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Astronomy. — *"Report on the expedition to Sumatra for observing the total solar eclipse of 1926 Jan. 14th."* By J. VAN DER BILT, M. G. J. MINNAERT, W. J. H. MOLL and A. PANNEKOEK.

(Communicated at the meetings of October 31, 1925 and June 26, 1926)

I. *Organization and instrumental outfit.*

In the spring of 1924 the Royal Academy of Sciences appointed a committee which, after the nomination of some members from outside the Academy, consisted of Messrs J. VAN DER BILT, E. VAN EVERDINGEN, E. HERTZSPRUNG, W. H. JULIUS, M. G. J. MINNAERT, W. J. H. MOLL, J. J. A. MULLER, A. A. NIJLAND, A. PANNEKOEK, P. J. VAN RHIJN, W. DE SITTER and J. P. VAN DER STOK. This committee, on April 5th 1924, discussed the eclipse-problems thought most important and the general way along which they might be studied. At the following meeting, December 13th 1924, it was reported that the necessary funds for an expedition would be available; the members VAN DER BILT, MINNAERT, MOLL and PANNEKOEK were asked to form the observing party and, with the president of the committee, to act as an executive committee of the expedition. Unfortunately we could only for a short while enjoy the expert advice of our president Prof. Dr. W. H. JULIUS, who died on April 15th 1925; but we were able to draw up the general lines of research under his direction.

Thanks to Messrs NIJLAND and ORNSTEIN we were able to do all the preparatory work in the Astronomical Observatory and the Physical Laboratory of the University at Utrecht. The executive committee engaged Miss J. C. THODEN VAN VELZEN, a candidate for the Doctor's degree, as assistant, her duties to begin on May 1st 1925. Mr. H. C. BURGER, Lector in Physics at the Utrecht University has greatly obliged the Committee by giving his valuable advice in many difficulties.

The expedition was organized entirely through private gifts and facilities. The important gift of 30.000 guilders from a resident of Amsterdam, which made the expedition at all possible, has been already announced at the meeting of the Royal Academy on December 27th 1924. It was followed by a gift of 5000 guilders from the „Bataafsche Petroleum Maatschappij", which, moreover, invited the observing party to its estate at Pladjoe near Palembang. Our assistant was enabled to join the expedition through funds from the „Ondernemersraad voor Nederl. Indië", the „Nederlandsche Handel Maatschappij", the „Koloniale Bank" and the „Deli Batavia Maatschappij". The Directors of the Navigation Companies „Nederland", „Rotterdamsche Lloyd" and „Kon. Paketvaart" allowed a free transport of the instruments and a reduction of 50 % to the personal passage.

Observing place.

The zone of total eclipse ran across Sumatra, Bangka and Borneo with a gradual decrease in the duration of totality. The central line on Sumatra ran South of Bengkoelen, over Tebing Tinggi and North of Palembang.

We were advised by employees of the „Bataafsche Petroleum Maatschappij" to build our camp near the coast or in the plains, at a sufficient distance from the mountains; observations concerning the gathering of clouds, which the Resident of Palembang, at our request, ordered to be made at different stations in January 1925, pointed in the same direction. In the neighbourhood of the mountains the chance of a clear sky proved to be much less than that along the coast, for which at the hour of total eclipse (2h. 30m. p.m.), the estimate was about 40 %. Though at Bengkoelen the chance for clear weather was a little more than at Palembang and the duration of total eclipse a little longer, we chose the neigbourhood of Palembang, on the ground that our instrumental outfit needed the vicinity of a well-equipped city; as such Bengkoelen stands decidedly behind Palembang. The hospitality offered by the „Bataafsche Petroleum Maatschappij" definitely settled our choise, since it would put the numerous technical facilities of Pladjoe at our disposal. So we decided to build an observing-camp on the central line near Talang Betoetoe, that seat of a Government official (Controleur), about 15 kms North West of Palembang. An additional advantage of this choice was that — most of the other parties having decided for Bengkoelen — it prevented the crowding of all the observers on a single spot of the central line.

Observing program.

In drawing up a programme of observations we thought it best to restrict ourselves to problems raised by the result of modern theoretical investigations.

