



THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XLVI.

SEPTEMBER, 1923.

No. 592.

S. S. Hough.

SYDNEY SAMUEL HOUGH was born at Stoke Newington on June 11, 1870. He was educated at Christ's Hospital School, where his mathematical ability was revealed and developed. He obtained an open Foundation Scholarship at St. John's College, Cambridge, in 1887, but did not proceed to the University till October 1889. He was Third Wrangler in 1892, and obtained Class I., Div. 3, in Part II. of the Mathematical Tripos in 1893. In 1894 he obtained the First Smith's Prize for an essay on the subject of the "Oscillations of a Rotating Ellipsoidal Shell containing Fluid," which was afterwards communicated to the Royal Society by Sir Robert Ball, and is published in the *Philosophical Transactions* for 1895. This research was undertaken in view of the then recent discovery of the variation of latitude. Hough showed that the extension of the period was not (as had been suggested by M. Folie) accounted for by the freedom a fluid would have in the interior of the Earth, and considered that Newcomb's explanation of the phenomenon as arising from the Earth's elasticity was probably correct.

He obtained an Isaac Newton Studentship and a Fellowship at St. John's College in 1895, and continued his researches on the cause of the prolongation of the period of latitude variation in a paper on "The Rotation of an Elastic Spheroid" (*Phil. Trans.* 1896). He obtained rigorous dynamical equations for the oscillations of such a system, and solved them for the case where the ellipticity and consequently the angular velocity are small. He found that the general character of the motion agreed with Newcomb's geometrical explanation, but differed slightly in the amount of the displacement of the Pole. He showed that the variation of latitude gave an effective rigidity of the Earth a little

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greater than that of steel in agreement with Lord Kelvin's result from tidal theory.

In 1897 and 1898, Hough undertook a revision of Laplace's 'Theory of the Tides.' The great value of this work is summarized in the following extract from Sir George Darwin's article on "Tides" in the *Encyclopædia Britannica* (11th Edn.):—

"In 1897 and 1898, S. S. Hough undertook an important revision of Laplace's theory, and succeeded not only in introducing the effects of the mutual gravitation of the ocean, but also in determining the nature and periods of the free oscillations of the sea. A dynamical problem of this character cannot be regarded as fully solved unless we are able not only to discuss the 'forced' oscillations of the system, but also the 'free.' Hence we regard Mr. Hough's work as the most important contribution to the dynamical theory of the tides since the time of Laplace. We shall accordingly present the theory briefly in the form due to Mr. Hough."

He was introduced by Sir George Darwin to Sir David Gill, and on the recommendation of the latter was appointed Chief Assistant at the Cape in September 1898. In the 'History of the Cape Observatory' Gill remarks: "He threw himself into the work of the Observatory with much earnestness, ability and interest, rapidly acquiring familiarity with those departments of practical astronomy in which he had no previous experience."

Hough's training and mathematical ability were admirably suited to supplement and carry through work which Gill's energy and instrumental skill had begun. He made a very complete discussion of the heliometer triangulation of the stars near the South Pole, and followed this up by a photographic triangulation of the same region. The combination of these series of observations gave very accurate positions of stars which were required in the Southern observatories. He did not relinquish his interest in dynamical astronomy, and published in the *Acta Mathematica* a valuable paper on "Periodic Orbits."

Gill's new transit circle made it possible greatly to improve the fundamental positions of stars in the Southern Hemisphere. Hough studied the instrument with great care. To the *Monthly Notices* for 1904 he communicated a paper on the division errors of the circle, in which he considered how the great labour involved in such determinations should be bestowed in order to obtain the most accurate results. The work of determining the division errors, pivot errors, errors of screws, the investigation of the stability of the vertical collimators was carried out in 1904 and 1905, and Hough ably seconded Gill's efforts to make the Cape transit circle the best possible instrument for the purposes of fundamental astronomy. Hough was in charge of the Observatory during Gill's absence in England in 1900, 1904, and 1906, and was appointed H.M. Astronomer on Gill's retirement in February 1907. The results obtained with the new transit circle are

contained in two fundamental catalogues resulting from the observations in 1905-1911, and 1912-1916 respectively, and are probably the most valuable contributions of recent years to the correction of fundamental right ascensions and declinations. At least 16 observations were made of each star, equally distributed in four positions of the instrument. The discussion of the results from different positions of the instrument leaves no doubt of their accuracy. The southern circumpolars were thoroughly observed, and the results compared with those previously obtained with the heliometer and by photography. The observations of Sun and inner planets made after the introduction of the new transit circle are exhaustively discussed by Hough in the Introduction to vol. viii. of the *Cape Annals* to give corrections to the equinox and the elements of the planets. The heliometer observations of the outer planets, instituted by Gill, are similarly discussed in another section of the same volume.

