

Biographical Encyclopedia of Astronomers

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Chapman, Sydney

Born in Eccles near Manchester, England, 29 January 1888

Died in Boulder, Colorado, USA, 16 June 1970

British geophysicist Sydney Chapman contributed a number of ideas to the physics of magnetic fields and ionized gases, particularly those of the Earth and of the solar wind interacting with the Earth. He began his advanced education at a technical institute, now the University of Salford, in 1902, going on, under a competitive scholarship, to the University of Manchester in 1904 and receiving his first degree, in engineering, in 1907. Chapman added Manchester B.Sc. and M.A. degrees in mathematics before moving on, again under a scholarship, to Trinity College, Cambridge. Although he could not receive his mathematics degree until 1911, he had completed the examinations in 1910 and accepted

a position as one of the chief assistants at the Greenwich Observatory under Frank Dyson. The other chief assistant was Arthur Eddington. Chapman's first published paper, in 1910, dealt with the kinetic theory of gases, which he had taken up at the urging of Joseph Larmor

At Greenwich Observatory, Chapman established a station for regular measurements of the Earth's magnetic field, and geomagnetism, to which he gave its name, remained one of his major fields of activity throughout his life. Appointed to a fellowship at Trinity College and a lectureship in mathematics at Cambridge University in 1914, Chapman was regarded as essential to education and exempted from military service. A pacifist, he did, however, return to Greenwich Observatory and its vital timekeeping and other activities in 1916–1918 as a replacement for Harold Spencer Jones, who was serving the country. By the time of World War II, Chapman's attitude had changed, and he served as a scientific advisor first to the Ministry of Home Security (1942–1943) and then to the Army Council (1943–1945).

Soon after returning to Cambridge, where some of his work had already clarified the importance of convection and diffusion in transporting both material and heat in stars, Chapman was appointed professor of mathematics at the University of Manchester (1919) as successor to Horace Lamb, who had been his advisor there. He married Katherine Nora Steinthal, daughter of the university treasurer, in 1922; she died in 1967, and their four children survived him. While at the University of Manchester, Chapman had apparently shown that the magnetic field of the Sun could influence only its very near environment. This was proven incorrect by Thomas Cowling, and after Chapman was elected to the chief professorship of mathematics at Imperial College, London, in 1924, one of his first actions was to hire Cowling there. Another of his important London appointments was that of William McCrea. Chapman's first student (Ph.D.: 1931) there was Vincenzo Ferraro. Together they developed the first theory of how a wind from the Sun, ionized but electrically neutral, would interact with the Earth's magnetic field. Another collaboration during this period, with Edward Milne, demonstrated that the Earth's upper atmosphere was not chemically homogeneous and that charged particles would penetrate into it, producing aurorae. A series of papers by Chapman and Ferraro in the early 1930s showed that what is now called the solar wind would form a comet-shaped cavity around the Earth when it impacted the terrestrial magnetic field. This is now called the magnetosphere and is the subject of a significant part of space physics.

Part of the Earth's magnetic response to charged flow from the Sun occurs in the atmosphere, but, as Arthur Schuster had first suggested in 1889, more important is the induction of currents and fields in the ground and ocean. Chapman and Alfred Whitehead (who had been his predecessor at Imperial College) worked out the beginnings of the theory of those processes in 1923. An extension of this work won Chapman the 1929 Adams Prize from Cambridge University, a condition of which was the publication of a book. The book finally appeared as a collaboration with his old friend Julius Bartels of Göttingen in 1940, under the title *Geomagnetism* (Oxford: Clarendon Press). They had to exchange evidence through Switzerland, owing to the outbreak of World War II (and the process suggests that Chapman was still not entirely committed to the war effort).

In 1946, Chapman succeeded A. E. H. Love as Sedilian Professor of Natural Philosophy at Oxford University. Among the topics he tackled was the response of the Earth's atmosphere to day/night changes in the gravitational and heating effects of the Sun and Moon. Chapman showed that an important factor was the absorption of sunlight by ozone, carbon dioxide, and water vapor very high in the atmosphere. This raises and lowers the upper-atmosphere layers, contributing to the drag on satellites and the decay of their orbits. Another of his very important contributions over the years was the recognition that the upper atmosphere must have a layer of permanent ionization about 100 km up. This is now recognized as the lowest layer of the ionosphere

Chapman reached retirement age at Oxford University in 1953 but immediately moved on, firstly, to spearheading, as president of the Special Committee (1953-1959) for the International Geophysical Year, the coordination of a wide range of scientific activities to be carried out during the 1957/1958 maximum of the solar activity cycle, and, secondly, to shared research and advisory positions at the High Altitude Observatory in Boulder, Colorado, USA, and the Geophysical Institute at the University of Alaska. With the last of his students there, Syun-Ichi Akasofu, he completed more than 25 joint papers dealing particularly with polar and auroral substorms and a book on solar-terrestrial physics His last book, summarizing the work of many years on Atmospheric Tides, appeared jointly with R. S. Lundzen in 1970. A final major review of The Earth, prepared for the 150th anniversary of the Royal Astro-nomical Society, was published after Chapman's death.

Chapman held major offices in, and received prizes and medals from, the Royal Society, the Royal Astronomical Society, the London Mathematical Society, the Royal Meteorological Society, and the Physical Society (all United Kingdom), and is said to have declined a knighthood. He was a foreign or honorary member of the United States National Academy of Sciences and scientific academies in six other countries. Chapman received a total of seven honorary doctorates.

Virginia Trimble

Selected Reference

Akasofu, Syun-Ichi, Benson Fogle, and Bernhard Haurwitz (1968). *Sydney Chapman, Eighty, from His Friends*. Colorado: University of Colorado Press