Of these, the problem of the corona is doubtless the most important. Its spectrum consists of a continuous background with a number of bright lines. The first is probably formed by reflected sunlight and light from the corona itself; this is suggested by the fact that the Fraunhofer lines are weaker than those of the solar spectrum. A quantitative comparison of these two continuous spectra of the corona may add to our knowledge of its constitution.

As to the bright-line spectrum of the corona, not a single line of it is represented in the spectra of known elements. The best working hypothesis is to ascribe these lines to atoms with an abnormal number of electrons, i.e. to a multiple ionization of the atoms. The lines have not yet been reproduced in the laboratory; so their wavelengths are uncertain and suggestions as to their origin, based upon their numerical relations could neither be proved nor disproved. Our knowledge, then, must be drawn from a study of the corona itself. For this it would be needful to get as many lines as possible and to measure their wavelengths with the highest precision. This will also enable us to judge of the reality of a number of doubtful lines, observed on a single occasion; and it will teach us — when duly repeated at future eclipses — whether the corona spectrum is variable or not. In the third place it is important to study the distribution of light in monochromatic images of the corona produced by different lines; this may teach us, which of them originate from the same kind of atoms and which from different kinds.

The spectrum of the chromosphere, too, must be observed from a modern point of view. The theory of ionization has emphasized the importance of accurate values for the intensities of the different lines of the same element. The great intensity of the enhanced lines suggests that in the outer atmosphere of the sun the atoms are more ionized than in the layers, which, by their absorption, yield the Fraunhofer spectrum. Thus also a variation of the ionization with increasing height may be expected. There exist, however, no reliable quantitative data about line-intensities. On the photographic plate a difference in intensity shows itself as a difference in the density of the silver deposit, which can be measured with a microphotometer. For the reduction of densities to intensities and for the interpretation of a change in intensity along each line, we must have some comparison line-spectra, weakened in a known ratio. Moreover, in order to compare the lines in different spectral regions, some standard-spectrum of known distribution of energy must be photographed on the same plate.

The usual flash-spectra obtained with a prismatic camera are not adequate to this investigation, because the light-source is an arc of the chromosphere of unequal width, and consequently the blackness of its image will depend not only on its intensity but also on the width of the arc. Therefore, in order to get accurate intensities, the spectrograms must be taken with a slit-spectrograph.

The continuous corona spectrum.

For the measurement of the intensities of the Fraunhofer lines, no great dispersion is wanted. For the sake of an increased brightness, a small dispersion together with a large angular aperture may be recommended. The two prism-spectrograph, built for the eclipse of 1901 seemed very appropriate for this purpose. The solar image is formed by an objective of 10 cm. with a focal length of 38 cm. The objectives of the collimator and the camera have a diameter of 36 mm. and a focal length of 13 cm.; the two compound prisms are 60 mm. wide and 38 mm. high. Upon examination, the prisms proved to give bad images, chiefly caused by large striae in the Canada balsam; these prisms were re-polished and freshly cemented by the firm of Carl Zeiss, and after this they gave very good images.

In their report on the observation of the eclipse of August 21th, 1914, Messrs MIETHE, SEEGERT and WEIDERT have given a description of the spectrograph, with which they intended to photograph the continuous corona spectrum. In this instrument the focal ratio of the diameter of the camera-objective is only 1 : 2, and it, therefore, seemed to serve our purpose even better than our own spectrograph. The director of the GOERZ Works most kindly and disinterestedly lent us this instrument. We decided to compare the corona-spectrum which it would yield, with a number of comparison spectra, obtained by mixing sunlight and artificial white light in various known proportions.

The bright line-spectra of the corona and the chromosphere.

For the observation of these spectra we intended to use two spectrographs. One was the three prism-spectrograph, built for the eclipse of 1901 and described in the reports on that eclipse. The solar image is formed by an objective of 80 mm. with a focal length of 61 cm ; the objectives of the collimator and the camera have a diameter of 55 mm and a focal length of 42 cm. The compound prisms are 60 mm wide and 55 mm high.

With this instrument, too, the prisms, at first, gave bad images. The ZEISS firm did not succeed in fully correcting these prisms, but they were so far improved as to yield very satisfactory images. We intended to place the slit along the East-West diameter of the solar image ; thus, we got on both sides of the moon a radial section through the corona, nearly coinciding with the direction of the sun's equator. The plate would contain an iron-arc comparison spectrum, adjusted so as to get the iron lines only across the dark lunar disk and outside the corona.

