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(*b*. Eccles, near Manchester, England, 29 January 1888; *d*. Boulder, Colorado, 16 June 1970)

geophysics, natural philosophy.

Chapman man was the second son of Joseph Chapman, chief cashier of a textiles firm, and of his wife, Sarah Gray. Their family was a nonconformist one of strict principles, but Sydney's attitude to religion grew steadily more relaxed with time. In 1922 he married Katharine Nora Steinthal; they had three sons and one daughter. He enjoyed good health. partly because of daily exercise (cycling, swimming, walking). He was elected fellow of the Royal Society of London in 1919.

Initially Chapman's father did not envisage his son as a candidate for higher education. However. aided by the advice of friends who recognized his ability, and by scholarships, Sydney's horizons expanded until he attained an M.Sc. in mathematics at Manchester University (1908) and a first class in the mathematical tripos at Cambridge University (1911). Even before he had completed the residence requirements for the tripos, he began research; his first paper was in pure mathematics, although Joseph Larmor suggested as a suitable subject one of the unsolved problems of gas theory.

What proved decisive for Chapman's future research, however, was his acceptance of an offer by Frank Dyson, the astronomer royal. of a post as senior assistant at the Greenwich Observatory. There Dyson set him to supervise the installation of new instruments in the magnetic observatory. Chapman noted that "magneticians," though assiduous in collecting data about variations in the geomagnetic field, spent little time seeking their interpretation. Encouraged by Dyson and Arthur Schuster, he set to work to rectify this. Thus began his lifelong study of the influences of the sun and the moon on terrestrial phenomena.

Chapman enjoyed meeting the distinguished people who came to visit Greenwich but found the observatory routine restrictive. Thus in 1914 he left Greenwich and returned to Cambridge as a college lecturer. During World War I his religious principles made him a pacifist. He was given exemption from military service but was asked to help the deplcted Greenwich staff (1916–1918).

Despite his moves, the years 1912 to 1919 were a period of intense scientific activity for Chapman. In 1917 he, and independently David Enskog in Sweden, gave a solution to the hitherto unsolved problems of the viscosity, thermal conductivity, and diffusion of gases. They identified the hitherto overlooked phenomenon of thermal diffusion, about which Chapman always showed a paternal pride.

In four massive papers (1913–1919) Chapman (following Schuster) examined the regular variations in the geomagnetic field arising from tidal flows in the ionosphere. He gave an improved estimate of the total conductivity of the ionosphere that depended on properties of the ionosphere not yet accessible to observation. He also showed that the lunar geomagnetic tide depends on the variable ionizing effect of solar radiation. In 1918 Chapman isolated a lunar atmospheric tide at Greenwich from sixty years of barometric records, a tide that George Airy had been unable to identify because of its smallness. He followed this up during the next thirty years with determinations of lunar tides at numerous stations scattered over the surface of the globe.

Also in 1918 Chapman made a first attempt at a theory of magnetic storms, which are sudden, irregular changes in the geomagnetic field followed by a slower recovery pattern. The theory was soon abandoned as unsound, but the preliminary analysis of storm morphology was to prove invaluable.

In 1919 Chapman was appointed to succeed a former teacher, Horace Lamb, as professor of mathematics at Manchester. He was there until 1924. when he accepted an invitation to become chief professor of mathematics at Imperial College, London. He was succeeded at Manchester by E. Arthur Milne, who had worked with him on upper-atmosphere problems at Cambridge.

After 1920 Chapman's next period of intense research activity was in the years 1928 to 1932. In 1922 and 1928 he extended his gas-theory methods to estimate the electrical conductivity of plasmas In 1930 he joined with a junior colleague, Albert T. Price, to study what could be inferred about the earth's interior from surface magnetic variations With a research student, V. C. A. Ferraro, he produced the first satisfactory theory of the initial phase of magnetic storms (1931)—that they were due to compression of the geomagnetic field by plasma streams emanating from the sun. The Chapman-Ferraro theory explained only one feature of magnetic storms; it treated neither the later phases nor the auroras that regularly accompany the storms. For this reason it was strongly criticized in 1939 and 1940 by Hannes Alfvén, who produced a rival theory that was especially

concerned with auroras. The most significant feature of the Chapman-Ferraro theory was its recognition, twenty years before the postwar explosion of interest in plasmas, that the behavior of plasmas is essentially different from that of single charged particles.

