technologies and genetic markers that accelerated the development of cereal genetics and facilitated more efficient plant breeding. He made major and influential contributions to international agricultural research, particularly targeted at developing countries.
Fotis Kafatos was a Greek developmental and molecular biologist and influential research leader who made tremendous contributions in the fields of genetics and genomics. He developed ‘cDNA cloning’, a technique that has been critical to modern molecular biology, and was a key figure in insect genome sequencing programmes. His team at Harvard was the first to clone an entire mammalian gene, and to demonstrate that gene regulation sequences were the same in evolutionarily distant animals.

Roger Slack, with Marshall (‘Hal’) Hatch, developed an essentially complete understanding of an alternative pathway of carbon flow in photosynthesis in higher plants, the C4 pathway, extending the earlier pathway developed for C3 photosynthesis. With Grattan Roughan, he made important contributions to understanding plant lipid metabolism, and with Roger Haslemore to malting barley breeding.

Chemistry and Crystallography

Kenneth Jack applied his knowledge of chemistry and skills in crystallography to the three main areas of materials science: metals, glasses and ceramics. In the 1940s and 50s he carried out classic studies of the interstitial alloys of the iron-carbon-nitrogen system; between 1957 and 1964, he made seminal contributions to glass technology; from 1964 onwards he pioneered a whole new field of oxy-nitride ceramics and glasses, the sialons, and in doing so put the North-East UK firmly on the international map as a centre of excellence in ceramic science.

Sydney Leach spent most of his scientific life in Paris, working principally at Orsay and, in his later years, at the Observatoire de Paris-Meudon. He was a pioneering advocate of synchrotron radiation, and a driving force for its use in spectroscopy and photodynamics, along with free-electron lasers, supersonic jets, coincidence spectroscopy and matrix isolation. His seminal studies of polyatomic molecular ions opened new vistas in cometary spectroscopy, polycyclic aromatic hydrocarbons, fullerenes and their possible roles in the chemistry of the interstellar medium and helping to instigate the newly developing subject of astrobiology.

Paul O’Brien brought a deep understanding and knowledge of classical coordination chemistry to bear on routes to thin films and nanoparticles of technologically important materials, particularly metal chalcogenides. His development of molecular precursor chemistry as a method of producing very high quality materials safely, inexpensively and on a large scale laid the foundations for the successful technological exploitation of quantum dots. He was passionate about the exploitation of science and engineering to improve society, both in the UK and around the world, most notably in Africa.

Mathematics

Michael Atiyah was the dominant figure in UK mathematics in the latter half of the 20th century. He made outstanding contributions to geometry, topology, global analysis and, particularly over the last 30 years, to theoretical physics. His most notable mathematical achievement, with Isadore Singer, was the Index Theorem which occupied him for over 20 years, generating results in topology, geometry and number theory. He won the Fields Medal in 1966 and the Abel Prize in 2004. His irrepressible energy and broad interests led him to take on many national roles, including the Presidency of the Royal Society, the Mastership of Trinity College Cambridge and the founding Directorship of the Isaac Newton Institute for Mathematical Sciences.
Frank Bonsall’s research interests focused primarily on functional analysis, the area of mathematics that brings together various strands of analysis under a single abstract framework, and on the related theory of linear operators on Banach spaces. He influenced a generation of young mathematicians with the elegance of his written and oral expositions, both of his own research and that of others.

Peter Chadwick’s research focussed primarily on wave propagation, making major contributions to the mathematical theory of elastic wave propagation in which he became a world-leading authority. He also made fundamental advances in the modelling of the thermo-elastic properties of rubberlike materials. He gave considerable service to the University of East Anglia and the scientific community in a number of capacities.

Edward Fraenkel began as an experimentalist at the Royal Aircraft Establishment, Farnborough, but his preoccupation with theoretical and mathematical aspects of aerodynamics led him to academia, working initially in aerodynamics and classical applied mathematics, but later in the modern theory of nonlinear partial differential equations and its applications to fluid mechanics. He made outstanding contributions to the mathematical theories of viscous flow separation, steady vortex rings and surface waves on water.

Christopher Hooley was one of the leading analytic number theorists of his day. His early work on Artin’s conjecture for primitive roots remains the definitive investigation in the area. His greatest contribution was the introduction of exponential sums into every corner of analytic number theory, bringing the power of Deligne’s ‘Riemann hypothesis’ for varieties over finite fields to bear throughout the subject. For many he was a figure who bridged the classical period of Hardy and Littlewood with the modern era.