The second instrument, with which we planned to photograph the spectrum of the corona and the chromosphere, was originally a large prismatic camera, built by Messrs TROUGHTON, COOKE and SIMMS for the eclipse of 1901. For our purpose we had it changed into an auto-collimating slit-spectrograph (Littrow-adjustment) ; its excellent TAYLOR-triplet (aperture 16 cm; focal length 260 cm.) now being at the same time collimator and camera objective. One of the two 45° prisms proved to give very bad images, probably the result of internal strains. We, therefore, ordered from COOKE a third prism of the same dimensions. At the same time, the rejected prism was sent to the SCHOTT Glass Works at Jena to be submitted to a renewed process of annealing and cooling (Präzisionskühlung) after which it was ground again at the ZEISS Works. The result was quite satisfactory ; after its return the prism showed about the same qualities as the other ones and therefore all three were mounted in the new spectrograph.

We planned to observe the corona spectrum and the 1st and 2nd flash on plates, which would also contain iron-arc comparison-spectra for accurate wavelengths of the corona-lines and for reliable intensities for those of the chromosphere. At either contact a number of exposures would be made. For this purpose 12 plates were to be adjusted at the surface of a rotating cylinder. A solar image would be formed on the slit of this instrument by the STEINHEIL photographic objective belonging to the Utrecht Observatory; this has a diameter of 26 cm and a focal length of 345 cm.

In order to get the successive layers of the chromosphere with maximum extension on the slit, the latter must be tangent to the solar image at the point of contact.

The relative positions of solar image and slit must remain exactly the same during the observations. A rotating coelostat is generally used for this purpose, but such an arrangement could not fulfil our requirements. The sun's image was not allowed to shift its position relative to the slit more than 1 or 2 seconds of arc, whereas the displacements, due to the imperfection of the usual coelostats and siderostats proved to be 5 to 10 seconds. Even an exceptionally well built coelostat, which was offered us by Prof. MIETHE at Charlottenburg, showed oscillations of the image, which were quite unallowable. In order to escape from these difficulties, we have chosen a fundamentally different arrangement. This consists in clamping the coelostat mirror and moving the objective in the opposite direction in which the image would travel in case of a stationary lens. If, then, the speed of the lens is made to equal that of the moving image, this will be kept in a fixed position. The screw, moving the lens, will have its errors, as well as that of the coelostat. But the effect of these errors on the steadiness of the image will be much less. In fact, compared with that, due to the coelostat-errors, it will be as many times smaller as the radius of the wormwheel is contained in the focal length of the lens. In our case this ratio is about 25. With a screw of the same quality as used in the coelostat, we, therefore, may expect the displacements of the sun's image to be much below one second of arc. The screw moves the lens by way of a small electro-motor, properly geared down, and regulated by a clock ; a scheme, designed by GERRISH for driving the telescopes at the Harvard Observatory. In this way the sun's image will be kept in the same steady position for both the 1st flash and the corona ; the coelostat-mirror will then be turned over an accurately determined angle for the second flash.

Monochromatic images of the corona.

In order to obtain the distribution of the radiation in the corona for various wavelengths, the use of a prismatic camera is indicated ; this will yield a number of monochromatic images of the corona. The usual prismatic cameras having all been designed for the flash spectrum, we had to discuss the demands for work on the corona. The inner-corona sends us some faint monochromatic radiations and a rather strong continuous spectrum. The surface-brightness of the monochromatic corona images depends on the angular aperture of the camera ; the contrast between these images and the continuous spectrum depends on the dispersion of the prisms. Hence, both the angular aperture of the camera and the dispersion had to be taken as large as possible. According to this principle we designed two prismatic cameras of a special type.

The first one has a camera with a ZEISS Astrotriplet, with an aperture of 6 cm and a focal length of 27 cm, making the inner diameter of the corona-rings 2.4 mm. In front of this objective are four flint prisms of 66° ; they give a dispersion of 5°,5 from H_β to H_γ. With such a long path inside the prisms, there is a danger that light-beams, far away from the central one, will partly be cut off ; this was compensated by increasing the size of the prisms as they came farther from the camera. As a result of the strong astigmatism caused by such a series of prisms, the corona-ring is circular only for the central wave-length ; for the shorter waves the rings are elongated in the direction of the spectrum ; for the longer waves they are elongated perpendicular to the spectrum. Since the camera would be in the way of the incident light, we placed a small mirror in front of the first prism. This mirror sends the light reflected from a coelostat-mirror through the train of prisms. The instrument was constructed in the ZEISS Works at Jena.

