10. COMMISSION DES PHENOMENES PHOTOSPHERIQUES

PRÉSIDENT: M. M. WALDMEIER, *Directeur de l'Observatoire Fédéral, Zürich* (*Suisse*).

PRÉSIDENT D'HONNEUR: M. W BRUNNER.

MEMBRES: MM. Abetti, Alfvén, Allen, Bečvář, Bourgeois, Chapman, Cimino, d'Azambuja, Eigenson, Grotrian, Gullón, Heines, Kiepenheuer, H. W Newton, Nicholson, Öhman, Roberts, Romañá, A. H. Shapley, Slonim, Stetson, Stratton.

RESEARCH WORK

Solar Granulation. The difference in brightness between the granulation elements and the intergranular spaces has been determined by various observers with differing results: 10·8% (R. S. Richardson and M. Schwarzschild), 15% (Ph. C. Keenan), 18% (P ten Bruggencate and H. Müller), 30–40% (M. Waldmeier). Recently G. Thiessen (*Naturwiss.* **37**, 427, 1950) without correcting for stray light or image unsteadiness has found the difference in intensity to be 25%, thus verifying the high value obtained by M. Waldmeier (1939). In a series of three papers (*C.R.* **228**, 1792, 1948, **228**, 2010, 1949 and **229**, 112, 1949), C. Macris has investigated granulation, first verifying previous results, that the size of the granulation elements varies between 0·7″ and 2·1″ (average: 1·5″), and that the granules have no sideways motion. New results which were found are, that granules lying in the immediate vicinity of sunspots tend to be smaller than those in undisturbed regions (diameter: 1·25″), and furthermore that the granules are about 0·2″ longer in the east-west direction than in the north-south direction. The first successful attempts to study granulation spectroscopically were made by R. S. Richardson and M. Schwarzschild (*Ap. J* **111**, 351, 1950). For granules with a diameter of 2″ they find an average velocity of 0·37 km./sec. upwards. A frequency spectrum is presented according to which very bright turbulence elements should exist with a size of 100–200 km. and a velocity of 2 km./sec.

Faculae. M. Waldmeier (*Z. f. Astr.* **26**, 147, 1949 = *Astron. Mitt. Zürich*, No. 159) has shown that solar faculae are seen best at a distance of about 63° from the centre of the Sun's disk. The decrease in visibility of the faculae between 63° and the Sun's limb is to be explained by foreshortening and by the variation in contrast of the faculae against the undisturbed photosphere. That contrast shows a maximum at a distance of 71° from the centre of the Sun's disk. The variation of the radiation density with optical depth is deduced from the centre-limb variation of the contrast giving an optical depth for the high temperature layer producing the faculae of about $\tau = 0{\cdot}6$.

Unpublished observations by C. Macris, indicate a lifetime for facula granules of one to ten minutes. This is in contradiction with M. Waldmeier's (Arosa) photographs, which often allow facula granules to be identified after several hours.

For taking routine solar photographs Y Oehman is using an ultra-violet filter (Schott and Gen, *U.G.* **2**); these photographs show the faculae over the entire solar image (*Tellus*, **2**, 4, 1950), thus resembling in a way metallic line spectroheliograms.

Sunspots. A polarimetric arrangement has been described by H. von Klüber (*Z. Astr.* **25**, 187, 1948) which has shown itself to be most satisfactory at Potsdam. The method allows twice the desired Zeeman separation to be obtained differentially and not falsified by the Doppler effect. Another contribution to the observation of Zeeman effects in sunspots by using Savart fringes has been given by Y Oehman (*Ap. J* **111**, 362, 1950). K. Brunnckow and W Grotrian (*Z. Astr.* **26**, 313, 1949) have investigated the variation in the course of a day in the magnetic field strength of sunspots. It turns out that even quiet spots experience fluctuations in the field strength up to 20–30 Oersteds per hour. Short, stronger fluctuations were also indicated but were not sufficiently over the probable error to be considered certain. In a further work by W Grotrian and H. Künzel (*Z. Astr.* **26**, 325, 1949) the daily changes of the field strength have been studied using data from Mount Wilson for 1917–24. The distribution curve of the daily changes in field strength

can be well represented by the superposition of two probability curves with average daily changes in the field of 230 and 500 Oersteds. The group with the small changes is associated with spots in a stationary stage; that with the large changes, with active spots which are rapidly developing or dividing. In another paper (*Z. Astr* **28**, 28, 1950), W Grotrian and H. Künzel establish with the use of data from Mount Wilson and Potsdam, that the induction current through *p*-spots is about three to four times larger than that through *f*-spots.

