

found with sufficient accuracy from its expansion in series, which in those circumstances is so convergent that the first term,  $\frac{1}{6}\sin^3(E'-M)$ , or  $\frac{1}{6}e^3 \sin^3 E'$ , will ordinarily be all that is needed.

Since  $E' - M - \sin(E' - M)$  reduces to  $M' - M$ , where  $M'$  is the value of the mean anomaly corresponding to an eccentric anomaly equal to  $E'$ , it will be seen that equations (vi) and (vii) are of general application and can be used in conjunction with any method of first approximation other than that which forms the basis of the present paper. When, however, the first approximation is derived from equation (iii) or (iv),  $\sin(E' - M)$  may be conveniently substituted for  $e \sin E'$  in equation (vi), as the value of the former quantity will have already been obtained in calculating  $p$ , except when tables of  $\theta - \sin \theta$  are used.

As a numerical example in illustration of the formulæ let it be required to find the value of  $E$  when  $M = 9^\circ$  and  $e = 0.8$ . With these values we obtain from equation (iii)  $E' - \frac{1}{2}M = 35^\circ 18' 37''.9$ , and hence as the value of  $\sin(E' - M)$  in sexagesimal measure  $29^\circ 20' 49''.0$ , and consequently of  $E' - M - \sin(E' - M)$  or  $p$ ,  $5,268''.9$ . With  $\log\left(\frac{1}{e} \sec E'\right) = 0.21145$  as argument, or  $B$ , we find as the corresponding function  $C$  in the table of subtraction-logarithms,  $\log\left(\frac{1}{q}\right) = 0.41401$ ,

whence  $\frac{p}{q} = 13,668''.8$ . The succeeding terms of the series are now readily calculated, their values being as follows:  $+601''.8$ ,  $+53''.0$ ,  $-16''.0$ ,  $+5''.8$ , and  $-3''.5$ . The algebraical sum of the six terms is  $14,309''.9$  or  $3^\circ 58' 29''.9$ , which subtracted from  $E' = 39^\circ 48' 37''.9$  gives  $E = 35^\circ 50' 8''$ . We may now test this result by means of equation (vii). It will be seen that the sum of the first three terms of the series amounts to  $14,323''.6$ . Taking this as the value of  $\Delta E'$  we obtain for the small term in the numerator in equation (vii)  $-1''.8$ . Then with  $E' - \frac{1}{2}\Delta E' = 37^\circ 49' 16''$  we find as the co-logarithm of the denominator,  $0.43407$ , whence  $E' - E = 14,310''.0$ , and  $E = 35^\circ 50' 7''.9$ , a result which is correct to the nearest decimal of a second.

## Obituary.

### The late Sir Nathaniel Dunlop.

Sir Nathaniel Dunlop, D.L., LL.D., of Shieldhill, Biggar, Lanarkshire, died on 13th November 1919. The West of Scotland Branch have drawn up the following Minute in reference to his death:—

“The West of Scotland Branch of the British Astronomical Association wish to place on record their deep sense of the loss sustained by the death of Sir Nathaniel Dunlop, D.L., LL.D. Joining the Branch in February 1896, in the second session of

its existence, Sir Nathaniel became a Life Member. Although one so fully occupied in business affairs and in philanthropic and many other departments of public service could necessarily devote only a relatively small proportion of his time and energies to matters of less directly practical bearing, he yet showed a keen interest in science in general and in astronomy in particular, and in the work of this Association in furthering study and investigation therein. At the close of session 1912-13 he was unanimously requested by the Council of the Branch to accept nomination for the office of Honorary Vice-President. While indicating that he had some diffidence in doing so, on account of the fact that his advancing years forbade venturing out in the evenings to attend meetings, he kindly acceded in view of the urgently expressed desire of the Council. During the succeeding three years his tenure of the position was annually continued, and the Branch highly esteemed the honour of reckoning in their list of office-bearers one possessing his distinguished attainments in so many spheres of knowledge and activity. At the close of session 1915-16, when, according to the regulations, his tenure of office necessarily terminated, he addressed to the Annual General Meeting a paper dealing with the mariner's compass and Lord Kelvin's work in perfecting it. The paper, which contained most interesting reminiscences of Sir Nathaniel's association with Lord Kelvin, was much appreciated and enjoyed. Towards the end of last session, when the office of Honorary Vice-President had again to be filled up, the Council unanimously invited Sir Nathaniel to accept nomination for a further term, but were sorry to hear that from failing health he felt obliged to decline.