In our second prismatic camera we used a liquid prism. As a consequence of the great dispersion of highly refractive liquids, a single liquid prism will give a dispersion equal to that of a number of glass prisms. Such prisms find no application in research work, because small differences of temperature cause striae in the liquid, which may distort the spectral images. By seeing to good isolation, we hope to prevent rapid changes of temperature. The same intention led us to the use of a direct-vision prism ; the thick pieces of glass in front and behind the liquid, help to protect it from the heat. Since the instrument will only be exposed when the sun is eclipsed, the heating by the radiation itself will be negligible.

We, therefore, ordered from Messrs STEEG und REUTER at Homburg v. d. Höhe, a direct-vision "WERNICKE"-prism, to be filled with ethylcinnamate. We intend to use this in combination with a ZEISS camera of the same type as used in the last mentioned instrument.

We have thought it an interesting experiment to see whether, in eclipse-work, such a peculiar prismatic camera could be useful.

Solar radiation.

ABBOT derived the distribution of the energy over the sun's disc by direct measurements in a solar image. These do not include more than 95 % of the radius, reckoned from the centre, whereas just the sun's edge, from which comes all the radiation, emitted under angles of 72° to 90°, is of fundamental importance to our knowledge of the physical constitution of the photosphere.

JULIUS remarked that measurements in a solar image will not give correct results, since it is covered by light, diffused by the earth's atmosphere. He, therefore, proposed a method to deduce the distribution of intensity from measurements of the radiation during a solar eclipse. This method, which is entirely free from the disturbing effect, just mentioned, has been applied at the eclipses of 1905 (Burgos, Spain), 1912 (Maastricht, Holland)

and 1914 (Hernösand, Sweden); on the last occasion for a number of spectral regions.

The results of the 1914 eclipse, however, showed that the method is only reliable just before and after totality, i.e. when observing the radiation of the outermost regions. We originally planned to apply JULIUS' method, thus limited, at the Sumatra-eclipse. But since this eclipse did not seem to serve the purpose very well (difference between the solar and lunar diameter rather large; a damp, tropical climate) we resolved to try measurements outside an eclipse, using refined instruments and choosing the most favourable observing site. As such we decided for the Gornergrat, Switserland; Messrs MOLL, BURGER and VAN DER BILT spent the month of August 1925 up there and got a series of preliminary measurements, the results of which have been published in the Bulletin of the Astronomical Institutes of the Netherlands (Vol. III N⁰. 91). Measurements during a solar eclipse following JULIUS' suggestion remain desirable, even now, but only at an eclipse of short duration, observable in a good climate.

II. *The expedition to Sumatra.*

The journey.

The observing party left Marseilles for Singapore on the „Rotterdamsche Lloyd" liner „Tabanan", November 10th 1925. From Singapore the ss „van Swoll" of the „Koninklijke Paketvaart Maatschappij" conveyed the expedition to Palembang, where it arrived on Dec. 4th. A few hours earlier the ss „Wega" of the Colonial Service Marine, put at our disposal by the Vice-admiral, Commander in chief of the naval forces at Batavia, had been anchored on the river. Its commanding officer, Mr. J. M. VOOREN and his staff, enlarged at our request with two additional officers, have regularly taken part in the mounting of the instruments, in the drills and the observations. The „Wega" had also brought to Palembang Mr. N. P. MIEDEMA, chief-instrumentmaker in the Topografic-Service of the Army; we are much obliged to the chief of this Service for sending us this officer, whose zeal and capability have been of great value to us. On Dec. 31st Messrs P. VAN LEEUWEN BOOMKAMP and L. E. VAN LEEUWEN BOOMKAMP joined the party and at once took part in the work.

