

photographs of Eros in 1900 for the determination of the solar parallax. While at Virginia he discovered 250 new nebulae, and in his later years he turned his attention to long-period variables.

In 1883 Professor Leavenworth married Miss Jennie Campbell of Louisville, Kentucky, and is survived by his three children, a daughter and two sons. He died on 1928 November 12, a year after his retirement from active work. He was a member of the Phi Beta Kappa and Sigma Psi fraternities, and was elected a Fellow of the Society on 1922 June 9.

E. W. MAUNDER.—By the death of Edward Walter Maunder there passes one who has been a notable figure in the astronomical world of the last half century. His name will always be associated with the study of sunspots and the sunspot cycle, but besides his many contributions to that subject to be found in the *Monthly Notices*, either over his own name or as communications from the Royal Observatory, Greenwich, his activities embraced other branches, and these activities, together with his share in establishing an organization which is universally considered to be an asset of great value to astronomy, it is proposed to describe categorically in the following paragraphs.

In the year 1860 the erection of an instrument at Greenwich, known as the Great or the South-east Equatorial, which carried a telescope with an object-glass by Merz, 12 $\frac{3}{4}$ inches in diameter, was completed, its avowed purpose being the determination of position. But after an initial effort in that direction which took the form of measuring the system of Saturn, for ten years the instrument was used for desultory purposes, such as making drawings of the planets, examining the surface of the Moon, or observing eclipses and occultations, the most ambitious undertaking being a determination of the heat of some of the brighter stars, made by Mr. E. J. Stone with a thermopile, in the years 1869–70. In his Report of the year 1872 the Astronomer Royal, perhaps inspired by Mr. Christie, who by that time had joined the staff as Chief Assistant, wrote that it might be desirable to procure a good spectroscope for occasional attachment to the telescope, and further, in the same Report, set down his views on adding some observations of a physical nature to the programme of work of the Royal Observatory. He considered that a continued series of observations of solar spots was quite consistent with the character of the establishment, but that it was doubtful whether the same could be said of solar spectroscopy; and that if it was decided that any work of this kind should be taken up, it would be necessary to add another assistant to the establishment. Following up these ideas, a photo-heliograph that had been used at Kew was planted in the South ground before the date of the next Report (1873 May), and on 1873 November 6 Mr. E. W. Maunder was appointed Photographic and Spectroscopic Assistant at the Royal Observatory. It may be mentioned as a matter of history that he had competed at an examination held by the Civil Service Commissioners at the end of the year 1872, the first of its kind, to fill vacancies at the Royal Observatories at Greenwich and the

Cape, which resulted in A. M. W. Downing being appointed as Assistant at the first-named and W. H. Finlay as First Assistant at the second. As the result of another similar examination Maunder was appointed as above mentioned, the newly created post ranking as equivalent to that of an Assistant of the Second Class.

The Kew photoheliograph was brought into use in 1874 April and the Greenwich Record of Sunspots begins on April 17, though some photographs were taken before that date with an instrument made by Dallmeyer for the Transit of Venus expedition. One of these was set up in place of the Kew instrument after its return. A spectroscope received from Mr. Browning, adapted for sweeping round the Sun's limb with a view to mapping the prominences, but also available for work on stars and nebulae, is mentioned in the Astronomer Royal's Report for 1874, and with these instruments Maunder worked in the early years of his career. Wet-plate photography had not then been superseded, and the manipulation of the process was more arduous than the photography of to-day. In the early years a tabulation of the spots only was made, and it was not until the beginning of the year 1877 that a position micrometer for measuring the positions and areas of spots and faculae on the photographs was procured and used. The spectroscope demanded a great deal of Maunder's attention. There was much to be done in the way of improvement and adjustment of a novel instrument, and at such times as weather and other circumstances permitted it was used by day for sweeping the chromosphere to detect the prominences, and at night for measuring the displacement of lines in the spectra of bright stars to determine, according to Doppler's principle, their velocity in the line of sight, a work in which Mr. Christie took an occasional part. The first of an almost annual series giving the results of these observations will be found in the *Monthly Notices* for 1875 November. It must be said that from the beginning the uncertainty that attended the deduced results was quite realised, and, because of discordances between those with the Greenwich instrument and those obtained by Dr. Huggins, Mr. Christie pointed out in a paper in the *Monthly Notices*, 1876 May, the difficulties and instrumental reasons that militated against complete success; and it implies no derogation of Maunder's efforts and skill to say that these results are not of the same class as others made later with instruments improved by more knowledge and experience. The series was interrupted in the years 1877 to 1879, partly on account of the mounting of a spectroscope of a new type, the half-prism, and partly because of the necessities of the photographic work. In this period, which included a very close opposition of Mars, the instrument was used by Maunder for making sketches of the surface features of that planet, and other occasional observations.

