isolated, band of light across the zenith, but as soon as it was dark that evening, the zodiacal light was distinctly seen to stretch across the whole sky, forming that faint band of light previously observed; I then began to note its position, but the best observations were made on the night of the 27th, when it was most distinct.

On that night it passed centrally over the planet Venus, and then over the stars δ Capricorni, γ Aquarii, o Piscium, and reached a point between the Pleiades and the Hyades, so that the central portion of the light traced out the course of the Ecliptic with wonderful precision; it was brightest in the central part of the band, and gradually faded off towards the edges; its illumination about Venus was somewhat greater than that of the Milky Way, but became fainter and fainter as the light proceeded along the Ecliptic; it was impossible to trace it beyond the Hyades, where it seemed absolutely to terminate; at midnight, however, a feeble glow could be seen above the eastern horizon in Leo and Cancer, but nothing was certain about this branch.

Returning to the western and brighter branch, at Venus its breadth was about 40°, and as the longitude of the planet was 280° while that of the sun was 246°, its breadth was 40° at a distance of 34° from the sun; at δ Capricorni its breadth was 20°, at γ Aquarii 16°, and at o Piscium 10°, so that we get the following results :—

Distance from sun	Breadth
34°	40°
66	20
93	16
139	10

and its extreme distance from the sun was about 177°, where it was too faint to note anything but its existence. The light seemed perfectly fixed in the heavens, and there was no sign of any displacement such as might be caused by parallax combined with the earth's rotation; and when the brighter part had set and was far below the horizon, the band across the zenith was quite as distinct as before.

Now these few facts go a long way towards explaining the nature of the zodiacal light, and a few more observations at different times of the year may be all that are necessary to do so satisfactorily; but as the light was so vivid here, it must have been seen in other parts of the world, and a comparison of the different accounts may bring about the desired result; hence these notes, and the following rough explanation.

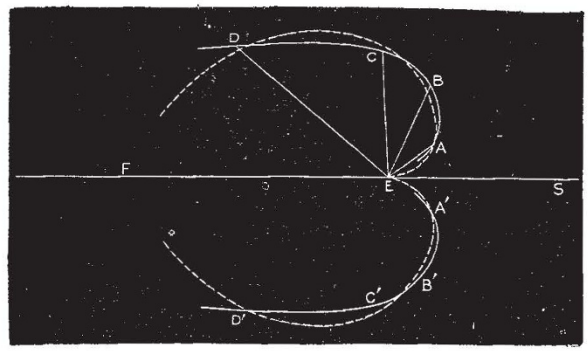
The zodiacal light has generally been supposed to be a luminous ring, surrounding the Sun, and situated between the orbits of Venus and Mars; the fact that the light has often been seen in both the east and west at the same place and time does not affect the probability of this explanation, as we have only to suppose the earth to be just within the ring; but there are many difficulties to encounter, and the explanation never seemed satisfactory. The instant, however, that I saw the prolonged ray, I felt sure that the zodiacal light was similar in its nature to the rays issued from a comet towards the sun, which, drifting over the nucleus, are then forced backwards and form the tail; and that in the case of the earth, the light is generated in those regions to which the sun is vertical, and passing round the earth, the light is swept back in a direct line from the sun, thus forming a train which always tends towards a point in the heavens 180° from the sun, and which is therefore stationary with regard to the earth's axial rotation.

It is not easy, however, to test the truth of these ideas by means of the notes above, but the following attempt may not prove uninteresting.

If the zodiacal light were a ring, and the earth within it, we could compare the distances of the different parts of the ring by means of their apparent angular breadths, supposing the actual breadth of the ring to be uniform; in order to see whether that prolonged ray was part of a ring or not, let E S be the line joining the earth and the sun, the plane of the paper coinciding with the Ecliptic; and at an angle of 34° (θ_1) measure off any length E A (r_1), in which direction the breadth of the light was 40° (ϕ_1); now, the distance r_2 of any point where the angular breadth is ϕ_2, will be determined by the equation—

$$r_2 = r_1 \tan \frac{\phi_1}{2} \cot \frac{\phi_2}{2}$$

so that we can draw E B, E C, and E D, corresponding to the second, third, and fourth observations; but the



curve drawn through these points is by no means an arc of a circle, and very fairly represents what we have expressed in words above, so that the rays issuing from E towards S are swept to the right hand and to the left, and passing by the earth they form a train of light stretching out into space.