The members of the expeditions gladly accepted the invitations from the Directors of the „Bataafsche Petroleum Maatschappij" to live in cottages of the Pladjoe-estate and from the Commander of the Navy to use the first class cabins of the „Wega". Two days after the eclipse, the whole party left Palembang for Batavia on this ship. From there, Mr. PANNEKOEK went straight to the „Bosscha Observatory" at Lembang in order to continue his observations of the southern Milky Way, which he had already started during the outward trip. The other members spent a few days in Batavia; there they payed their respects to Their Excellencies the Governor General and the Commander in chief of the naval forces, and thanked them for the courtesies and assistance which all the various government services had extended to the expedition. Mr. P. VAN LEEUWEN BOOMKAMP then, invited them for a short stay in Java (including a visit to the Bosscha Observatory) and in Deli (East-coast of Sumatra). From there they returned in Holland on Febr. 14th 1926 in the Nederland-liner „Koningin der Nederlanden". Mr. PANNEKOEK left Java in the same ship on May 19th.

The eclipse-camp.

Prof. E. W. BROWN of Yale University had informed us that, judging from the 1925 eclipse-results, the central line on Sumatra would run about half a mile north of the almanac-line. We, therefore, choose for the installation of our instruments, a site about 18 kms from Palembang, by the road from Talang Betoetoe to Pangkalan Benteng. The coordinaties of this place were

$$\text{Latitude} = 2^\circ\, 52'\, 58'' \quad \text{South}$$
$$\text{Longitude} = 6^h\, 58^m\, 40^s.2 \quad \text{East}$$

After the brush had been cut and the ground cleared, the "Bataafsche" started with the building of our camp according to our instructions. They had put their architect Mr. B. C. VAN DE WETERING in charge of the work; he finished it promptly to our entire satisfaction. The relative position of the piers is shown in the diagram; over these piers we had shelters, the upper part of which could be removed when the observations made this necessary.

To the North of the piers a large barrack was built, which contained a dark room, a workshop, a dining room, a packingroom, and a garage. Through the care of the Chief Engineer of the Civil Public Works, the camp was surrounded by a barbed wire railing. Outside this railing barracks were built for a non-commissioned officer and seven soldiers, who by order of the Military Officer in command, would have to guard our camp.

About 100 m. from the piers a gasmotor and dynamo were installed; the latter supplied the current for two electric arc-lamps, the storage batteries, the illumination of the dark room and a number of dim lamps near the instruments. The storage batteries were lent to us by the „Borneo Sumatra Handel Maatschappij" and charged by the „Nederlandsch Indische Gas Maatschappij".

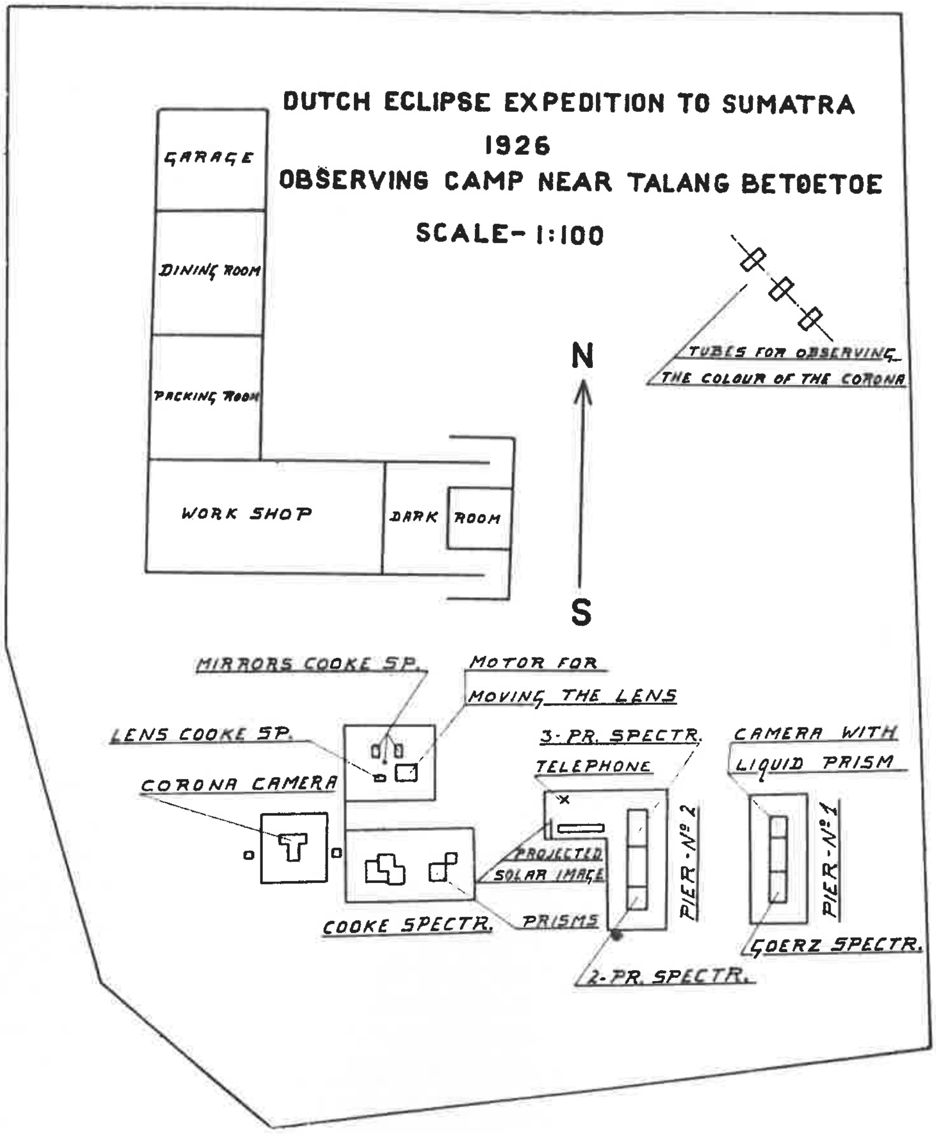
A motor-launch and a motor-car, both of the „Bataafsche" secured a regular communication between Pladjoe, Palembang and the eclipse camp.

