

George Ellery Hale, For. Mem. R.S., Hon. F.R.S.E.

BY the death, on February 22, 1938, of George Ellery Hale, astronomy has lost one who notably influenced the progress of the science, both by his outstanding powers of organisation and by his individual researches. The Observatories of Yerkes and Mount Wilson remain as monuments to the memory of Hale the organiser, and a long record of published research has been recognised by many honours, including the award of the Royal Astronomical Society's Gold Medal in 1904, and the Copley Medal of the Royal Society in 1932.

Hale was born in Chicago on June 29, 1868. His interest in practical astronomy dates from his boyhood, when with the aid of a small grating spectroscope he observed the solar spectrum, and compared it with flame and arc spectra. He entered the Massachusetts Institute of Technology in 1886 and graduated in 1890. During this period he officially studied mathematics, physics and chemistry, but he found time to serve as a volunteer assistant at Harvard Observatory, and tried out his first spectroheliograph in 1889. This was the forerunner of the perfected instrument, the completion of which was announced in 1892, and which provided a means of photographing the sun's disc in monochromatic light. In the hands of Hale himself, Deslandres and others it has proved to be an effective instrument of research, and the production of it alone would rank as an instrumental achievement of the highest order.

After his graduation, Hale was offered the opportunity of developing his spectroheliograph at Lick Observatory. He declined this offer, and established with the aid of his father a private observatory at Kenwood, in a suburb of Chicago. In 1891 he photographed the spectrum of a prominence, being the first to do this without the aid of an eclipse. Important studies of the whole solar disc, using his newly perfected spectroheliograph, were carried out at about this time, and Hale discovered the presence of large bright calcium flocculi on the disc, particularly around sunspots.

The three years' research at Kenwood were interrupted by a visit to Europe in 1891, where Hale met many astronomers and spectroscopists and studied their equipment. He spent the winter of 1893-94 at Berlin, where he attended Planck's lectures on thermodynamics. But his private

research at Kenwood was destined to be of short duration. In 1892 his pioneer work had won him recognition by the University of Chicago, of which he became an Associate Professor of Astrophysics. With the backing and help of the President of the University he formed plans for the building of a great observatory, and eventually Mr Yerkes, a Chicago millionaire, was persuaded by President Harper and Hale to provide the funds. The Yerkes Observatory was completed in 1897, and Hale surrounded himself with a talented staff including Barnard, Burnham, Wadsworth, Frost and Ellerman.

The foundation and development of an observatory such as Yerkes was in itself an achievement which could only be carried through by a man combining exceptional powers of organisation with high technical ability. But a greater task was in store. In the winter of 1903-4 Hale was in southern California owing to illness in his family, and he found time to make tests of the conditions prevailing on Mount Wilson. He recognised the astronomical value of the site, and with the aid of a grant from the Carnegie Institution of Washington an expedition came from Yerkes and set up the Snow horizontal telescope, consisting of a large spectrograph and long-focus concave mirror fed by a cœlostat. The Carnegie Institution then decided to finance a new observatory, and in December 1904 the Snow telescope was purchased from Yerkes.

So began the world-famous Mount Wilson Observatory. Expansion of its activities was rapid under Hale's leadership. The 60-foot and 150-foot tower telescopes were designed and erected, and the work of the new observatory, which at first was devoted to solar research, expanded into the domains of stellar astronomy, the 60-inch reflector being followed by the 100-inch Hooker telescope which was eventually completed in 1919. Hale remained Director till 1923 and then was compelled to retire owing to reasons of health. He erected for himself a small private observatory for solar research in Pasadena, and it was there that he designed and perfected the spectroheliograph, an instrument allowing an observer to obtain a visual image of the solar disc in monochromatic light. It was soon realised that here was an instrument ideally designed for the study of short-lived chromospheric phenomena, and the first-fruits of the new instrument lie in the recognition, by its aid, of intense transient bright flocculi in hydrogen light and of their correlation with ionospheric disturbances.

During the last years of his life Hale played a prominent part in the plans for the new 200-inch telescope, now in process of completion, and while it is a matter for deep regret that he has not survived to see this instrument in use, it is some consolation to know that its progress was far

enough advanced for him to realise that the battle was won, and that the instrument was assured of coming into active use.

We must now turn to Hale's individual contributions to research. The majority of his papers are to be found in the publications of the Yerkes and Mount Wilson Observatories and in the *Astrophysical Journal*. We select for special comment the researches carried out by himself and his colleagues on Solar Magnetic Fields. In 1908 he discovered unmistakable evidence of a Zeeman effect in the sunspot spectrum, the components of the doubled iron lines being shown, by the use of a Fresnel rhomb and Nicol prism, to be circularly polarised in opposite directions. The existence of strong magnetic fields in sunspots of the order of 3000 gauss was thus established. Later researches revealed a wealth of interesting phenomena. It was found that the two members of a bipolar spot group have opposite magnetic polarities, that the polarities of the preceding and following members have opposite polarities in the northern and southern solar hemispheres, and that the whole polarity scheme reverses for successive sunspot cycles. These and other beautiful results achieved by the enthusiasm, skill and patience which were characteristic of Hale, and which he knew well how to induce in his colleagues, present the theoretical astrophysicist of to-day with some extremely interesting—and extremely difficult—problems.

A further problem was tackled—the possible existence of a general magnetic field of the Sun as shown by the Zeeman effect. The field, if any, is relatively small and the task of measurement very difficult. The measurements of 1909 and 1910 indicated a maximum field strength of the order of fifty gauss, but later measurements suggest smaller values. The present position may be stated thus—there is a presumption for the existence of the field, but complete and definite proof is still lacking.

Hale's success was due in no small measure to his personality. The fact that he was able to get men like Yerkes and Hooker to finance his schemes speaks for the confidence which he always inspired in others. He possessed a capacity for surrounding himself with highly efficient colleagues, and for obtaining their esteem and affection, which were shared by astronomers in all countries of the world. The news of his death, which took place on February 22, 1938, at Pasadena, was received with universal regret.

His scientific activities extended beyond his own research work and the affairs of the observatories he founded. In conjunction with James E. Keeler he founded the *Astrophysical Journal* in 1895. It was on his initiative that the International Solar Union was founded in 1904, and when the work of this body was eventually merged in the wider activities

of the International Astronomical Union he became President of the Commission of Solar Physics. He was Foreign Secretary of the National Academy of Sciences and was active in establishing the National Research Council of the United States. In 1919 the International Research Council was formed, and Hale was naturally and inevitably an active member of the original executive. In the last years of his life he became President (1934–37) of the International Council of Scientific Unions.

He was elected an Honorary Fellow of the Society in 1913.

See also *Obituary Notices of Fellows of the Royal Society*, vol. ii, 1936–38, pp. 523–529.

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