McCrea, Sir William Hunter [Bill]

(1904–1999)

- Leon Mestel

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McCrea, Sir William Hunter [Bill] (1904–1999), astrophysicist, was born on 13 December 1904 in Dublin, the elder son and eldest child of Robert Hunter McCrea (1877–1956), a schoolmaster, and his wife, Margaret, *née* Hutton (1879–1962). His parents, of Irish stock, were strict nonconformists, but by the age of eighteen he had become a confirmed Anglican, a faith he retained all his life. By 1907 the family had moved to Chesterfield, Derbyshire, where he attended first the central (elementary) school and then the grammar school, from which he won an entrance scholarship in mathematics to Trinity College, Cambridge. He read for the mathematical tripos, becoming a wrangler in 1926.

As an undergraduate McCrea specialized in those branches of mathematical physics which were stimulating exciting research at Cambridge, and after graduating he began research as one of the many pupils of R. H. Fowler (to whom he paid warm tribute on his centenary in 1989). Although he worked initially on basic problems in quantum physics and relativity, and also on related problems in pure mathematics, his interest gradually focused on the application of theoretical physics to the astronomical universe, ranging from the constitution of stellar atmospheres, through the formation of planets and stars, to cosmology, the study of the universe as a whole. Recognition came early with a Cambridge University Rayleigh prize, a Trinity College Rouse Ball senior studentship, a Sheepshanks exhibition, and an Isaac Newton studentship.

Academic career

After spending the year 1928–9 as visitor at Göttingen University in Germany, McCrea began his rapid rise up the regular academic ladder as lecturer in the Edinburgh department of mathematics, headed by Edmund Whittaker. While at Edinburgh he met Marian Nicol Core (1911–1995), second daughter of Thomas Webster, a mining engineer, of Burdiehouse, Edinburgh. They were married on 28 July 1933. They had two daughters, Isabella and Sheila, and a son, Roderick.

In 1932 McCrea became reader in mathematics at Imperial College, London. In 1936 he moved to Queen's University, Belfast, as professor of mathematics. In 1943 he was given leave from Belfast while doing operational research in the Admiralty in the team led by Patrick Blackett. After VE-day in 1945, with the rank of captain in the Royal Naval Volunteer Reserve, he had the task of interviewing German naval officers in Schleswig-Holstein. He did not return to Belfast, having in 1944 been appointed professor at Royal Holloway College, London, and taken up the appointment at the end of the war.

McCrea remained at Holloway until 1966, when he took up his last appointment as research professor of theoretical astronomy (supported by the Science Research Council) at the recently established University of Sussex. Shortly after the war, he had urged the setting up of a national institute of theoretical astronomy. The subsequent rather tortuous negotiations led to the establishment of the Institute of Theoretical Astronomy in Cambridge (later united with the Cambridge observatories to form the Institute of Astronomy), and the smaller Sussex Astronomy Centre, with McCrea as the first research professor and Roger Tayler as the first professor supported by the University Grants Committee. With the enthusiastic support of the astronomer royal, Sir Richard Woolley, and the other senior staff at the Royal Greenwich Observatory, McCrea and Tayler jointly put Sussex on to the world astronomy map.

Contributions to astrophysics and relativity

McCrea was a versatile astrophysicist. Many of his papers profoundly affected the way in which subsequent workers formulated problems. One of his earliest papers proposed turbulent pressure as the means of support of the solar chromosphere—the layer between the surface and the hot corona, observable through the emission of spectral lines by calcium and other elements. His paper 'Model stellar atmospheres', published in 1931, followed on from the basic mathematical treatments of Karl Schwarzschild, Arthur Eddington, and E. Arthur Milne. For a gas of given chemical composition McCrea pioneered the now standard procedure that constructs the degree of ionization and so also the coefficient of opacity by the direct application of quantum mechanics and statistical mechanics. From his careful studies he came to the cautious but prescient conclusion that 'hydrogen is of importance in some stars in some parts of their spectra' (W. H. McCrea, Model stellar atmospheres, *Monthly Notices of the Royal Astronomical Society*, 91, 1931, 836–57). The later discovery by Rupert Wildt of the strong contribution to the opacity in cool stars of the negative hydrogen ion effectively removed the objections, noted by Milne, to hydrogen being in fact the dominant element, as had been urged earlier by Cecilia Payne-Gaposchkin, and which McCrea himself had surmised from his study of the chromosphere. This conclusion—of great cosmological significance—was supported by the parallel studies of Bengt Strömgren and others, extending Eddington's theory of stellar structure.

McCrea had a lifelong interest in the physics and dynamics of stellar and planetary formation. Just before his birth, James Jeans had introduced the picture of the breakup of a uniform gaseous medium through ‘gravitational instability’. A rigorous discussion of this fragmentation into bodies with the ‘Jeans mass’ requires a self-consistent treatment of the initially unperturbed medium. Parallel to Rolf Ebert and William Bonnor, McCrea gave an approximate but elegant treatment of the equilibrium of an isothermal gas cloud, as a balance between internal pressure, self-gravitation, and external pressure. Under steadily increasing external pressure, the cloud density goes up until the Jeans mass becomes less than the cloud mass, and gravitational collapse begins. As emphasized by Fred Hoyle, for the collapse to persist and lead to possible breakup into masses of stellar order, the heat of compression must be largely radiated away. Together with Derek McNally, McCrea pioneered the study of the formation of molecules in dusty interstellar clouds, especially the hydrogen molecule, which is a powerful cooling agent.