But to what an astonishing distance must this train proceed, in order to acquire an angular distance of 177° from the sun! It is, however, quite possible that the two branches close together near the point F, following the dotted curves; these curves are the positive and negative branches of the spiral of Archimedes, and fairly represent our curves for an angular distance of 90° from the sun.

MAXWELL HALL

Jamaica

THE LATE PROFESSOR W. J. MACQUORN RANKINE

THE death of Prof. Macquorn Rankine, which we announced a fortnight ago, will excite a pang in the hearts of many persons who had enjoyed actual intercourse with the genial spirit whose early loss we now mourn, and of a still greater number who were only acquainted with him through his published works. He died at his residence in Glasgow, on Christmas Eve, in his fifty-third year, the date of his birth being July 5, 1820. For several months he had been labouring under a serious derangement of his eyesight, coupled with heart disease; but it was confidently hoped for a time that his valuable life might be preserved for the benefit of science, provided that he rested himself from all his ordinary labours. Latterly he did take that rest which seemed to be so imperatively demanded by his physical nature, the chief portion of his ordinary work, namely, that of conducting his class in the University of Glasgow, being handed over to Mr. Bamber, C.E., who formerly distinguished himself as a student under the deceased professor; but the bodily system had evidently little power of resisting the ravages of the insidious disease under which it laboured; paralysis set in on Sunday, the 22nd ult., and in forty-eight hours Macquorn Rankine was dead.

The amount of space at our disposal is quite insufficient for the simple mention of the many important facts that

are intimately bound up with the professional and scientific career of Professor Rankine, and therefore our sketch, at the best, can only be of the most cursory sort. In due time, doubtless, a suitable tribute will be paid to his memory and his scientific genius by the hand of one of his literary executors.

Professor Rankine was born in Edinburgh, and received most of his ordinary school education in the Burgh Academy of the town of Ayr, and in the High School of Glasgow; but he received the most valuable part of his education, doubtless, from his father, who was a retired lieutenant of the Rifle Brigade, during the residence of the family at Edinburgh. At a very early age young Rankine entered himself as a student in the University of Edinburgh, where he enjoyed the invaluable benefit of instruction in chemistry from Dr. D. B. Reid; in natural history (including zoology, geology, and mineralogy) from Prof. Jameson, a man of European reputation as a naturalist; in botany from Prof. Graham; and in natural philosophy from Prof. James D. Forbes. The extraordinary genius which he displayed in after life in pure and applied mathematics seems to have owed little or nothing to any external or adventitious aid in the shape of professional instruction: he was a born mathematician.

The bent of his mind began very early to show itself, for before he was out of his "teens" he had written two essays on purely physical subjects—"The Undulatory Theory of Light," and "Methods of Physical Investigation." When he was about eighteen years of age he betook himself to the profession of civil engineering, and served as a pupil under an eminent master, Sir John Macneil, for three or four years, a large portion of which was spent on engineering works in Ireland. He was afterwards employed for several years on railway and other engineering works in Scotland, and in 1850 or 1851 he settled down in Glasgow to pursue his profession in partnership with Mr. John Thomson, C.E.

Meanwhile, Mr. Rankine had been prosecuting inquiry in reference to several purely scientific subjects, as well as those that more immediately pertained to his profession as a civil engineer; and he did not fail to put on record the results of his investigations, almost all of which he gave to the world through the medium of one of the learned societies. He was elected a Fellow of the Royal Scottish Society of Arts in 1842, an Associate of the Institution of Civil Engineers in 1843, a Fellow of the Royal Society of Edinburgh in 1849, a Member of the Philosophical Society of Glasgow in 1853, and a Fellow of the Royal Society of London in the same year. In the year 1850 he first cast in his lot with the British Association, and at the meeting held in Edinburgh that year he was the Secretary of the Physical and Mathematical Section. He afterwards occupied still more prominent positions both in Section A and Section G, and many of his admirers looked forward with pleasure to an early meeting of the Association being held in Glasgow, when they hoped to see him filling the presidential chair.