The instruments.

1. *Adjustment.* As indicated in the diagram, the prismatic camera with liquid prism and the Goerz-spectrograph were fed by the mirrors of the Eastern-most siderostat; this was a double polar siderostat, clockdriven. The two- and three-prism spectrographs were fed by the mirrors of the second siderostat; this too, was a double polar siderostat, driven by a motor which was regulated by a pendulum-clock.

The mirrors and the spectrographs were adjusted with respect to the pole of the heavens by using two universal instruments, borrowed from Prof. H. J. HEUVELINK of Delft and Prof. J. W. DIEPERINK of Wageningen. With a view to make these adjustments independent of weather conditions, we began with the measurement of the azimuth of a land-mark, a fork in a leafless tree, about 900 m Southward of the camp.

The siderostats and coelostats were adjusted by a method differing from that usually followed. In order to apply this method, both universal



instruments had been supplied with a Gaussian eye piece, through which auto-collimation became possible. Now, to adjust the axis of the siderostat with respect to the pole, one of the mirrors was placed perpendicular to the axis; then a universal instrument was placed in front of the mirror, and its telescope — by way of the known latitude of the camp and the azimuth of the landmark — carefully adjusted so as to be parallel to the earth's axis. We had then only to correct the inclination and the azimuth of the axis of the siderostat, till the observer at the telescope saw the cross-wires coincide with their reflected images.

The spectrographs were adjusted in the following way; the universal instrument was placed on the pier of the spectrograph with its telescope properly adjusted so as to be parallel to the earth's axis, and the mirror adjusted so as to get a solar image on the cross-wires. Then, the driving mechanism of the siderostat was started, the universal instrument exchanged for the spectrograph and the latter adjusted so as to get the solar image on the slit.

With the coelostat used for the corona camera we proceeded as follows: the two universal instruments were placed on either side of the mirror, the telescopes pointing East and West and their optical axes coinciding. Then, by adjusting the mirror in its box and changing the azimuth of the axis of the coelostat, a position could be arrived at, in which the cross wires of both telescopes could be brought into coincidence with their reflected images. This meant that the plane of the mirror was parallel to the axis, and the axis was in the meridian plane. It remained to give the latter its proper inclination; this was done with one universal instrument, whose telescope was in the meridian, and at right angles to the earth's axis. The inclination of the axis of the coelostat was then corrected, till the observer at the telescope saw the wires cover their reflected images.

The method of auto-collimation was again very useful on the day of the eclipse; it allowed the coelostat mirrors, which could not be adjusted in hour-angle, to be clamped in the exact position on starting the driving mechanism.

All the mirrors have been resilvered a week before the eclipse. Mr. G. F. F. AVÉ LALLEMANT, in charge of the hospital at Pladjoe, had the courtesy to abandone his well lighted and dust-free operating room for this purpose.

