Eclipse Observations in Sumatra, January 14, 1926.

By Lieut.-Col. F. J. M. STRATTON.

EXCEPT for an Italian expedition to the east coast of Africa, all the astronomical expeditions to observe the eclipse of January 14 stationed themselves

a passing cloud robbed the observers of the first two minutes of totality.

At Benkulen, on the south-west coast, three or more expeditions placed themselves. The German expedition under Dr. Freundlich consisted of Prof. Keinle, Dr. von Klüber, and Dr. Mollet. Prof. Voûte, of the Lembang Observatory in Java, Mr. Kerkhoven, and Dr. Knol also joined this party. The programme was mainly the Einstein problem with some spectroscopic work as well. The equatorial telescope taken to Christmas Island in 1922 was used again, and in addition two horizontal telescopes, fed by the same cœlostat and giving simultaneously the sun's field and a second star field, were in use. The sky near the sun was clear throughout totality save for slight cirrus cloud passing over the sun, but the complete programme, including all the comparison plates, was carried out, and it is hoped that the required stars figure on the Einstein plates, and that Prof. Freundlich's continued ill luck at eclipses has ended happily. Attached to this expedition, but available for the

FIG. 1.—Mr. C. R. Davidson, with the 20-foot camera and 40-foot objective prism camera.

in Sumatra. A Dutch expedition under Dr. van der Bilt, with Prof. Pannekoek, Dr. Moll, and Dr. Mynnaert, was at Talangbetoetoe on the central line, near Palembang. Its programme was mainly spectroscopic and spectrophotometric—the distribution of gases in the layers of the corona being a special problem attacked. Most unfortunately, this station was clouded out completely.

A party from the American Naval Observatory, basing the choice of station on experience from the 1901 eclipse in Sumatra, was established at Kepahiang, a station in a high valley amongst the mountains which form the backbone of Sumatra. This party consisted of Capt. Littell, Dr. Peters, Dr. Kellars, Lieut. Ransford of the U.S. Naval Observatory, with Dr. Anderson, of the Mount Wilson Observatory. The party was assisted by a detachment of sailors from the U.S. Navy. A telescope of 70 ft. focal length was erected for direct photographs of the corona, and the programme included grating spectrograms with a moving plate of the flash and of the corona. Unfortunately, the sky at Kepahiang only cleared for the last seventy seconds of totality, but a curtailed programme was carried out successfully. The sky had been clear two minutes before totality, but

other parties at Benkulen, was a field workshop under Mr. Verhoeff.

The American expedition from Swarthmore College

FIG. 2.—Mr. Z. A. Merfield, with spectrophotometric equipment.

was also at Benkulen. Prof. Miller was the leader of the party, and his consistent good luck at eclipses held once more. With him was Prof. H. D. Curtis from

Allegheny, Dr. Marriott, Mr. Dominick, Mr. Wilson Powell, Mr. A. Rubel, and Dr. D. B. McLaughlin. Their programme included the Einstein problem, photographs of the corona with a 63 ft. tower telescope, interferometer measurements of the wave-length of the green coronal line, objective grating spectrograms in the infra-red, and colour photographs. The early development of their plates showed general success over the whole programme. Another expedition, camped in the same field, came from Harvard under Prof. Stetson, with whom were Dr. Coblentz, Mr. Weld Arnold, and Mr. W. A. Spurr. Their programme was mainly photometric, and was partially spoiled by the slight haze present in the sky. Capt. Harris, of the U.S. Signal Corps, also joined the American expedition with a cinema camera with which he hoped that he had been successful in photographing the elusive shadow bands as well as the whole eclipse.

The expedition sent out by the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society consisted of Mr. C. R. Davidson and Lieut.-Col. F. J. M. Stratton. There joined the party as volunteers Dr. F. W. Aston, Col. J. Waley Cohen, Mr. E. G. Barton, and Major R. G. R. Davies.

The expedition was very appropriately and most happily given accommodation in the old British fort—Fort Marlborough—built more than two hundred years

the immediate neighbourhood of the sun—cloud which passed over the sun during totality for the American and German expeditions less than half a mile away. The main programme was spectroscopic, both the corona and the flash being examined in the extreme infra-red and ultra-violet. Objective prism spectro-

FIG. 3.—Prof. Freundlich's Einstein camera.

FIG. 4.—Prof. J. A. Miller's 63-foot tower telescope with the Einstein telescope in foreground.

ago and now the barracks of the native police. At this station the sun was absolutely clear during the whole of totality, though there was thin cirrus cloud in

grams were also obtained of the flash and of the corona in the photographic and visual regions.

At the time of writing, only part of the plates have been developed, but they are sufficient to show that the expedition has been generally successful in its programme. Mr. Barton's programme was mainly photometric, his intention being to measure the total intensity of light from first to last contact; unfortunately, just at the commencement of totality the recording tape broke through a flaw in the paper, an accident which robbed his work of its most important phase.

