16. COMMISSION POUR LES OBSERVATIONS PHYSIQUES DES PLANÈTES, DES COMÈTES ET DES SATELLITES

PRÉSIDENT: M. T. E. R. PHILLIPS.

MEMBRES: Mlle Harwood, MM. Andrea, Bianchi, L. Campbell, Delporte, Donitch, Gastardi, Hepburn, Jarry-Desloges, Luplau-Janssen, Maggini, Mascart, S. B. Nicholson, Pickering, Quenisset, E. C. Slipher, Steavenson, Stroobant, Thomson.

Since the Cambridge meeting of the Union in 1925 the Commission has sustained the loss by death of one of its members and its first President, viz. Professor V. Cerulli, a Vice-President of the Union, and a distinguished planetary observer in former years who was one of the first to suggest an optical interpretation of certain markings on Mars.

Several important researches covered by the scope of the Commission have been carried out at various observatories and references to some of the results obtained and methods employed are given in this Report.

I. THE MAJOR PLANETS

(1) PHOTOGRAPHY IN RADIATIONS OF DIFFERENT WAVE-LENGTHS

Important work on these lines has been done at observatories in America by R. W. Wood, W. H. Wright, E. C. Slipher, F. E. Ross and others in photographing the planets in ultra-violet and extreme red light. Wright's work has shown that this method promises to be specially effective in the investigation of the properties of the planetary atmospheres, such as their extent, density and transparency. So far it has been applied chiefly to Mars, Jupiter, and Saturn; as regards Jupiter a systematic study on these lines would appear to offer the greatest promise of determining the relative altitudes of the various features telescopically observed. During the last half century, a great mass of information concerning the forms, colours, drift and life history of the Jovian markings has been accumulated by observers, but before this material can be applied to the construction of a satisfactory theory a knowledge of the relative levels of the markings is essential.

Photography on these lines is also likely to give valuable information concerning the problem presented by Venus. Thus photographs of the planet taken by Dr Ross at the Mt Wilson Observatory in 1927 in ultra-violet light show parallel dark belts perpendicular to the terminator which varied from night to night, and bright areas at the N. and S. points of the disc. These features would seem to indicate a quick rotation, yet on June 26, 1927, a wedge-shaped marking was photographed which remained stationary for an hour. These features were not obtained with other colour filters at Mt Wilson. At the Lowell Observatory, however, dark and light markings appear on photographs taken with the refracting telescope and blue-violet (visual) light, though less prominently than with ultra-violet light.

(2) RADIOMETRIC OBSERVATIONS AND PLANETARY TEMPERATURES

Following on the preliminary work of Dr Coblentz in 1914 a study of the radiations received from the planets has been carried out during the last few years by Dr Pettit and Dr Nicholson at Mt Wilson and by Messrs Coblentz and Lampland at the Lowell Observatory, Flagstaff. In conjunction with the

https://doi.org/10.1017/S0251107X00013043 Published online by Cambridge University Press

thermo-couple and galvanometer transmission screens of water, quartz, glass and fluorite have been used; and, since at definite thicknesses these are opaque to radiations in particular parts of the spectrum, it has been possible to resolve the total radiation received from a planet and transmitted by the earth's atmosphere, *i.e.* between 0·3 μ ($\mu = 0{\cdot}001$ mm.) and 15 μ, into a number of spectral components, viz. 0·3 μ to 1·4 μ; 1·4 μ to 4·1 μ; 4·1 μ to 8 μ; 8 μ to 12·5 μ; and 12·5 μ to 15 μ. The intensities of these components have then been expressed as percentages of the total radiation transmitted and the corresponding temperatures at the apparent surfaces of the planets deduced by Menzel, from Prof. H. N. Russell's formulae and by other methods.

There are, of course, certain inherent difficulties arising from ignorance of the absorption in the planetary atmospheres of which the constituents are almost entirely unknown, but on the whole consistent results have been obtained and the method is full of promise for the future. Receivers have been constructed which are so small that it has been possible to take readings from particular parts of the planetary surfaces.

The results deduced from radiometric observations of the planets are instructive. The latest observations of Mercury, by Pettit and Nicholson, with water cell transmission yielded a value for the temperature of the illuminated surface which is in substantial agreement with the conclusion that (neglecting libration) the planet turns a constant face to the sun and is practically without an atmosphere.

Measurements of the radiations from Venus, made at Mt Wilson and Flagstaff, have shown a considerable quantity of heat to be emitted by the dark part of the disc.

From radiometric measures of Mars it would appear that the day temperature rises well above the freezing point; that the summer is warmer than the winter hemisphere; that the forenoon temperature is lower than that of the afternoon; and that the dark areas are warmer than the bright ones.