2. *Focussing*. We devised the following method for obtaining a sharply focussed image on the slit of the spectrograph. A large screen with a central hole of about 1 cm was moved to and fro before the objective; if the slit is not exactly in the focal plane of the lens, the sun's image will be seen either to follow the motion of the screen, or to move in an opposite direction. Since the human eye is very sensitive to small displacements, this method affords a very sharp focussing. With regard to the spectral regions under observation, the use of a blue glass was necessary.

The two prismatic cameras were photographically focussed, using a collimator and an iron arc-lamp. About the camera with liquid prism we want to say that the results came up to our expectations; even without special precautions, the sharpness of the iron lines was very satisfactory. The ethylcinnamate in the brass tube, after some days, showed a slight precipitation and was therefore replaced by fresh liquid one day before the eclipse.

3. *Adjustment of the slit of the large spectrograph.* The mounting of the large auto-collimating Cooke-spectrograph required a number of piers (see diagram).

A mirror mounted as a coelostat sent a highly inclined beam of sunlight in the plane of the meridian to a second mirror, which reflected the light to the Southpoint of the horizon. Thus, the rotation of the sky caused the solar image to travel in a horizontal direction over the slit; this motion, as has been stated above, could be compensated by a horizontal motion of the objective.

The mirrors were clamped in such a position, that two minutes before totality the solar image was 1 cm from the slit and was approaching it. On the instant it reached the slit, the carrier of the lens was coupled to the already working motor, causing the solar image to remain fixed. The observer at the viewing eyepiece of the spectrograph could visually observe the spectrum and move the slit parallel to itself with a micrometer-screw. By the length of the continuous spectrum he could judge what part of the slit covered the sun's image. Practical considerations induced us to adjust the slit parallel to the tangent, 1″ inside the solar image. In this position the slit cut edge of the image 2°.5 from the point of contact in a point, where the chromosphere would be covered by the moon only by 0″.02. This position would be kept while photographing the spectrum of the corona. In order to get the second flash, an assistant could turn the coelostat mirror through a previously determined angle. The moving lens compensated the rotation of the sky and the mirror could be adjusted for the second flash with a precision that left nothing to be desired.

The colour of the corona.

Some days before the eclipse, we decided to have colour observations of the corona made by amateur-observers. The contradictory results to which colour-estimates of the corona have led, are probably due to a lack of a suitable object for comparison. As such we choose a piece of white cardboard, illuminated by a Philips' daylight-lamp. The observer, looking in a cardboard tube could simultaneously view the corona and the illuminated screen and compare their colours. We found Messrs VAN DE WETERING, MOORMANN and WALLIS DE VRIES willing to make these observations.

Time-service.

The Navy Department in Holland, had granted us the loan of 3 chronometers. During our stay at the eclipse camp these were kept under control by comparing them with one of the chronometers of the „Vega", the correction for which was derived from daily wireless time signals. Since the calculated time of the first flash could not be trusted to a few seconds, we took two precautions so as to be exactly in time. Firstly we arranged to have a solar image of about 10 cm projected on a screen and to observe the moment at which the distance between the horns of the crescent was that computed for 12 seconds before totality. Secondly we had a telephonic connection made between the camp and a post on the central line, 10 kms distant. An observer at this point would see totality begin 12 seconds earlier than the observers in the camp. This responsible post was held by Mr. H. J. SCHMIDT, acting Resident of Palembang. His signal was received by Mr. J. VAN DER BILT, who also observed the projected solar-image, and with the assistance of Mr. ADAM, 4th officer of the Government's Navy, counted and called the seconds during the total phase of the eclipse.

Eclipse-day.

A week before the eclipse we decided upon the operations to be carried out on the eclipse-day; during the following days the observers went through regular rehearsals. On the eve of the 14th all the instruments stood carefully adjusted and tested; and we had the agreeable feeling that our rather complicated equipment, every detail of which had been cared for, would fully justify our expectations.