The magnetic field over stationary sunspots has been computed by E. G. v. Roka (*Z. Astr.* **27**, 15, 1950) from certain assumptions about the current system. R. S. Richardson (*Ap. J* **107**, 78, 1948) made a study especially of sunspot groups with irregular magnetic activity. Out of 7890 groups (Jan. 1, 1917–Dec. 31, 1946), 6387 were classified magnetically. Of those classified, 549 or 8·6% were unipolar. Among 5814 bipolar groups were 180 or 3·1% which did not conform to the laws of sunspot polarity. Such groups are said to be of irregular magnetic polarity. The purpose of the investigation was to determine whether the groups of irregular polarity were also unusual in another way. The irregular groups range in size from the smallest to those visible with the naked eye; in general they tend to be a little smaller and less stable than regular ones. The inclination of their axes is somewhat larger than in the regular groups. In the cycle 1922–35 the relative number of occurrences of irregular groups was 30% higher than in the other cycles.

The main emphasis in the theory of solar activity, in particular the phenomenon of sunspots, has been placed on improving the foundations of the theory of H. Alfvén and H. Walén. M. Schwarzschild (*Ann. Astrophys.* **12**, 148, 1949) and W. Grotrian (*Z. angew. Phys.* **2**, 376, 1950) have tried to unite the magnetic field and the pulsations into a theory of the periodicity of sunspots. A new study of the sun's pulsations by T. Fortini (*Linc. Rend. Sci.* **7**, 304, 1949), based on observations made in Rome, verifies the large (1″) fluctuations of the Sun's diameter and their 22-year period. These measurements are to be compared to those of Schur and Ambroun (1890–1903) which give fluctuations ten times smaller. A new re-working of these by B. Meyermann (*A.N* **279**, 45, 1950) gives the 11-year period for both the polar and equatorial diameters, the maxima and minima coinciding with those in sunspot activity.

M. Kopecky (*B.A.C.* **2**, 14, 1950) decides that the 11-year cycles with even numbers in the Zürich scheme are the first part of the 22-year cycles, a conclusion also reached earlier by M. N. Gnevyshev and A. I. Ol.

The obliquity of the axes of sunspots has been redetermined by A. Romana and J. Torroja (*Urania*, **32**, 1, 1948; *Miscelanea Obs. del Ebro*, No. 3, 1948) from the east-west excess, with a result of 1° 55′ S. Lundquist has given an experimental determination of the magnetic-hydrodynamic waves (*Nature*, **164**, 145, 1949). Alfvén's theory predicts that a big spot at a certain latitude should be associated with increased activity at the same latitude in the other hemisphere during the following cycle. Alfvén (*Ark. Mat. Astr. Fysik.* **34**A, No. 23, 1948) believed that he had verified this statistically. On the other hand, M. Waldmeier (*Experientia*, **5**, 44, 1949) has pointed out, that corresponding to a spot with longitude l and latitude b there are often three others with co-ordinates l, $-b$; $l+180°$, b; and $l+180°$, $-b$, making a tetrapolar disturbance. A new theory of sunspots has been given by H. D. Menzel (*Nature*, **166**, 31, 1950), according to which gas flows outwardly in the polar regions and inwardly at lower latitudes, carrying the magnetic moment with it.