"Sir Nathaniel's character furnishes a typical example of the perseverance and industry which have made the name of Scotland illustrious. On 13th November 1919 he passed away, full of years and honours, retaining to the last his active mental powers, and while his death will be a loss to so many good causes, which can ill spare the benefits of his patronage and generous assistance, his memory will remain as an incentive and example to all who in any way came within the influence of his beneficent personality. The Branch desire to express their feelings of sorrow at his demise, and to offer to his daughter and other relatives their respectful sympathy in their bereavement."

#### Charles Thomas Whitmell.

Charles Thomas Whitmell, M.A., B.Sc., F.R.A.S., died 10th December 1919. A whole-hearted follower of science, he pursued its teachings in many various, though cognate, branches, concentrating himself finally on astronomy. He was one of those persons, of great value to the world, who not only study, but stimulate others to study; an enthusiastic admirer of the world as it presents itself to our senses; and not forgetful, either, of that other world which lies deeper than our senses, the world in which personal feeling rules.

He was born on the 10th of July 1849, in Leeds, where his father was a clerk of the Bank of England (and chief clerk for some years before his retirement). Educated as a boy in the

Leeds Grammar School, he won a Queen's Prize for proficiency in Inorganic Chemistry in May 1864; and it is interesting to learn that six months before that date he had received a letter from Faraday (which I believe exists still). In another field of activity, he won a prize for throwing the cricket ball. He left the Grammar School at the end of 1864, and from that date until August 1868, he studied for a scientific degree (B.Sc.), at the London University, which he gained; and with it he won the exhibition of £40 a year for two years, awarded for proficiency in Natural Philosophy and Chemistry. He had also made attempts at a more permanent livelihood, but these came to nothing; and on 9th April 1869 he obtained a Natural Science Scholarship at Trinity College, Cambridge, being then three months short of 20 years old.

In his college career he obtained distinctions (among others a Winchester Reading Prize), and every now and then he delivered lectures to societies (one on Hamlet soon after taking his degree). In the Mathematical Tripos he was 52nd (10th Senior Optime), a very fair degree; but in the Natural Sciences Tripos he was 1st in the 1st Class, a high distinction. This was towards the end of 1872; and during the following year he took pupils at Cambridge. Also he gave lectures on behalf of the University of Cambridge (University Extension lectures), and for a couple of years was a master at Tonbridge School; but in 1879 he entered upon the most long-continued activity of his life, being appointed an Inspector of Schools under the Education Department. Though his primary ambition had lain in wider fields of theory, he applied himself most faithfully to the practical work; and his rare courtesy and considerateness towards the teachers whose work he supervised and controlled was answered on their part with trust and gratitude, as was shown by testimonials and addresses received by him both at Cardiff and Leeds, the two principal centres where his work had lain. "The great affection and esteem in which you are held"—such were the terms in which the Leeds teachers expressed their feelings towards him.

All this time he was not forgetful of science; and in his travels in North America in 1883 he had been particularly interested in the geology of the Yellowstone district, of the Yosemite valley, and, above all, of the Colorado cañons, and had accumulated literature on these subjects. Moreover, he was in continuous scientific correspondence (chiefly mathematical and astronomical) with all manner of persons, high and low; and this correspondence he preserved in a series of invaluable logbooks, which it is to be hoped may find a safe and permanent home. Pamphlets also he kept, in great number, valuable and various. He was a Member of the Royal Astronomical Society, the British Astronomical Society, and of all the scientific societies in Leeds.

He married in 1903; his charming, gifted wife (*née* Lucy Foster), author of the well-known poem "Christ in Flanders," died in 1917, to his great grief. He himself wrote poetry, some of which deserves to be remembered.

Requiescat, reviviscat.

JOHN R. MOZLEY.