The arrangement for eclipse-day was the following:

a. *Corona camera with liquid prism:* Mr. E. K. VAN MELLE, 2nd officer Governm. Navy.

b. *Goerz-spectrograph:* Mr. A. J. LOUET FEISSER, 2nd officer G. N.

c. *Two-prism spectrograph:* Mr. J. M. VOOREN, Commanding officer G. N.

d. *Three-prism spectrograph:* Dr. A. PANNEKOEK, for the manipulation of the iron-arc lamp assisted by Mr. R. TROOST, 2nd officer G. N.

e. *Cooke-spectrograph:* Dr. M. G. J. MINNAERT, assisted by Mr. P. VAN LEEUWEN BOOMKAMP at the revolving plate-holder and the slit-shutter; by Mr. J. J. NEESSEN, acting 1st off. G. N. at the iron-arc lamp; by Mr. L. E. VAN LEEUWEN BOOMKAMP at the mechanism for moving the lens; and by Mr. B. M. D. FHIJNBEEN, non-commissioned officer of the Army, at the handle for turning the coelostat mirror.

f. *Corona-camera.* Miss J. C. THODEN VAN VELZEN.

Dr. W. J. H. MOLL superintended the correct execution of the program, ready to act in case of emergency. The instrumentmaker, Mr. MIEDEMA stood by him.

Before we left Holland, we had gathered from various informations, that we should encounter a rather regular change of weather in the course of a day, with little chance of a clear sky in the afternoon. But, to our surprise, the weather, during the six weeks of our stay at Palembang, was without any regularity. Entirely cloudy days were sometimes followed by rains, sometimes by sunshine ; and this, apparently, regardless of the hour of the day. The last five days before the eclipse, conditions at eclipse-time were rather favorable.

On the morning of January 14th there were thin clouds in the sky. Shortly before noon, denser clouds came over from the North-West, soon covering the whole Western sky ; they brought us a shower about half an hour before 1st contact. It looked for a while as if there would be a change for the better ; but then a layer of cirro-cumuli began to cover the sun.

The mirrors and the projected solar image could still be adjusted, but towards 2nd contact the sheet became thicker and, though the beginning of totality could be seen with the naked eye, the flash spectrum was not visible in the viewing telescopes of the 3-prism spectrographs. The signal from the observer in the telephone-hut, where the sun was free from clouds, came exactly 12 seconds before totality ; the screen had since long ceased to show anything of the sun's image. Totality began two seconds later than was computed. Towards the time of third contact, the sheet of clouds became a little thinner. The observers duly went through all the operations, but were convinced of the fruitlessness of it ; development of the plates proved that they were right. The plates taken with the slit spectrographs revealed nothing. On those, taken with the slitless spectrographs, the prominences have left faint traces ; the plate of the corona camera showing the $H\beta$, $H\gamma$ and $H\delta$ images and that of the liquid prism camera showing in addition to these, the H and K lines. This fact is an indication of the great light-gathering power of the two instruments. Needless to say, that, in these circumstances, colour-estimates of the corona could not be made.

Final remarks. The expedition had no success ; but neither the effort nor the expense have been made for nothing. In the course of the preparative work new problems have been brought forward, new methods have been devised and new instruments have been constructed, which could be tested not only in the laboratory, but also under the peculiar conditions of an eclips-camp in a tropical climate.

This last experience is valuable in view of the eclipses of 1929 and 1934, which will be visible in the Dutch East Indies.

Our expedition, though missing its mark, has not been entirely fruitless. It led to the expedition to the Gornergrat and it offered to Mr. PANNEKOEK an opportunity to extend his researches on the structure of the Milky Way to the whole sky. We consider these two facts to constitute a positive gain to science. Moreover, thanks to the improvement of the older instruments and the construction of modern ones, the Royal Academy now possesses a valuable instrumental outfit, which is not solely useful for future eclipse-work, but, between eclipses, will be available for scientific work of different kind.

In concluding, we wish to express our appreciation and gratitude to

Mr. P. van Leeuwen Boomkamp who, feeling sure that the Dutch Government would not be prepared to pay the heavy expenses of a solar eclipse expedition, generously provided the necessary funds, both for the Gornergrat- and the Sumatra expeditions. He thus saved the honour of our national science at an international scientific event.

Furthermore, we are greatly indebted to the Directors of the ,,Bataafsche Petroleum Maatschappij" and to all the other Companies mentioned in this and in our first report.

We also want to express our gratefulness to all the Government employees ; and to all the managers and employees of estates and factories, whom we met on our way ; they all did their best to be useful to our work and to make our ocean trips and our stay in India a real pleasure to us all.