Statistical Work

The following observatories have co-operated on the international sunspot statistics: Royal Greenwich Observatory, Herstmonceux, Observatoire Royal de Belgique, Uccle, Statne Observatorium Skalnate Pleso, Osservatorio Astrofisico, Arcetri-Firenze, Osservatorio Monte Mario, Roma, Osservatorio Astrofisico, Catania, Observatorio del Ebro, Observatorio Astronomico de Madrid, Observatorio de Cartuja, Observatorio Astronomico de Valencia, National Observatory Athens, Universitätssternwarte Istanbul, Astronomisches Institut der Karls-Universität, Prag, Astrophysikalisches Observatorium,

Potsdam, Sternwarte Sonneberg, Mount Wilson Observatory, Mount Holyoke College Observatory, South Hadley, Carter Observatory, Tokio Astronomical Observatory. Mitaka, Observatoire de Belgrad, Geophysikalisches Institut, Zagreb, Fraunhofer-Institut, Freiburg.

Along with the Zürich relative sunspot number, the so-called American relative numbers were introduced in 1946. From year to year the discrepancy between the two has increased. This behaviour has been investigated by W Gleissberg (*Publ. Istanbul Obs.* No. 35, 1949, compare also H. A. Shapley, *P.A.S.P.* **61**, 12, 1949), who finds that the American scale has changed, the Zürich one not. It was suggested by H. A. Shapley that there is a definite need for a detailed, up-to-date account of the scheme used in deriving the Zürich relative sunspot numbers, in particular the criteria for rejecting observations made under less favourable conditions.

Running beside the statistics on relative sunspot numbers are the statistics on sunspot areas. The Greenwich photographic results for 1938 have been published; also the measurements of the combined series of photographs (Greenwich, Cape, Kodaikanal) through 1948.

Advance tables of the mean daily areas of faculae and sunspots for each synodic rotation together with mean heliographic latitudes of sunspots up to the end of 1945 have been published in *M.N.R.A.S.* The results of the area measurements made by the U.S. Naval Observatory (supplemented by photographs from Mount Wilson) appear regularly in *U.S. Naval Obs. Circulars* with a delay of about six months, the results from the Mount Mario Observatory (Rome) in the *Mem. Soc. Astr. Ital.*

The Zürich relative sunspot numbers are published monthly, quarterly, or yearly in *Astronomische Mitteilungen Zürich, Geophysical Research, Popular Astronomy, L'Astronomie, Meteorologische Rundschau, Meteorologische Zeitschift, Die Sterne,* and along with the American numbers of *Ionospheric Data,* U.S. Dept. Commerce Nat. Bureau of Standards, Washington.

Other periodical publications on sunspot activity which should be mentioned are *Die heliographischen Karten der Photosphäre* (a publication of the Swiss Federal Observatory, Zürich), *Sonnenzirkular* (Fraunhofer-Institut, Freiburg i.Br.), 'L'activité solaire' (appears in *Communications* of the Royal Belgian Observatory), *Bulletin of Solar Phenomena* (Tokyo Astronomical Observatory).

Prediction of Solar Activity

Predicting the Sun's activity is a practical problem as well as an academic one. For the practical applications, smoothed-out relative sunspot numbers are forecast monthly for each of the coming six months by the Swiss Federal Observatory in Zürich. These predictions are obtained by a graphical method and by use of the known regularities (M. Waldmeier, 1935) in the sunspot curve. Attempts to compute sunspot activity in advance have been made by W Gleissberg (*Ap. J* **109**, 321, 1949; **110**, 90, 94, 1949; *Publ. Istanbul Obs.* No. 36, 1949; *Z. Astr.* **28**, 17, 1950), M. Kopecky (*B.A.C.* **2**, 30, 1950) and A. F. Cook (*J Geophys. Res.* **54**, 347, 1949).

International Collaboration on the Study of Sunspot Development

At the convention of the I.A.U. in 1948 it was resolved that 'the commission recommends that international collaboration be organized for the purpose of better investigating the development of sunspots, whether by the use of photographs existing already or by the systematic and frequent taking of new photographs of details of the groups' This co-operative work is being conducted by the Swiss Federal Observatory in Zürich. At present it includes in addition the following solar observatories:

Kodaikanal (India).
Wendelstein-Observatorium (Germany).
Observatorio del Ebro (Spain).

