13. COMMISSION DES ÉCLIPSES SOLAIRES

PRÉSIDENT: M. STRATTON, *Director of the Solar Physics Observatory, Cambridge, England.*

MEMBRES: MM. Curtis, Danjon, C. R. Davidson, de la Baume Pluvinel, Donitch, Freundlich, Gerasimovič, Grotrian, Horn d'Arturo, McNally, Menzel, Miller, Minnaert, Mitchell, J. H. Moore, Oikawa, Stetson, Voûte.

(*a*) COMING ECLIPSES

(i) 1936, *June* 19. The Eclipse Committees of Japan and the U.S.S.R. have been making preliminary meteorological studies of the weather conditions along the belt of totality in their respective countries. The Japanese Committee report (*Bulletin, Kwasan Observatory*, 283, 1934) that, while at the extreme east and west of their totality zone the weather prospects are unfavourable, for the central part, along the north-east coast of the island of Hokkaido, from Esasi to Monpetu and in a region round Syari the weather conditions are as good as in the best seasons of Tokyo and Kyoto in an ordinary year. A pamphlet giving all information is being prepared and will shortly be circulated in astronomical circles, but it may be mentioned that Monpetu and Syari are accessible by rail from the port of Otaru. There is electric current, 100 V, A.C., labour is readily available and accommodation will be possible for small parties.

As a result of the work of eight expeditions organized by the Academy of Sciences of the U.S.S.R., the Eclipse Committee is able to report that the best region for observation from the meteorological point of view is between 47° and 58° E. The conditions deteriorate east of 58° E. and are poor near Lake Baikal. Living conditions, transport, etc., will be best in the Oranburg-Orsk region.

(ii) 1937, *June* 8. The belt of totality of this eclipse of long duration stretches across the Pacific Ocean and only crosses land at Canton or Mary Island 2° 28′ 53″S. 171° 42′ 35″ W., and at Enderbury Island 3° 8′ 30″ S., 171° 10′ 0″ W.

Enderbury Island is 30 ft. high, uninhabited and without fresh water. It is surrounded by a coral reef, which is steep-to, there is no anchorage and landing is difficult.

Canton Island is a coral atoll, 10–12 ft. high, with a lagoon. Coconuts have been planted in places; the island is said to be uninhabited. There is an anchorage in 10 fathoms, not safe with westerly winds, close to the entrance to the lagoon on the west side.

Sarah Anne Island, once reported by the U.S. navy at a point in the belt of totality, is no longer to be found.

(iii) 1940, *October* 1. Dr Jackson reports that the meteorological conditions for the 1940 eclipse in South Africa are well above normal, with every prospect for a clear sky. In the western half of the track, Bitterfontein (altitude 1300 ft.), is a railhead with a hotel; rainfall 5–6 in. a year. Nieuwerust, 10 miles south of Bitterfontein is an educational centre, but has no electrical supply at present. Calvinia (altitude 3200 ft.) has a population of 2700, an aerodrome, two hotels and other accommodation, electric light (220 V, D.C.) with rainfall 10–12 in. a year: there are mountains rising to 5000 ft. easily accessible from Calvinia. Other possible sites for an eclipse camp are at Nieuwoudtville, 40 miles west of Calvinia, and Williston, 70 miles east of Calvinia. Further east the largest town near the central line is Cradock (altitude 2800 ft.): electric current is available and weather prospects are good.

(*b*) Expeditions notified for the 1936 Eclipse

The Observatory of Starya-Doubassary is arranging an expedition under Dr Donitch to a point near the central line on the coast of the Black Sea; programme: (1) Slit spectrograms over as long a range as possible of the chromospheric spectrum; (2) Objective prism spectrograms of the upper atmosphere of the sun; (3) Slit spectrograms of the corona (low dispersion); (4) Direct photographs of the corona with a lens of 10 in. focal length and with a short focus lens for faint extensions.

Poulkovo Observatory is sending two expeditions: (i) to somewhere near Oranburg to study chromospheric problems and (ii) to the region of Krasnojarsk or Kansk to study the corona. It is understood that Dr Menzel and Dr Boyce will also go to Siberia from Harvard Observatory for a spectrophotometric study of the chromosphere and the corona over as wide a range of spectrum as possible, and Dr R. L. Waterfield will go to the Tomsk region to secure photographs of the corona in the blue and infra-red, with special attention to long extensions, and infra-red spectrograms of the chromosphere and corona.

The British Eclipse Committee report that Prof. Carroll, Aberdeen University, will probably go to near Krasnoyarsk for interferometric measures of the widths and detailed structure of chromospheric lines, and of internal motions in the corona, and a second expedition (Prof. Stratton, Dr Redman and others) to Hokkaido. The programme of the latter party will, it is hoped, include (1) Spectrophotometry of the chromosphere by means of a series of short exposures on a plate fixed for each exposure; (2) Polarization of the corona and the distribution of intensity in the corona; (3) Extension of the spectrum of the corona in the ultra-violet; (4) Accurate wave-lengths of absorption lines at the limb and of bright chromospheric lines; (5) Photographs of the corona in the extreme infra-red.