The results found for Jupiter and Saturn are at first sight very surprising. Because of their low density and the great disturbances and changes in their surface features (especially in those of Jupiter) these planets have hitherto been supposed to possess considerable stores of heat. Yet the surface temperatures derived from the observations are of the order of $-100°$ C. to $-75°$ C. only, which, though much higher than could be produced by Solar radiation alone, are much lower than those which the observed resemblances of these planets to the sun suggest as probable. On the other hand, it will be remembered that on purely theoretical grounds, viz. the density distribution of their materials as deduced from their polar flattening and considerations of their probable age, Dr H. Jeffreys has concluded that these planets are likely to have long since lost their stores of heat and to be now at a low temperature (*M.N., R.A.S.* LXXXIII, 350 and LXXXIV, 534). Telescopic observers find it difficult to reconcile this last conclusion with the magnitude of the changes and motions shown by the surface features. The difficulty might be resolved by the assumption that the clouds, which are conspicuous in the planetary surfaces, consist of some substance which, like carbon dioxide, has a very low boiling point.

The problem presented by these planets has now reached a particularly interesting stage, and it is of great importance that all lines of research should be energetically followed up.

(3) Photometric and Spectrographic Observations

(1) A photographic photometry of planetary surfaces of a differential character is being carried out at Flagstaff. The purpose of this is to determine the albedo of particular areas of planetary discs or individual markings, as, *e.g.*, the polar caps, temporary bright areas, white spots, desert areas, and the more prominent dark markings on Mars; the various belts and portions of belts on Jupiter etc., as well as photometric measures of Uranus and Neptune.

(2) The work at Flagstaff also includes a further spectrographic study of the planets, especially of the absorptive properties of their atmospheres. In the cases of Jupiter, Mars, Saturn and Venus it is hoped that particular portions of the discs may be investigated.

(4) Telescopic Observations

Systematic observations of the planets have been continued at various observatories, official and private, and reports of work done have appeared in the usual publications.

Among the outstanding events under this heading since the last meeting of the Union are the following:

(1) M. E. M. Antoniadi, using the 33 in. refractor of the Meudon Observatory, has made observations indicating the identity of the periods of rotation and revolution of Mercury. Full details of this very important research, together with drawings, will be found in *L'Astronomie*, January, 1928.

(2) Professor W. H. Pickering has published in *Popular Astronomy* (Vol. **35**, 317) a revised position for the axis of Mars based on observations of various points on the planet's surface during six different apparitions, extending throughout a complete revolution. His final figures for the position of the N. pole of Mars are R.A. 316° 7′, Dec. + 53° 38′·5 and for the inclination of the axis of rotation to that of the orbit 24° 1′, the epoch being 1905. A re-determination of the position of the axis has also been made by Dr Trumpler at Lick (*L.O.B.* 387) from the measurements of photographs. The place found by him for the pole at the equinox of 1925·0 is R.A. 315°·9 ± 0°·3, Dec. + 54°·7 ± 0°·2.

(3) The extensive changes in the surface markings of Jupiter shown in 1919 were repeated in 1926 when the S. part of the S. equatorial belt, the S. Tropical disturbance and the Red Spot Hollow again disappeared. They were still invisible at the close of the 1927 apparition, but as in 1919, the Red Spot itself has been unusually prominent, and it has now regained something of its former redness. It is of great importance that observers should be on the alert for the recovery of the above-mentioned features and for any such developments as accompanied their revival in 1920.

M. Luplau Janssen urges more effective co-ordination of observers, especially in regard to the discussion of observations and results.

Professor M. J. Mascart suggests another attempt to secure simultaneous observations of Jupiter by observers with instruments of various kinds and apertures such as he organized in 1907.

Moreover, since the difficulties and uncertainties affecting planetary drawings which arise from subjective causes are not yet completely cleared up, he recommends further tests with discs containing complicated markings and details at the limit of visibility (see a paper "Experiments as to the actuality of the 'Canals' observed on Mars," by E. W. Maunder and J. E. Evans in *M.N., R.A.S.* **63**, 488—June, 1903).

https://doi.org/10.1017/S0251107X00013043 Published online by Cambridge University Press

In connection with this question of the subjectivity of the forms of Martian features as perceived by the eye, attention is drawn to the pamphlet *L'ipotesi ottica delle macchie di Marte*, by Professor Maggini, in which he concurs with the views put forward by Cerulli in 1898.

M. Donitch recommends that, during transits of Mercury, the spectrum of the black ligament be observed with apertures as large as possible to diminish the effect of diffraction, and at the moment of contact as determined by calculation and given by the chronometer.