Stockholms Observatorium Saltsjöbaden (Sweden).
Mount Wilson Observatory (California).
U.S. Naval Observatory (Washington D.C.).
Osservatorio Monte Mario (Rome).
Astrophysikalisches Observatorium Potsdam (Germany).
Fraunhofer-Institut, Schauinsland (Germany).
Observatorium Kanzelhöhe (Austria).
McMath-Hulbert Observatory (Michigan).
Astrophysikalisches Observatorium Arosa (Switzerland).

Quarterly Bulletin on Solar Activity

Since the last Report of the Commission, Nos. 78–94 (April 1947 to June 1951) have been printed. Each contains the four parts:

I. Sunspots.
II. Eruptions chromosphériques brillantes.
III. Intensité de la couronne solaire.
IV Solar Radio Noises.

To reduce costs, a change was made to offset printing with *Bulletin* No. 83. Also, the 'Evolution Tables of Sunspot Groups' have been omitted since the beginning of 1949.

Suggestions

The Commission recommends the renewal for the period until the next Congress of the Union of the annual grant of 1000.00 gold francs granted by the last General Assembly of the I.A.U. to the Observatory at Zürich for the publication of the 'Heliographic Maps of the Photosphere' Since the last Congress, with this subsidy from the I.A.U., the 'Heliographic Maps of the Photosphere' for the years 1947, 1948, 1949 and 1950 have appeared.

M. Waldmeier
President of the Commission

Procès-verbal de la séance

Président: Prof. M. Waldmeier.

Secrétaire: P Cardús.

Les séances de la Commission ont eu lieu le 5 et le 8 Septembre.

Concernant la publication des *Heliographische Karten der Photosphäre* on a approuvé la résolution suivante:

La commission propose d'accorder à l'Observatoire Fédéral de Zürich pour la période qui s'étendra jusqu'au prochain congrès une subvention annuelle de 1000-francs-or destinée à la publication des 'Cartes Héliographiques de la Photosphère', qui sont élaborées avec l'aide d'un grand nombre d'observatoires de divers pays.

M. le Président fait un petit rapport sur les différentes données publiées dans le *Quarterly Bulletin on Solar Activity* et demande s'il faut y ajouter, et comment, des données sur les protubérances. La proposition est discutée par MM. d'Azambuja, Abetti, Das et Waldmeier, aucun changement n'ayant été décidé pour le moment, à cause des difficultés, qu'il y avait à le faire.

Sur la demande de MM. Allen et Gleissberg et après les commentaires de MM. Newton, Öhman, Waldmeier et Shapley l'on adopte la résolution suivante:

Il est à souhaiter que les observatoires publiant des données sur les aires des taches solaires donnent non seulement les aires corrigées mais aussi les aires mesurées.

Ayant discuté la convenance de l'adoption d'une valeur de la rotation solaire satisfaisant les besoins des astronomes et des géophysiciens, on se rapporte à l'avis de quelques observatoires intéressés à cette question (Waldmeier, Kiepenheuer, d'Azambuja, Newton, Allen, Miss Dodson).

Au commencement de la deuxième séance on approuve les Draft Reports.

Concernant la résolution prise à l'Assemblée de Zürich relative à une coopération internationale pour l'étude de l'évolution individuelle des taches, M. le Président fait remarquer l'impossibilité d'utiliser les matériaux déjà existant, à cause des trop grandes différences dans la grandeur et la qualité des images. Il propose de profiter de ces années de minimum pour étudier une systématisation du travail à soumettre à l'assemblée prochaine. M. d'Azambuja fait remarquer la nécessité de déterminer le pouvoir séparateur minimum des appareils employés.

A continuation on donne lecture à diverses communications.

M. Macris examine la durée de la vie moyenne des granules faculaires et des filaments dans la pénombre des taches.

Le Prof. Grotrian s'occupe des différences systématiques entre les mesures des champs magnétiques des taches solaires faites à Potsdam et au Mount Wilson.

M. A. H. Shapley rend compte de la méthode employée à la A.A.V.S.O. pour la détermination des nombres relatives des taches.

M. Newton communique dans quelle forme on va tâcher de regagner le retard dans la publication des 'Greenwich Photo-Heliographic Results'

M. Michard expose ses recherches sur le spectre continu des taches et sur la variation du rapport entre son intensité dans la tache et à la photosphère avec la longueur d'onde et la position sur le disque.