The comparatively few but very bright O and B stars have lifetimes much less than the galactic age. McCrea explored the possibility that they are born as stars of moderate mass but subsequently grow by gravitational accretion of gas from the interstellar medium, as discussed by Hoyle, Ray Lyttleton, and Hermann Bondi. He argued that this would occur occasionally when an already slowly moving star enters a gas cloud and is reduced almost to rest through dynamical drag. However, he was well aware that studies in cosmogony which ignored angular momentum could be suggestive but not definitive. One of his later papers attempted to give a unified picture of the formation of the sun and the surrounding planets through the spontaneous evolution of a rotating disc with a highly supersonic turbulence. He argued that the very process by which the turbulence decays, by the mutual collision and adherence of 'floccules', moving randomly and with supersonic speeds, acts broadly like a gross macro-viscosity, yielding a slowly rotating, condensed core containing most of the mass, surrounded by a Keplerian disc containing very little mass but most of the angular momentum. Altogether his contributions to cosmogony warranted a permanent place in the literature, though, like many of his generation, he was slow to appreciate the importance of electromagnetic processes in astronomy.

McCrea made many contributions to both special and general relativity theory. In a famous controversy with Herbert Dingle, he vigorously rebutted misunderstandings of the so-called ‘twin paradox’ that kept reappearing in the literature. Together with Arthur Milne he showed that the various cosmological models emerging from Einstein's theory had simply-understood Newtonian analogues. In a profound paper entitled 'Observable relations in cosmology' (*Zeitschrift für Astrophysik*, 9, 1935, 290–314), the first in a series, he spelt out the different possible definitions of distance in cosmology, showing how counts of galaxies and their observed change of brightness with distance can in principle be used to constrain the parameters in standard homogeneous, isotropic models of the expanding universe. Later he argued that the cosmical constant Λ that appeared in Einstein's modified version of general relativity, leading to the 'cosmical repulsion', can be regarded as determining the zero point of density and stress. Einstein subsequently regretted his introduction of the Λ-term, calling it 'the biggest blunder of my life' (G. Gamow, *My World Line*, 1970, 64). However, most other workers in relativistic cosmology were happy to retain it, and in fact it is currently cited as a likely explanation of the observationally inferred acceleration of the cosmical expansion.

A decade or so later, when evolutionary cosmology appeared to face observational difficulties, McCrea showed a commendable flexibility of mind in taking seriously the alternative steady-state theory proposed in 1948 by Thomas Gold, Hermann Bondi, and Fred Hoyle. The experience gained from his thorough studies of the mathematical structure of general relativity enabled him to show how, with a suitable modification of the equation of state, the steady-state model could be treated within the framework of general relativity. (Later work on inflationary ‘big bang’ cosmology was likewise concerned with the appropriate equation of state.) However, he later accepted that the steady-state theory, at least in its original form, could no longer hold up against the accumulating evidence from optical and radio observations. In his later years he appeared in private conversation to backtrack from the theme of his earlier work, expressing a growing scepticism about the feasibility of the whole cosmological enterprise.

Publications and honours

In addition to his many papers and reviews, McCrea wrote the texts *Relativity Physics* (1935) and *Analytical Geometry of Three Dimensions* (1942), the less technical *Physics of the Sun and Stars* (1950), a history of *The Royal Greenwich*

Observatory (1975), and, together with Tayler, the second volume of the *History of the Royal Astronomical Society* (1987). Over his long life, he knew personally many of the great figures in twentieth-century physics and astronomy. His personal recollections of Jeans and Eddington, his essay review on the origin of wave mechanics written for Erwin Schrödinger's centenary, and his article 'Cambridge physics, 1925–1929: diamond jubilee of golden years', published in the *Interdisciplinary Science Reviews* for 1986, were all lasting contributions to the history of science.

McCrea was elected a fellow of the Royal Society of Edinburgh in 1931 and of the Royal Society of London in 1952. He received many invitations from all over the world. He was a bye-fellow at Caius College, Cambridge, and visiting professor or lecturer at Berkeley, the Case Institute at Cleveland, the University of British Columbia at Vancouver, Louvain, Cairo, Istanbul, and Otago, among others. Like Tayler's, his services to astronomy went far beyond his technical contributions. He was successively council member, secretary, president, foreign correspondent, and treasurer of the Royal Astronomical Society, and for some years he was editor of *Observatory* and of the society's *Monthly Notices*. He received the society's gold medal in 1976. He also served on the councils of the Royal Society, of the London Mathematical Society, and of the Royal Institute of Philosophy, and gave public service as a school governor. He was knighted in 1985.

McCrea was a kindly, rather shy man with hidden reserves of strength, and remained intellectually active well into his nineties. His personal integrity was patent; his public services, especially to the Royal Astronomical Society, were so much appreciated because everyone instinctively trusted him. His somewhat formal manner was rather misleading: he was a gregarious figure, especially committed to the Royal Astronomical Society and the Royal Society dining clubs. His death, in Lewes, Sussex, on 25 April 1999, was mourned worldwide by colleagues and friends, and not least by former undergraduate and graduate students, who recalled with gratitude his help and warm encouragement. He was buried at Lewes, survived by his three children, his wife having predeceased him.

Sources

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- *The Scotsman* (21 May 1999)
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- *WWW*
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Archives

- CAC Cam., MSS
- Royal Holloway College, Egham, Surrey, papers

Likenesses

- photograph (as president of the Royal Astronomical Society), Burlington House, Piccadilly, London
- photograph, repro. in McCrea, ‘Clustering of astronomers’
- photograph, RS
- photograph (with Subrahmanyan Chandrasekhar), repro. in Barrow and McNally, ‘Sir William Hunter McCrea’, 36

Wealth at Death

£302,643—gross; £299,665—net: probate, 16 July 1999, *CGPLA Eng. & Wales*