In conjunction with Dr. Halm, who was appointed Chief Assistant in 1907, two important researches were carried out. One of these was a discussion of the radial velocities obtained with the Victoria telescope, and the other a discussion of the systematic motions of the Bradley stars.

Next to fundamental astronomy, Hough gave most thought to the completion of the 'Astrographic Catalogue.' He was not satisfied that the measures should be published till an exhaustive comparison had been made of the overlapping plates. In this way a number of false stars were eliminated and mistakes in measures corrected. It led to a very thorough investigation of the plate constants, and the determination of a scale correction for stars of different magnitudes. This very heavy piece of work was carried through, and Hough had the satisfaction of seeing three-quarters of this work through the press. In addition, a magnificent volume was completed, giving the Right Ascensions and Declinations of the reference stars and all stars down to 9^m.0 in the Cape Photographic *Durchmusterung*—over 20,000 stars in all. Meridian observations were combined with the photographs, and positions of the stars in the region from Dec. -40° to -52° for the epoch 1900 are given with the highest accuracy obtainable from combined meridian and astrographic work. The elaborate and careful discussion on lines designed by Hough was carried out under Mr. Power's direction and by his personal work, and a well-deserved tribute to his skill and industry is paid by Hough in the Introduction to the catalogue. Another service which Hough rendered to the 'Astrographic Catalogue' was in the compilation with Backlund of a series of fundamental reference stars for use in that undertaking.

Hough became a Fellow of the Royal Society in 1902, and was President of the South African Philosophical Society in 1907, and on the reconstruction of that Society as the Royal Society of South Africa was its first President. On the formation of the

Astronomical Union he was made Chairman of the Committee on Fundamental Astronomy, and at the meeting in Rome was elected a Vice-President of the Union. During his stay at the Cape he visited Europe several times as representative at various astronomical conferences. He did not speak much in the formal meetings, but his colleagues valued his opinion and were glad of these opportunities to consult him.

In 1906, Hough married Gertrude Annie, daughter of J. H. Lee, of Halstead, Essex, a former student of Newnham College, who had gone to Cape Town as a mistress at the Cape Town High School for Girls. Mrs. Hough accompanied her husband to Europe on several occasions, and some of his colleagues, including the writer, had the pleasure of receiving her kind hospitality in a short visit to the Cape Observatory on the way to Australia in 1914. Their very happy married life was terminated by Mrs. Hough's death from pneumonia following influenza in 1918.

Hough came to the Meeting of the Astronomical Union in May, 1922, and stayed in England for the centenary celebrations of the Royal Astronomical Society. He appeared to be in good health, but at the beginning of 1923 disquieting letters were received from the Cape. His medical adviser sent him, accompanied by a nurse, to London, where he underwent operations in a nursing home, and the effect of radium was tried. After leaving the home he stayed with his brother at Gerrard's Cross, and had recovered sufficiently to contemplate a return to the Cape in September. But his illness progressed rapidly, and he died on July 8. He was buried at Chingford Mount Cemetery on July 13. The service was conducted by Dr. Pearce, the Vice-Chancellor of Cambridge University, and was attended by relatives and friends and colleagues representing the Admiralty, the Royal and Royal Astronomical Societies, and the Royal Observatories of Greenwich and the Cape of Good Hope. His death is a great loss to astronomy and a personal loss to many friends in England and South Africa.

F. W. DYSON.

The Origin of the Spiral Nebulae.

SEVERAL days after the following notes for an article on the Spiral Nebulae were written down, *The Observatory* for May was received containing an account of the Meeting of the Royal Astronomical Society on April 13, in which Prof. Lindemann presented a paper on the constitution of these bodies. After reading *The Observatory*, it became impracticable to elaborate the article as originally intended developing the points of view solely from my own personal angle, uninfluenced. As there are points