(5) Polarization Observations

M. Lyot has measured the proportion of the polarized light of the planets by means of a polarimeter invented by himself. He has compared the curves obtained with those of many terrestrial substances (*Revue d'optique*, 1926, p. 108, *Comptes rendus*, 1924–1927 *passim*).

II. THE MINOR PLANETS

Miss M. Harwood and Mr Leon Campbell both lay emphasis on the need of preparation for the approaching opposition of Eros in 1931. Mr Campbell urges that it should be observed very completely from the time it comes within range late in 1930 until long after opposition in 1931. "If," he writes, "Eros undergoes the variations it did nearly 30 years ago, at one time with a range of a magnitude and soon after with one of only a fraction of a tenth, we should know just how and when it does these tricks."

The following report on the observation of Asteroids was presented by Miss Harwood and Mr Campbell at the recent New Haven meeting of the American section of the I.A.U. and recommended by the meeting for consideration by this Commission.

Committee 16,
American Section,
I.A.U.

Asteroids

Variation in the brightness of asteroids should be studied more extensively, both photographically and photometrically, over as wide a change in phase angle as possible.

Of seventy-four minor planets listed in *Harvard Circular* 269 as having been examined for variability of light, thirteen have been proved to vary, and thirty-six others are suspected. Many of these have not been observed with sufficient accuracy to ascertain whether or not they vary or how much. By a sufficiently continued series of observations the direction of rotation of an asteroid can be found.

The chief difficulty in the observation of asteroids is the constant necessity of changing comparison stars, for which accurate magnitudes must be known. As the periods are short, less than one day, so far as is known, variability is best tested by observations made at short intervals in a single night. For photographic work, several exposures made on the same plate are both an economical and an accurate method of detecting small variations of light intensity.

Eros (433) should be observed in as many ways and for as long a time as possible during its near approach to the Earth in 1931. With the largest reflectors it seems possible that the form or shape of Eros can be observed. And with polarizing photometers and photoelectric cells the range of variations of

https://doi.org/10.1017/S0251107X00013043 Published online by Cambridge University Press

light and the periods can be found accurately. For photographic work on Eros, very short exposures should be made on plates which also have images of comparison stars of known magnitude. Means should be taken for the study of the coefficient of phase of Eros, which has also been found to change.

Work that must be done in advance of the opposition of 1931 is the careful determination of magnitudes of comparison stars along the path of Eros from 1930 to 1932.

FRANK E. ROSS
Chairman

Professor Stroobant writes that he has arranged, in agreement with M. Delporte, for determination of the planet's brightness to be made in 1930–31 at the Royal Observatory of Belgium, Uccle, both visually with the Toepfer photometer, and photographically by means of a Zeiss astrograph of 0·30 cm. aperture and 1·5 m. focal length, so long as the altitude of the planet is sufficient.

III. SATELLITES.

Satellite observations have been continued at various observatories, and special attention has been given to J. III. Observing in Jamaica, Professor W. H. Pickering has concluded that this Satellite exhibits an oscillation in about 3½ hours, which, he suggests, may be a tidal action rather than a rotation and somewhat analogous to that shown by the Cepheid variables. M. Antoniadi, observing the satellite during the 1927 apparition with the 33 in. refractor at Meudon, has found the surface markings constant, indicating that its periods of axial rotation and orbital revolution are the same (*L'Astronomie*, Dec. 1927). Photometric observations of the Galilean Satellites for testing the constancy of the sun's radiation carried out by Professor J. Stebbins at Lick (*L.O.B.* 385) corroborate the conclusion of Guthnick, viz. that *all four* satellites turn a constant face to Jupiter, by showing that their variations of brightness are definitely related to their orbital positions.

The Moon. Dr Merriam, President of the Carnegie Institution, has appointed a committee of geologists, physicists and astronomers to study the physical features of the moon's surface. A report of this Committee is published in the *Year Book* of the Carnegie Institution for 1926–1927. They have studied the effects of reflection by terrestrial materials and compared these results with what can be observed on the moon. This included the comparison of photographs with ultra-violet and infra-red light and a study of polarization effects.

M. Donitch recommends that during lunar eclipses spectrograms be taken at the beginning and ending of totality, the position-angle in each case being as nearly as possible that of the contact.

THEODORE E. R. PHILLIPS
President of the Commission

HEADLEY RECTORY
EPSOM
ENGLAND
19 *March* 1928

Section IV of this Commission's report, "Comets," will be found in the report of the meeting of Commission 16 (p. 239).

https://doi.org/10.1017/S0251107X00013043 Published online by Cambridge University Press