Dr Johnson, California Institute of Technology, will also go to Hokkaido to continue the work on polarization which he carried out at the last eclipse.

Attention should be drawn to the new formulae in connection with eclipse computations contained in the *Nautical Almanac* for 1934, pp. 806–821, especially to the corrections from an assumed station to the one finally selected by an eclipse expedition (pp. 812–816).

(*c*) Recent reports on eclipse results

(i) Donitch reports the unexplained appearance on an objective-prism spectrogram of the corona and the high chromosphere of dark crescents on one limb immediately above the bright crescents due to $H\alpha$, D3, $H\beta$, $H\gamma$, [H], [K] and $H\delta$. The dark crescents extend from a height of about 50,000 km. to about 100,000 km. above the limb (*Bull. de l'Acad. Roumanie*, 16 année, No. 4, 1933).

(ii) The results of the Lick Observatory expedition in 1932 demonstrated that the lines of the coronal spectrum are too wide for increased accuracy of wave-length to be obtained by the use of the interferometer. Lyot's interesting work at the Pic du Midi has confirmed the great widths of the lines. His wave-lengths for the red and green coronal lines may be compared with Mitchell's obtained at the 1930 eclipse from 10 and 14 measures respectively:

Mitchell	Lyot
5302·91 ±0·02	5302·85 ±0·03
6374·28 ±0·03	6374·75 ±0·15

Grotrian gives a fresh grouping of the coronal lines (*Z. f. Ast.* **7**, 26, 1934) from the 1929 eclipse, from which it appears that considerable variation in the relative intensities and intensity distribution of the various lines of the coronal spectrum are to be found from eclipse to eclipse. The discovery of the principal corona lines in the spectrum of R S Ophiuchi at its recent outburst, when coupled with the great strength of helium in that star's spectrum, lends support to the suggestions of Rosenthal (*Z. f. Ast.* **1**, 115, 1930) and of Goudsmit and Wu (*Ap. J.* **80**, 154, 1934) that the coronal lines may come from helium atoms with two electrons excited.

(iii) J. H. Moore has confirmed (*P.A.S.P.* **45**, 147, 1933) his previous result as to the displacement to the red of the Fraunhofer lines in the continuous spectrum of the outer corona, indicating that the cloud of particles reflecting the sunlight is moving outward with a velocity of over 20 km./sec. He has also confirmed from coronal spectrograms secured in 1922 and 1932 (*P.A.S.P.* **46**, 298, 1934) Grotrian's statement (*Z. f. Ast.* **8**, 124, 1934) that the breadths of the Fraunhofer lines in the outer coronal spectrum are appreciably the same as those in the solar spectrum. Moore gives an upper limit to the average velocity of the particles reflecting the light at 10 km./sec. This indicates that the scattering of the solar light giving the Fraunhofer lines must be done not by electrons but by particles whose diameters are three or four times the wave-length of light.

(iv) The form of the corona and its relation to sunspot and prominence frequencies have been examined further by Ludendorff (*Sitz. d. Preuss. Akad.* 1934, 204) and by Bergstrand (*M.N.R.A.S.* **95**, 436, 1935), with greater emphasis on the connection of the corona with prominences.

(v) Unpublished results obtained by Menzel indicate that above the highly excited regions of the chromosphere, where *He* II 4686 and the lines of *He* I are exceptionally strong, the corona reaches a maximum intensity, especially in the emission line 5303. The density gradient in the chromosphere is found to vary, being considerably less in the 1932 eclipse than in the 1930 eclipse; the variation depends upon atomic weights, ionization potentials and excitation potentials and the gradients vary not only in time but from place to place on the sun at the same moment.

(vi) Observations secured at the 1932 eclipse by Dufay and Grouiller (*C.R.* **196**, 1574, 1933) showed that the proportion of polarized light was independent of wave-length, in agreement with Minnaert's view that the corona diffuses light like a gas of free electrons. Their photographic measures of the percentage of polarization (a maximum of 26 per cent. at 10′ from the limb) agrees well with the visual estimate, 28 per cent. at 8′·5 from the limb, obtained at the 1934 eclipse by J. J. Johnson (*P.A.S.P.* **46**, 226, 1934). Cohn at both eclipses (*P.A.S.P.* **46**, 180, 1934) found that at 8° from the Sun during totality the plane of polarization of the skylight was rotated several degrees from the radial direction and the polarization was increased in amount. He also found unexplained maxims at 5910–6150 A and at 4610–4700 A in the sky spectra at this same point 8° from the Sun (*Nature*, **134**, 99, 1934).

The polarization of the sky-light at the zenith and 90° from the Sun were examined at the 1927 eclipse—during the partial phase—(Süring, Kuhl and Albrecht, *Veröff d. Preuss. Meteorologisches Inst.* Abh. x, No. 4, 1934) and were found to be below normal as also the proportion of UV radiation. This variation of the distribution of the solar continuous radiation during the partial phase of an eclipse, whether through changing condensation or for other reasons, is of special importance in any use made of the light from the partially eclipsed Sun in connection with the photometry of eclipse spectra.

