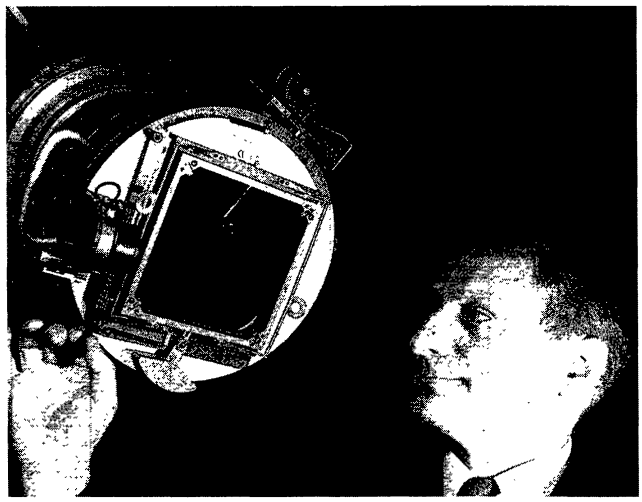
WILLIAM MARKOWITZ, 1907–1998

William Markowitz, an astronomer at the US Naval Observatory from 1936 to 1966, died in Pompano Beach, Florida on 10 October 1998. He served as Director of the Observatory's Time Service Department (1953–1966) during a period when timekeeping and time dissemination underwent rapid progress.

His principal research concerned the speed of rotation of the Earth and the motion of its pole; the polar motion occurring at decadal time scales known as the ''Markowitz wobble'' is named after him. Markowitz was born February 8, 1907 in Mlec, Austria, where his mother was visiting from her native Poland. In 1910 his family immigrated to Chicago. Interested in astronomy from an early age, Markowitz obtained his PhD in astronomy from the University of Chicago in 1931, working under W. D. MacMillan and writing his dissertation on the statistics of binary stars. During this period he also worked at Yerkes Observatory under Frank Ross. After teaching at Pennsylvania State College, he joined the US Naval Observatory in 1936, working under Paul Sollenberger and with Gerald Clemence. He spent almost his entire career in the Time Service Department, except for the years 1949–1952, during which he made visual observations of double stars. One of Markowitz's early duties was operating the Photographic Zenith Tube (PZT), designed by Ross and used at the Naval Observatory beginning in 1915 to observe astronomical latitude variations, and since 1934 to determine Universal Time.

In 1949, when the Observatory established a new time station near Miami, Florida, Markowitz and Sollenberger designed a new and improved PZT. The variation of latitude, also determined with the PZT, was one of the chief interests of Markowitz throughout his career; it was the analysis of this data that led to his contributions to the study of polar motion. Markowitz directed the Time Service Department during a period when methods for more uniform and accurate time were being devised. When ''Ephemeris Time'' was proposed in the early 1950s based on the orbital motion of the Earth rather than its rotation, Markowitz devised a practical means for its determination by inventing the dual-rate Moon camera bearing his name. The first such camera was placed in operation on the 12-inch refractor at the Naval Observatory in June 1952, and 20 cameras of a second model were used around the world during the International Geophysical Year (1957–1958). With data from these cameras, from 1955–1958 Markowitz worked with Louis Essen at the National Physical Laboratory in Teddington, England to calibrate the new atomic clocks in terms of the Ephemeris second. The number they determined, 9, 192, 631, 770, became the fundamental frequency of cesium atomic clocks, and has been used as the definition of the second internationally since 1967. In 1958, Markowitz also devised the first system of Atomic Time, designated A.1. As Director of the Time Service, Markowitz was fundamentally concerned with improvements to the dissemination of time. At the IAU meeting in Dublin in 1955 he proposed the system of UT0, UT1 and UT2, which corrected universal time successively for polar motion and seasonal variations in the Earth's rotation. The system went into effect within months, with UT2 being disseminated internationally. Markowitz was a participant in experiments in synchronizing time around the around the world using artificial satellites and atomic clocks transported by airplanes. He also contributed to the Navy system of time and frequency transmissions and the control of precise time via Loran-C and the Transit navigation satellite. Markowitz was heavily engaged in international cooperation in time. He served as President of the Commission on Time of the International Astronomical Union from 1955 to 1961, and was also active in the International Union of Geodesy and Geophysics, the American Geophysical Union, and the International Consultative Committee for Definition of the Second. After retiring from the Naval Observatory, Markowitz served as Professor of Physics at Marquette University (1966–1972), and Adjunct Professor at Nova University in Florida. Markowitz married Rosalyn Shulemson in 1943. He is survived by a sister, Mary, son, Toby, daughter-in-law, Dorothy, and granddaughter, Alison. An oral history interview is on deposit in the Library of the US Naval Observatory.



