spectrum from infra-red to ultra-violet. These instruments are described and illustrated in Chapter 4, which then goes on to a detailed account of the technique of reduction. The principle is very simple; the higher the sun the less the thickness of the atmosphere traversed and the greater the radiation. Hence, if the state of the atmosphere remains unchanged, a series of observations at different hours, preferably in the morning, can be extrapolated to give the radiation at zero air-mass, that is, the 'solar constant'. In the full or 'long' method computations have to be carried out for about forty different wavelengths, and even with the help of a special slide-rule they are laborious, but Dr. Abbot has been able to devise short cuts without appreciable loss of accuracy. The derivation of the 'short' method is described in detail but cannot be summarized here.

Dr. Abbot and his colleagues are continually improving their methods, and in order to maintain a homogeneous series of data, it was necessary to re-compute some of the earlier observations. This has now been done, and no less than seventy-eight pages of the report are occupied with the determinations for nearly every day from August 29, 1923, to September 29, 1939. The result is a series of "preferred" values of the solar constant, but even these are not always quite final. Some of the values show improbably large jumps from day to day, and these were checked by examination of the variations of the short-wave spectrum alone. If these gave more reasonable variations, the "preferred" values were adjusted accordingly, as a series of "improved preferred" values. Some of the resulting changes are relatively large, as much as 1 per cent, and this must to some extent impair confidence in the accuracy of the individual daily values. Dr. Abbot indeed admits as much. From a comparison of the results at three stations, he estimates the probable accidental error of a single daily value as only 0.16 per cent, but he expresses the view that only means of ten days or longer can be regarded as really reliable. Ten-day and monthly means are given from August 1920 to September 1939.

The last part of the volume is concerned with the periodogram analysis of these data. The method used is not described in detail but was apparently graphical; short periodicities were "disclosed" by inspection and removed, disclosing longer periodicities and so on. The method is dangerous, giving rather free play to preconceived ideas of the lengths to be expected, and since all those found are integral parts of 273 months, a check by rigid Fourier analysis would have been both simple and desirable. Dr. Abbot's objection to this is that none of the periodicities is of sine form. He gives an illustration of the determination of three periodicities, and remarks, "We think readers may not be too favourably impressed by the comparison of the 34-month periodicity". He is quite correct in the case of one reader at least; practically the whole of the amplitude found results from the enormous range of the first of the six waves shown. His justification is that the reconstructed curve agrees closely with the original; this claim would be legitimate if all the fourteen waves were of sine form, but is doubtfully so with the complicated forms shown, each of which could be expressed as the result of several sub-waves. The lengths determined range from 8.3 to 273 months; recurrences at intervals of twenty-seven days associated with the sun's mean rotation period are also illustrated and there is a tantalizing reference to the temporary existence of

shorter periods measured in days. No relation is found between solar radiation and sunspot numbers.

The great future importance of the study of variations in the solar constant lies in its probable application to weather forecasting. Periodicity is the most obvious method of this application, for if the solar variations are truly periodic they should be reflected, in favourable circumstances, in periodicity of weather. From the point of view of the Astrophysical Observatory, however, this is only a by-product. Dr. Abbot casually mentions that he verified the lengths of the solar periodicities of 8-68 months in meteorological data for a hundred years for three stations (with due allowance for seasonal changes) and he claims two-thirds success for long-period rainfall forecasts, but until the relations between solar and terrestrial phenomena are more fully understood forecasts are probably premature. His great service still lies in the record itself rather than in its applications.

OBITUARIES

Prof. W. H. Young, F.R.S.

WILLIAM HENRY YOUNG, who died in Lausanne on July 7 when nearly eighty, was one of the mathematicians who had contributed most to the revival of English mathematics during the last fifty years.

Young was born in London on October 20, 1863; his family had worked in the City for some generations. His first education was at the City of London School: the headmaster, Abbott, had been a schoolfellow of his father. He went up to Cambridge, at Peterhouse, in 1881, was fourth Wrangler in 1884, and a fellow of his College from 1886 until 1892; in 1939 he was made an honorary fellow. In his early graduate years he did a great deal of teaching, both as a private coach (as was usual with Cambridge mathematicians then) and more officially as a lecturer at Girton. In 1896 he married Grace Chisholm, who had been one of his pupils and was also a fine mathematician. He was the first Hardinge professor of mathematics in Calcutta from 1913 until 1916, professor of the philosophy and history of mathematics in Liverpool from 1913 until 1919, and professor of pure mathematics in Aberystwyth from 1919 until 1923; but the first two of these chairs were rather 'occasional' appointments, and it is something of a scandal that he should never have occupied a regular position really worthy of a mathematician of his rank.

Young became a fellow of the Royal Society in 1907, and was Sylvester Medallist in 1928; was de Morgan Medallist of the London Mathematical Society in 1917, and president from 1922 until 1924; and president of that rather unhappy body, the International Union of Mathematicians, from 1929 until 1936. He leaves his wife and five children, two of whom are also well-known mathematicians.

Young wrote three books (two in collaboration with his wife) and about two hundred papers, all crowded into a little more than twenty years of his life; he was over forty when his first important papers were published. He belonged to the generation of mathematicians which includes Burnside, A. C. Dixon, Forsyth, Hobson, Love, and MacMahon, and was fully the equal of any of them in originality and power; but all of them had established their

reputations before he began, and this late start was a serious impediment in the way of his recognition. This was also delayed by a certain conservative hostility to the subjects which he represented, and which scarcely anyone in England understood.