(*d*) Outstanding Problems

A list of suggestions for observers' programmes was drawn up at the last meeting of the Union (*Trans. I.A.U.* **4**, 233, 1932). The following supplementary suggestions have been received through members of the Commission.

Prof. Slocum: I hope that, in spite of the negative report, interferometer observations will be tried again, especially in an attempt to detect rotation in the corona.

Dr Adams: Among observations that we should like to see undertaken are the photography of the ultra-violet and infra-red corona lines and the photography of the prominent flash spectrum lines with a moving picture camera, as planned by Dr Dunham at Lancaster in 1932.

Mr Pettit: One problem that is greatly in need of attention is that of the spectrum of the prominences showing their forms in the various chromospheric lines in such a way that intensities can be obtained. A grating spectrogram with dispersion of about 5 or 6 A/mm. would be desirable with calibrations. The exposures would be made between the flash contacts, with a short one of about 5 sec. for the brighter lines and a longer one for the fainter lines.

Dr de Lury: I regard as most desirable moving plate and motion picture records (with chronographic recording) of the flash spectra—bright gratings and fast lenses, might be used to make possible the recording of 2 or 3 orders simultaneously, limb spectra observed just before and after totality might throw light on the depressing effect of the overlapping sky spectrum or the measures of solar rotation.

Prof. J. A. Miller: We should like to stress photometric studies of the corona on plates taken through certain filters, long focus photographs of the corona and an attack on the coronal rotation by the method used by Moore in 1922 and 1932.

Prof. H. D. Curtis: Long focus (40-foot) plates of the corona and shorter focal lengths of greater speed with filters: objective prism or grating spectrograms in the visual and infra-red regions; motion pictures with chronographic record: also an étalon interferometer.

Prof. S. A. Mitchell: One of the most important of all eclipse problems is the exact determination of coronal wave-lengths; this will be possible only with prism spectrographs of good light-gathering power and of high dispersion. It is of the greatest importance to repeat the observations of Moore and Grotrian (see (*c*) (iii) above).

Dr M. Minnaert: It seems to me that by far the most important problem for the moment is the spectrophotometry of the chromosphere at different levels, either with a moving plate or discontinuous records. In addition we need a photometric study of the coronal continuous spectrum *and its Fraunhofer lines*. The amount of polarization and the profiles of the Fraunhofer lines in the outer corona should be closely connected with each other. It would be very interesting to investigate whether in *coronal streamers* the polarization is *greater* and at the same time the lines are *shallower*. Similar variations will probably be found if the polar regions are investigated during sunspot minima and maxima. The simultaneous measurement of line profiles and polarization at the same eclipse at the same point of the corona should be very important for the theory of the corona. The use of portable instruments capable of quick adjustment should be borne in mind when main roads lie along the belt of totality permitting of the rapid movement of an observer, if necessary, to a site with better immediate prospects of good observing conditions.

Dr Grotrian: The measurement of the brightness of the corona to the greatest

possible distance from the Sun and especially an examination of any deviation from circular isophotes (see Donitch, *Bull. de l'Acad. Roumanie*, **16**, 19, 1933) is important to test any possible connection between the cloud of small particles giving the Fraunhofer lines in the outer corona and the zodiacal light. The use of plates sensitive to the infra-red with a suitable filter and a specially designed lens should be helpful. An observation of the corona from the stratosphere during the eclipse might be of great interest. A photometric study of the coronal continuous spectrum and of the polarization for as great a distance as possible from the Sun's limb would also be valuable.

Prof. Donitch. The spectrum should be divided into separate regions allotted to different expeditions, so that the whole accessible range (say 3000 to 7306 A) should be covered at each eclipse both for the chromosphere and for the corona and with as great an accuracy as possible, to 0·01 A. Slit spectrographs with a dispersion of about 10 A/mm. at $H\gamma$ should be used and paraphenylene diamine can be recommended as a developer giving fine grain even on fast plates. For the focal plane the scale of 1 mm. = 1′ of arc could be adopted and a focal ratio of 1/20.

The following optical train is suggested: an image forming objective of 3·44 m. focal length working at f/20: a slit of 10 mm. length; a collimator and camera lens each of 1 m. focal length and the same focal ratio and two 60° prisms of good transparency. The slit should be placed along the solar diameter joining the points of second and third contact. The shutter would be placed behind the second prism and the exact moment of exposure would be determined by watching the spectrum from the first face of the second prism. For spectrophotometric investigation the spectrum of the photosphere should be photographed with low dispersion before and after the eclipse also that of some standardized terrestrial source.

(*e*) Programme for the Meeting

It is hoped that further information as to the conditions of observation in Japan and Siberia will be available at Paris. The various suggestions for observations needed will be discussed and it is hoped that arrangements can be made to cover the main requirements and to secure duplicate observations in the most important cases. Various practical problems such as the best method of securing standards for eclipse spectrophotometry will also be discussed.

F. J. M. Stratton
President of the Commission