The British expedition was joined by Mr. Z. A. Merfield, of the University of Melbourne, who was equipped with a moving plate grating spectrograph, a battery of eight cameras with different colour filters to study variation in the corona, and a moving plate colour filter photometer. The instruments were mounted on a polar axis and were all set up and adjusted in time, though owing to a series of accidents they did not arrive until eight days before the eclipse. Here

again, general success is indicated by the plates so far developed, and a useful contribution promised to the question of the distribution of solar vapours in

the higher chromosphere. Mr. Bridges, of the *Melbourne Herald*, was also attached to the British party as a volunteer, and a cinema camera of his was used with one of Mr. Merfield's parabolic gratings to get a timed series of photographs of the spectrum at the second and third contact. This instrument was worked by Capt. Akkersdyk, who was in command at the Fort and who helped the British expedition by every means that lay in his power. The photographs illustrating this article were taken by Mr. Bridges.

The choice of Benkulen as the site for most of the expeditions was based upon careful observations on cloudiness at eclipse time in previous years. These were made under the direction of Dr. Braak of Lembang, and they proved a useful guide to the visiting astronomers. It should be added that the facilities at Benkulen, and the friendly help given freely on every

side, showed how luckily the choice of a site had been made.

The season—the rainy season—was not at all promising, and for the month preceding the eclipse the numbers of fine and cloudy days were about equal. The day of the eclipse itself was cloudy most of the morning, but the sun cleared up for first contact. Thin cloud gathered between first and second contact, but cleared away shortly before totality. Five minutes after the end of totality, the sun was in cloud for the British station.

The corona was intermediate in type, resembling that of the 1900 eclipse in India. There were several very striking prominences on the limb, and the black moon, ringed with bright red prominences and surrounded by the pearl grey corona with its long irregular rays, made a wonderful picture, well worth travelling thousands of miles to see.

Space, Time, and the Universe.¹

By J. H. JEANS, Sec. R.S.

SOME of us may remember the story of the children who played truant in order to explore the regions where the rainbow ends. After travelling all day, up hill and down dale, they had to admit failure of the most thoroughgoing kind—the rainbow was, to all appearances, no nearer than when they started. Really scientific children might have thought of estimating their rate of approach to the rainbow by measuring the angle it subtended. If they had measured it in the morning it would have been $42^{\circ} 23'$; it would have been $42^{\circ} 23'$ at noon, and again at night it would still be precisely $42^{\circ} 23'$. If they had done this they must have felt that they were the victims of extreme bad luck, for they had clearly seen the rainbow in front of the nearest hill when they started out; could there be some sort of conspiracy on the part of rainbows, hills, and indeed the whole scheme of Nature, to prevent their getting close up to that rainbow?

In the year 1905 the world of physicists was engaged in a pastime which was, in many respects, very similar to that of chasing rainbows. They believed light to travel through an ether with a speed of 300,000 km. a second. If the solar system were travelling through this ether at a speed of, say, 1000 km. a second, it would partially overtake light travelling in the same direction, so that this light ought to appear to travel at only 299,000 km. a second. On the other hand, light travelling in the opposite direction ought to appear to travel with a velocity of 301,000 km. a second. This suggested an obvious means of discovering both the speed and direction of the earth's voyage through the ether—indeed, it was every bit as obvious as the children's plan for exploring the foot of the rainbow. Experiments were designed to utilise this principle and were tried time after time, not in one form only but in many. Time after time experiment gave the answer that the velocity of the earth through the ether was zero, or at least, to put it in another form, which was at that time thought to mean precisely the same thing, the velocity of light relative to the earth

was the same in all directions. No doubt it was conceivable that on the occasion of the first experiment the earth really might have happened to be at rest in the ether, but it was quite inconceivable that this should be the case every time; indeed, the earth's orbital motion alone required a variation of some 30 km. a second, and all the experiments were capable of detecting far smaller variations than this.

At first glance it looked as though the earth must be carrying its own private ether about with it, and I suppose this view would have prevailed had it not been for the astronomers, who were ready with an aberration-constant which at once, and, I think, irrevocably, dismissed the possibility of an ether being dragged about with us. Incidentally, this episode provides an often overlooked instance of the services of astronomy to the other sciences and to the growth of knowledge in general. The physicists on Jupiter may still believe that a luminiferous ether exists which follows Jupiter about wherever it goes; the reason is that there are no astronomers on Jupiter to put them right, their permanent blanket of clouds not encouraging this profession.

I forget the end of the story of the rainbow quest, but am prepared to provide an entirely unauthoritative ending. After the children had got completely tired in their bodies and still more completely bewildered in their wits, they rested for a long time, until they encountered a magician. He was not in the least the conventional magician, ponderous of speech and with a long white beard; indeed, he was a young man of twenty-seven, extraordinarily simple and unassuming in all that he said. What he said in brief was this: "I can tell you what is the matter. You have started to chase the rainbow on the supposition that it is a material arch; in actual fact it is all in your own eyes. Gretchen sees one rainbow and Hans sees a quite different one. But if Hans walks up to where Gretchen is standing, he simply changes his rainbow for hers; you don't get any nearer to a rainbow by walking this distance because there isn't really anything for you to get any nearer to. The angle you have been measuring must always stay at $42^{\circ} 23'$; it is fixed there by the

¹ Presidential address delivered before the Royal Astronomical Society on February 12, on the award of the gold medal of the Society to Prof. Albert Einstein for his researches on relativity and the theory of gravitation.