'Complex' function-theory had been introduced to Cambridge a little before (in a rather ill-digested form) by Forsyth, but the 'real' theory was still practically unknown. Hobson and Young were the first true English 'analysts', and "The Theory of Sets of Points", published by the Youngs in 1906, the first real English book on analysis. This is a first-rate book both in substance and in presentation, and it is most regrettable that it should never have been rewritten, in the light of later advances, and reprinted. But all Young's books were comparatively unsuccessful in England. His Cambridge Tract, "The Fundamental Theorems of the Differential Calculus" (1910), though much of its content is now 'classical' and is reproduced in the standard French courses of analysis, never went into a second edition; and the joint "First Book of Geometry", a most interesting and original 'book for children', written in 1905, was 'a complete flop' at home, though it has been translated into four foreign languages.

The theory of functions of a real variable has been completely rewritten since 1900. The remaking began with Borel's famous monograph "Leçons sur la théorie des fonctions", published in 1898. Among those who have remade it Lebesgue, by general consent, stands first; but there is no one else who has contributed more than Young. Young's first work was independent of Lebesgue; he had found definitions of measure and integration different in form from, and in some ways more natural than, Lebesgue's, but equivalent in essentials. He was anticipated by some two years, and the disappointment was a blow; but he recognized the anticipation magnanimously—"the Lebesgue integral" is his own phrase—and set himself whole-heartedly to work at the fuller development of the theory; he was the first, for example, to find a really satisfactory synthesis of the work of Stieltjes and Lebesgue. But his interests were not at all confined to the theory of integration; there is scarcely a chapter of real function-theory on which he has not left his mark. Thus he rewrote a large chapter of the differential calculus, and the theory of Fourier series, and other orthogonal developments, are full of striking theorems discovered by Young.

G. H. HARDY.

Sir Alfred William Flux, C.B.

ALFRED WILLIAM FLUX, who died recently in Denmark, aged seventy-five, was successively mathematician, economist and statistician. Successively, because after being classed as one of the Jubilee Senior Wranglers in 1887, he came under the influence of Alfred Marshall (who had succeeded to the chair of political economy at Cambridge in 1885), was one of the foundation members of the Economic Society (1890), and from 1893 until 1908 was a teacher of economics, first at Manchester and then at McGill University, Montreal.

Flux's main interest was not in the development of the mathematical theory of economics, but in its practical applications to commerce from the statistical point of view. He had been elected a fellow of the Statistical Society in 1893. Though he joined the Econometric Society in 1934, he appears never to

have used mathematics in his writings, except in his "Economic Principles" (1904), where, following Marshall, he gave them a subsidiary position. Indeed, he publicly deprecated mathematical tools except as a personal background to verbal analysis. In 1908 he returned to England and was attached to the Board of Trade until his retirement in 1932. During this period he was a very active participant in the work of the Royal Statistical Society, as member of council from 1908, honorary foreign secretary from 1925, and president during 1928-30. Soon after 1932 he made his home in Denmark, Lady Flux's native country, and during part of each year worked at the League of Nations in Geneva. The outbreak of war found him in Denmark.

Flux is best known because of his work on the British Censuses of Production. The first Census (1907) was already organized when he joined the Board of Trade, but he became director in 1911 and wrote the Final Report. He was responsible for the Censuses of 1911 and 1924 and for the initiation of that of 1930. Apart from the normal reports on production, he made three important developments. First he built up estimates of the total national income from the side of production, and contrasted and compared the results with earlier estimates based on the aggregate of individual incomes (Giffen's method); this analysis is of far-reaching importance (*J. Roy. Stat. Soc.*, 1913 and 1929). Secondly, he initiated an index of production, for which the Census provided the weights attached to the different quantity series (*J. Roy. Stat. Soc.*, 1927). Thirdly, he reconstituted Giffen's index of wholesale prices, again using the Census for weighting (*J. Roy. Stat. Soc.*, 1921). These results are now well known as the Board of Trade's Index-numbers of Production and of Wholesale Prices, though from time to time details have been modified.

The Board of Trade and its offshoot the Ministry of Labour have frequently been recruited from the ranks of trained economists who have brought wider views than are commonly taken by those without outside experience. This procedure has been abundantly justified by the importance and originality of the work which has here been too briefly summarized.

A. L. BOWLEY.

Dr. F. Dawtrey Drewitt

DR. FREDERIC GEORGE DAWTREY DREWITT, the biographer of Jenner and historian of the Chelsea Physic Garden, died at his home in Kensington after a long illness on July 29 at the age of ninety-four. He was educated at Winchester and Christ Church, Oxford, where he gained a second class in the School of Natural Science and received his medical training at St. George's Hospital. He qualified in 1876, and after being physician to the Victoria Hospital for Children during 1881-97 and at the West London Hospital during 1882-1902 he gave up medical practice for more congenial pursuits.

In 1903 Drewitt became a member of the British Ornithologists' Union, and afterwards served on the councils of the Zoological Society, the National Trust for Places of Interest or Beauty and the Society for the Promotion of Nature Reserves. He was best known, however, for his connexion with the Chelsea Physic Garden, on the board of management of which he had represented the Royal College of Physicians since 1921, and he was vice-chairman from 1929 until a few months before his death.