Shortly after Mr. Christie became Astronomer Royal he made considerable reorganisation of the work of the sunspot department. The photoheliograph was modified so that the diameter of the Sun on the photographs was 8 inches instead of 4 as it had been previously; a micrometer was obtained to measure plates of this size; the gelatine

dry-plate process was adopted; steps were taken to procure photographs from various sources to make up deficiencies in the early years, and the scheme was brought into action by which the Greenwich series of photographs was supplemented by others taken in India and Mauritius to make the current record complete. Thus was evolved the complete record of sunspots which was Maunder's staple work for the succeeding thirty years. At first his duty was to make only a journal or a day-by-day record of the spots and faculæ with their areas and positions, but this was added to gradually. Ledgers were formed of individual groups to show the changes in them during their apparition, these were tabulated later as groups that did or did not recur, and, in fact, all was done to extract the essence from this fruitful source of knowledge. Summaries of this kind are to be found in the annual communication to the *Monthly Notices*, entitled "Mean Areas and Heliographic Latitude of Sunspots." But beyond such as these, which may be classed as official routine, there are papers planned and worked out by Maunder that exhibit conclusions of striking interest derived from the sunspot records. "The Determination of the Solar Rotation Period," by himself and Mrs. Maunder (*M.N.*, 1905 June), emphasised the difference of the rotation period in different latitudes, and the proper motion of individual spots; two papers by himself and the present Astronomer Royal that appeared in the years 1912 and 1913 investigated the position of the Sun's axis of rotation; another exhibits the mean daily spotted area of the Sun for a series of years, the northern hemisphere being shown separately from the southern, leading to the conclusion, as he saw it, that the eleven-year cycle holds good for both hemispheres, though there may be differences in detail, and that there are no cycles of multiple or submultiple length. A short series of papers, begun as part of his official work, but continued on his own responsibility, treated of the Distribution of Spot-centres in Heliographic Latitude that culminated in what is generally known familiarly as his "butterfly" diagram, which exhibits this feature very vividly and completely. Deductions he drew from this will be found in *M.N.*, **82**, 537, as part of an address he delivered on this subject in connection with the Centenary Celebration in 1922.

It is not expedient to attempt to give here a complete list of Maunder's communications to the Society, but a series of remarkable papers on magnetic disturbances and their association with sunspots began in 1904 January with a paper "communicated by the Astronomer Royal," discussing only the "great" storms that were recorded between 1875 and 1903, and was followed by another in November of the same year by himself that extended the examination to a much larger number of disturbances, treating them from the point of view of their periodicity. The suggestion that the variations of terrestrial magnetism are connected with the rotation of the Sun had already been made by Hornstein * and Broun,† but a diagram in this

* *Vide* "On the Dependence of the Earth's Magnetism on the Rotation of the Sun," by Professor Hornstein of Prague, Vienna, *Imp. Acad. Sci.*, 1871 June 15.

† *Vide Proc. Roy. Soc.*, 1873 December 18.

paper by Maunder introduced a new point by showing a tendency for magnetic storms to recur after a period of about 27 days, which carried such conviction that it created an interest almost sensational. Conclusions that Maunder drew from his work on this paper that there are certain magnetically active areas on the Sun which may or may not be marked by a spot, and that from these emanate streams which affect the earth, may not be entirely a new thought, but their actuality is here made so convincing that Maunder must always be considered a pioneer in this enthralling research.

The regularity of his work on the sunspots was occasionally interrupted by journeys abroad to take part in the observation of solar eclipses, for since his daily work was photography of the Sun, it is not surprising that his services were in demand on such occasions. The first of these was the total eclipse of 1886 August 29, when he went with a party of well-known astronomers and physicists under the auspices of the British Government to the West Indies, and observing from the island of Carriacou, where Father Perry was his companion, obtained seven photographs of the corona and two of the coronal spectrum. His second official expedition was to observe the eclipse of 1901 May 18, for which he went as observer from the Royal Observatory to Mauritius and obtained a successful series of photographs. For the eclipse of 1905 August he went to Canada at the invitation of the Canadian Government, but on this occasion adverse weather conditions prevented any observations. Besides these eclipses he made journeys to observe others, with expeditions organised by the British Astronomical Association, with which he was closely connected, and of this connection some account may now be given.

Maunder during the early part of his career at the Royal Observatory had made the acquaintance by correspondence and otherwise, perhaps because he was editor of the *Observatory Magazine* as will be recounted later, of many astronomers professional and amateur, among the latter being members of the Liverpool Astronomical Society, an organisation that about the year 1887 comprised as many as six or seven hundred members, resident in all parts of Great Britain, mainly non-professional. Shortly after that date some disaffection arose in the Liverpool Society, which, coming to Maunder's knowledge, gave him the idea that there was room for a similar Society conducted differently in detail. The first definite move was made by Mr. W. H. S. Monck of Dublin, who proposed the formation of a body of this kind in a letter to the *English Mechanic* of 1890 July 18, that was followed by others to the same effect in that journal, and in the number for August 8 one appeared signed by E. W. Maunder saying that a Society upon the lines that Mr. Monck had suggested was then in process of formation, and that the writer would be pleased to receive the names of those who would like to join. It is not necessary to pursue this further. The success that has attended the career of the British Astronomical Association, and the value of the work done by its Sections, a feature that was Maunder's idea, are facts of common knowledge. He nursed and tended it in its early years till it was able to stand alone, and has left

it a thriving, self-supporting body, comprising in its ranks a multitude of keen and skilful astronomers.