In the year 1855 he was appointed by the Crown to the Regius Professorship of Civil Engineering and Mechanics in the University of Glasgow, in succession to Prof. Lewis Gordon, and in that highly honourable position he laboured with unexampled distinction for seventeen years. The spirit in which he conducted his class may be judged of by the following extract from the introductory lecture which he delivered on the occasion of taking possession of his chair; the subject of the lecture was, "The Harmony of Theory and Practice in Mechanics," in the course of which he said: "The objects of instruction in purely scientific mechanics and physics are, first, to produce in the student that improvement of the understanding which results from the cultivation of natural knowledge, and that elevation of mind which flows from the contemplation of the order of the universe; and, secondly, if possible, to qualify him to become a scientific discoverer. In this branch of study exactness is an essential feature, and mathematical difficulties must not be shrunk from when the nature of the subject leads to them. The ascertainment and illustration of truth are the objects; and structures and machines are looked upon merely as natural bodies are, namely, as furnishing experimental data for the ascertaining of principles and examples for their illustration."

When the British Association meeting was held in Dublin in 1857 Prof. Rankine had the honorary degree of LL.D. conferred upon him as a mark of the eminence which he had then attained as a physical investigator, although only thirty-seven years of age; and in the same year he was chosen as the first president of the Institution of Engineers in Scotland, an organisation which he materially helped to bring into existence. In November 1861 he also became President of the Philosophical Society of Glasgow, and during his term of office he conducted the business of the society with great tact and superlative ability; he delivered two addresses from the presidential chair and contributed several other papers, all of which were valuable contributions to science. We would only mention his first presidential address, the subject of which was "On the Use of Mechanical Hypotheses in Science, especially in the Theory of Heat." In it he gave a short account of the results which had been derived from that hypothesis which ascribes the mechanical action of heat to the centrifugal force of certain supposed molecular motions, a hypothesis which, like the wave theory of light, the hypothesis of atoms in chemistry, and all other physical hypotheses whatsoever, substitutes a supposed for a real phenomenon, namely, invisible motion for tangible heat; the object being to deduce the laws of the real phenomenon from those of the supposed one. Another of the most remarkable of his Philosophical Society papers was one which he read in January 1867, the subject being "On the Phrase 'Potential Energy,' and on the Definitions of Physical Quantities." This was suggested by a paper, entitled "On the Origin of Force," which Sir John Herschel contributed to the *Fortnightly Review*, and in which he expressed the opinion that the phrase in question was unfortunate, inasmuch as it went to substitute a truism for the announcement of a great dynamical fact.

Prof. Rankine did not content himself with being a "star of the first magnitude" in respect of the science of thermodynamics; he also plunged into, and won distinction in, the science of naval architecture, being impelled in that direction, doubtless, through the intimate friendly intercourse which he had with Mr. James R. Napier, F.R.S., one of the most original-minded naval architects and marine engineers that the Clyde has yet produced.

The deceased professor's writings are exceedingly numerous. He wrote and published, up to and including the year 1863, no fewer than eighty papers which were found to be worthy of mention in the Royal Society's catalogue; and between that and his death he had probably written as many more, in addition to the various treatises which he wrote upon "Civil Engineering," "Applied Mechanics," &c., all of which are of the very highest scientific and practical value. Whatever he wrote he executed with almost matchless perfection, whether we regard the elegance of his diction, the scientific order of his exposition, or the lucid methods of illustration which he adopted. His mind was of the very first order, and his death creates such a profound void in pure physics and scientific engineering that we could easily have afforded to give half-a-dozen of our most eminent practical engineers, civil or mechanical, that he might have been retained among us to pursue his original investigations and mould the minds of the engineers of the future.

JOHN MAYER