In the 1931 Bakerian Lecture to the Royal Society. Chapman gave a trailbreaking discussion of the effects of solar ultraviolet radiation on the earth's upper atmosphere. He provided a standard theory of ionized layer formation in the lower ionosphere with which later observations could be compared and gave an enlightening account of photochemical reactions in the upper atmosphere. At that time experimental data were at best only partially available; his aim was to point the way to the observers.

In the years 1933 to 1940 Chapman, always an internationalist, made no secret of his distaste for Hitler and did all he could to get refugee scientists settled in suitable posts. He maintained friendly relations with German scientists, however, and with one of them, Julius Bartels, he worked sporadically, beginning in 1929, on a treatise called *Geomagnetism* that was published in 1940. A second book, on which Chapman had begun work much earlier. *The Mathematical Theory of Non-uniform Gases*, had been published in 1939. with T. G. Cowling as coauthor. This book expounded the 1917 gas theory of Chapman and Enskog along with later developments, especially some for which David Burnett was responsible. Both books became standard texts,

In 1933 Chapman and Ferraro completed the presentation of their theory, and in 1937 Chapman drew his work on atmospheric tides to an end. In 1938, with E. Harry Vestine, he calculated the current system of geomagnetic disturbance, on the (inexact) assumption that the currents flow only in the ionosphere. This, and work on the books, left him time only for minor pieces of work before the war. During the war, no longer a pacifist, he undertook civilian war work. ultimately (1943–1945) working for the Army Council on problems of military operational research.

In 1946 Chapman became Sedleian professor of natural philosophy at Oxford. He did not appreciate the relatively secondary status he found allocated to science there and sought to improve that status by giving general science lectures to nonscientists. He also supervised research students who were later to make their mark, including Franz D. Kahn and K. C. Westfold. His status, however, was becoming that of elder statesman and counselor rather than that of producer of exciting new ideas.

Determined not to let himself be retired when he reached the official age, in 1953 Chapman resigned his Oxford chair and took up a research post in Alaska. In 1955 he added a similar post at the High Altitude Observatory in Boulder, Colorado, sharing his time between these two and institutes throughout the world. He also made short visits to secure the cooperation of groups in many countries in the work of the International Geophysical Year (IGY) of 1957 and 1958, of whose organizing committee he was president. His own especial contribution to the work of the IGY was as reporter of the results of auroras, in which he had now become deeply interested.

Soon after the IGY, Chapman was joined by SyunIchi Akasofu, a young geophysicist who had already done good work in his native Japan. Their cooperation over the decade 1960 to 1970 was remarkably fruitful. Chapman's great experience being admirably complemented by Akasofu's freshness of approach. They worked together on geomagnetic storms and auroras, drawing on recent discoveries about the van Allen belts, the magnetosphere, and the solar wind. Other collaborators during those years were Lawrence H. Aller. Peter C. Kendall. Joseph C. Cain, Marahira Sugiura, J. C. Gupta, and S. R. C. Malin.

In his last years Chapman tried, through books and review papers, to make generally available the wide knowledge he had accumulated during his career, Two of his longer papers were republished as books: *Solar Plasma, Geomagnetism and Aurora* (1963) and (written with Richard S. L, Lindzen) *Atmospheric Tides* (1970). At his death Chapman had largely completed his share of a new and comprehensive book (written with Akasofu), *Solar-Terrestrial Relations*, which was published in 1972. He died on 16 June 1970, after a few days' illness.

Chapman's most distinctive personal characteristics were kindliness, persistence, integrity, and simplicity. Those who penetrated his surface reserve found him always ready to help, and his many collaborators were made to feel increased in stature by working with him. He often returned to particular topics time and again to extend a partial solution. Chapman had a strong sense of duty and encouraged high standards in others. If convinced that a course of action was right, he would take it, even if it meant defying convention. When convinced he had made an error, he was always ready to acknowledge it. A simple directness pervaded both his writings and his way of life.

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T. G. Cowling