The indexes to the publications of the Association show Maunder's versatility. There are many papers to his name, the largest number being, as is to be expected, on sunspots, the solar rotation, and cognate topics. The planet Mars and its supposed canals formed the subject of several communications, his view as to the reality of the latter, as Schiaparelli and others had depicted them being that they were the integration by the eye of minute details too small to be separately and distinctly defined, which view he supported by a series of experiments made with the help of the headmaster and a class of boys of the Royal Hospital School, described in a communication to the *Monthly Notices* (1903 June). The zodiacal light was a favourite subject. The study of archaic astronomy, represented by papers dealing with the formation of the constellation figures and their date, had a fascination for him, but beyond this it may be said that he was able to make some useful contribution to whatever might be the subject of the moment. He was Director at various times of the Mars Section, the Coloured Star Section, and the Solar Section of the Association; Editor of its journal almost continuously for ten years and President in the years 1894-96. The eclipse expeditions, organized largely owing to Maunder's inspiration, have been pleasant events connected with the Association. In 1896 a large party made a voyage to Vadsö in Lapland for the purpose of observing the total solar eclipse of August 9 of that year, but the purpose was foiled by adverse weather, though the expedition was a great success from a social point of view. A smaller party, of which he and Mrs. Maunder were members, went to India to observe the total eclipse of 1898 January, and met with complete success, a ray of the corona photographed by Mrs. Maunder on the occasion being traced to a distance of 6 lunar radii from the limb, whilst for observation of the eclipse of 1900 May 28 Maunder went to Algiers with his family with an expedition, which was one of three arranged by the Association on that occasion. Accounts of these expeditions to India and to Portugal, Spain, and Algeria in 1900 have been given in two publications of the Association edited by Maunder.

It will be gathered from this that he had a facile pen and considerable literary skill, and these he exercised throughout almost the whole of his career at the Royal Observatory. The *Observatory Magazine* was founded by Mr. Christie in the early part of the year 1877, and was carried on by him single-handed until his appointment as Astronomer Royal in 1881 August, when he asked Maunder to join him as co-editor, and the number for November bore both names on its cover. From that time until the end of the year 1887 almost the whole duty of producing this publication fell upon Maunder, though for three of the years two of his colleagues were nominally associated with him in the editorship. For a period he supplied *Nature* with a weekly column, and at another the astronomical section of the periodical *Knowledge* was in his charge, and many articles on varied astronomical subjects are to be found in its pages. His book on the Royal Observatory,

Greenwich, which appeared in 1900, is a brightly written and choicely illustrated history of the institution; and another, *Astronomy without a Telescope*, published from the office of *Knowledge* in 1902, in which he collected much of the material that had appeared in his papers on the constellations, the zodiacal light, and on other subjects, has found many readers, and is often quoted from as a classic. Maunder's biblical knowledge was profound, which led to his being asked to prepare the astronomical section of *The International Standard Bible Encyclopædia*, and caused him to produce in 1908 the work, *Astronomy of the Bible: An Elementary Commentary on the Astronomical References of Holy Scripture*, in which he discussed the incidents described in Holy Writ that have astronomical bearing and may be dealt with from points of view of the science. There are two items in the series, called "The People's Books," with his name, and this does not complete the list of his literary efforts. He was an effective speaker and lecturer, and his services on this account were often in demand.

The subject of this note was the youngest of three sons of the Rev. George Maunder, a minister of the Wesleyan Society, and was born in the neighbourhood of London on 1851 April 12. He went to the school attached to University College in Gower Street, and afterwards attended classes at King's College, London. He had some service with a bank in the City of London, but joined the staff of the Royal Observatory as already narrated in 1873. He was twice married. By his first wife, who died in 1888, he had three sons and two daughters, and a son who died in infancy. In 1895 he married Miss A. S. D. Russell, then a member of the staff of the Royal Observatory, a well-known personage in the astronomical world, who has edited for some years past the *Journal of the British Astronomical Association*. Maunder retired from his post at the end of the year 1913, when he had completed forty years' service, but was recalled with Mrs. Maunder during the war years to carry on the sunspot record. After his retirement, in the years 1914 to 1916 he was Secretary of the Victoria Institute, a Society established in the year 1865 to investigate important questions of Philosophy and Science, especially those bearing upon Holy Scripture, and prepared and read several valuable papers that are published in its *Transactions*. Maunder was a man with no enemies, but many friends. A suavity of manner and a softness in speech were markedly in keeping with a kindness of heart and amiability of character that lay deeper than its outward manifestation. He died on March 21 last, within a month of the completion of his seventy-seventh year, having been afflicted with a painful internal trouble for some years previously.

He was elected a Fellow of the Society on 1875 February 12, was a member of the Council for several years, and served as Secretary from 1892 to 1897.

H. P. H.

GEORGE PEARSON was born in 1876 January at Kinross, where his father served in the employ of the North British Railway Company. The family soon afterwards removed to Edinburgh, and