Neuroscience

Eric Barnard was a protein biochemist who played a leading role in the delineation of the molecular components of neuromuscular transmission and the emergence of molecular neuroscience as a scientific discipline. His seminal contribution was the application of molecular biological methods to the study of many neurotransmitter receptors. Collaboratively, he developed the *Xenopus* oocyte system for the expression of receptors from total tissue mRNA. His was the first group to clone a neurotransmitter receptor subunit cDNA. His achievements led to the discovery of neurotransmitter receptor heterogeneity and the development of concepts of receptor families and super-families.

David Curtis was a pioneer in the identification of excitatory and inhibitory transmitters released at synapses in the central nervous system. He made major contributions to the identification of gamma-amino butyric acid (GABA) and glycine as inhibitory transmitters released at inhibitory synapses. His work laid the foundation for the subsequent acceptance that L-glutamate was the major excitatory transmitter.

Lawrence Weiskrantz was widely recognised as one of the world-leading researchers in cognitive neuroscience. While at Oxford, he led a series of ground-breaking neuropsychological studies of residual cognitive and behaviour processing in patients with amnesia and cortical blindness. His demonstration of residual, but unconscious, visually-driven behaviour in patients who were clinically blind from damage to primary visual cortex was his greatest legacy. Because of his pioneering work, the study of the neural substrates of unconscious cognitive processes is now an essential and prominent part of the cognitive neuroscience enterprise worldwide.
Anthony Laughton was an oceanographer whose research focussed on the shape of the seafloor, using underwater photography, ocean drilling, long-range side-scan sonar and scientific charting of the ocean floor. He joined the UK National Institute of Oceanography at Wormley, Surrey, becoming Director in 1978. He developed the first UK seafloor camera, was an enthusiastic supporter and user of the revolutionary Precision Echo Sounder and later of the GLORIA long-range side-scan sonar.

Stephen Moorbath spent almost the whole of his life in Oxford, where he became one of the world’s leading isotope geochemists. Using these techniques, he made major contributions in establishing the chronology of the geological and tectonic evolution of Precambrian crust in the Scottish Highlands and Islands, in West Greenland, Zimbabwe, South India and Ghana. He developed isotopic criteria for assessing the relative contributions of mantle and crustal sources to Tertiary igneous rocks in Scotland, Andean volcanics and the late Archaean granitoids of West Greenland. His abiding geological passion was the study of the early Archaean, especially the Godthåbsfjord and Isukasia areas of West Greenland.

Walter Munk was a leading geophysicist and physical oceanographer. He and Harald Sverdrup developed wave prediction schemes used by the Allies in World War II to evaluate whether amphibious landings would be feasible. His postwar research included major contributions to the understanding of ocean waves, as well as ocean circulation, tides, internal waves, mixing processes, and many other phenomena. He showed how variations in the Earth’s rotation contained a wealth of valuable geophysical information and showed how acoustic transmissions could be used to map ocean eddies and currents as well as to monitor temperature changes of whole ocean basins.

John Nye was an internationally renowned physicist who made fundamental contributions to the understanding of crystals, ice and light. He explored defects in crystal structures, in particular continuous distributions of dislocations. He explained the mechanics of the flow of glaciers, their advance and retreat, and how this depends on the underlying topography as well as how water flows beneath and within them. He was a pioneer of the study of optical singularities: stable caustics in geometrical optics, phase singularities in scalar waves and lines of circular and linear polarization in electromagnetic fields.

Acknowledgements

First, let me repeat our indebtedness to the authors of the Memoirs for their outstanding work in writing biographies of lasting value. These are authoritative and full of interest and pleasure for the insight they provide into the lives and works of a number of outstanding scientists. We are grateful to the United States National Academy of Sciences (NAS) for allowing us to co-publish their Memoir of Fotis Kafatos and to the Australian Academy of Sciences (AAS) for permission to republish their Memoir of David Curtis. I am also personally indebted to the Editorial and Production teams at the Royal Society, whose names and roles are listed on the title page. Their outstanding efforts have enabled us to continue the enhanced rate of publication of the Memoirs while maintaining the excellence of their content and high production values. It is a pleasure to acknowledge the efforts of the Editorial Board who have been very helpful indeed in supporting the increased activity by suggesting Memoir writers, helping with refereeing and keeping a sharp eye on all aspects of the growth of Biographical Memoirs.
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