William Markowitz. *Photo courtesy of the US Naval Observatory*

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SIR WILLIAM MCCREA, 1904–1999

Sir William Hunter ('Bill') McCrea, doyen of British astronomy, held in respect and affection by all generations, died peacefully on April 25, at the age of 94. McCrea was born in Dublin, the eldest child of a schoolmaster. His parents were strict members of the Plymouth Brethren, 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 Bill 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 Mathematics Tripos, becoming a Wrangler in 1926. He specialised 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

Sir William McCrea's official portrait as President of the Royal Astronomical Society, 1961–1963. *Photo courtesy of the Royal Astronomical Society, London.*

tribute on his 1989 Centenary). Although initially he worked 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. After spending the year 1928-29 as visitor in Goettingen, McCrea began his rapid rise up the regular academic ladder as Lecturer in the Edinburgh Department of Mathematics, headed by Edmund Whittaker, followed by four years as Reader 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 M.S. Blackett. After VE-day in 1945, with the rank of Temporary Captain in the RNVR he had the task of interviewing German naval officers in Schleswig-Holstein. He in fact did not return to Belfast, as in 1944 he had been appointed Professor at Royal Holloway College, London, taking up the appointment at the end of the War. McCrea remained at Holloway till 1966, when he took up his last appointment as SRC-supported Research Professor of Theoretical Astronomy 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 (now united with the Cambridge Observatories to form the Institute of Astronomy), and a smaller Astronomy Center in Sussex, with McCrea as the first Research Professor and the late Roger Tayler as the first UGC-supported professor. 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. McCrea was a versatile astrophysicist. Many of his papers have had a permanent effect on the way subsequent workers have formulated the various problems under discussion. He was an early advocate of the now accepted view that stars should have a high hydrogen content. He pioneered study of the formation in dusty interstellar clouds of the hydrogen molecule, a crucial cooling agent, and of other molecules, and gave an elegant treatment of the way such clouds, when externally compressed, can reach densities high enough for gravitational collapse to ensue, leading possibly to break-up into stars.

His other contributions to cosmical gas dynamics included a proposal for turbulent support for the solar chromosphere, and detailed studies of the gravitational accretion of interstellar gas by already formed stars; though like many of his generation, he was slow to appreciate the importance of electromagnetic processes in astronomy. Concerning relativity theory, he vigorously rebutted misunderstandings of the so-called 'twin paradox' that persisted in reappearing in the literature. He also pointed out that the cosmical constant that appears in Einstein's modified version of general relativity can be interpreted as the energy density of the vacuum. Together with Edward A. Milne he showed that the various cosmological models emerging from Einstein's theory have simply understood Newtonian analogues. When evolutionary cosmology appeared to face observational difficulties, he showed a commendable flexibility of mind (a quality not always visible in members of the scientific Establishment) in his taking seriously the alternative steady-state theory, proposed by Hermann Bondi, Thomas Gold and Fred Hoyle, and in fact showed how the model could be treated within the mathematical framework of general relativity; but he later accepted that, at least in its original form, the theory could no longer hold up against the accumulating evidence from optical and radio observations. In his later years, he expressed scepticism about the feasibility of the whole cosmological enterprise.

In addition to his many papers and reviews, McCrea wrote the texts *Relativity Physics* and *Analytical Geometry of Three Dimensions*, the less technical *Physics of the Sun and Stars*, and together with Tayler, the second volume of the *History of the Royal Astronomical Society*. Like Tayler, his services to astronomy went far beyond his technical contributions. He was successively Council member, Secretary, President, Foreign Correspondent and Treasurer of the RAS, and for some years he was editor of *Observatory* and of the RAS *Monthly Notices*. He served on the Councils of the