

10. COMMISSION DES TACHES SOLAIRES ET DES NOMBRES
CARACTÉRISTIQUES SOLAIRES

PRÉSIDENT: M. W. BRUNNER, *Observatoire Astronomique Fédéral, Zurich, Suisse.*

MEMBRES: MM. Abetti, Butler, S. Chapman, G. S. da Costa Lobo, d'Azambuja, Dufay, Evershed, Moss, Newall, Newton, Nicholson, Mlle Novaková, MM. Perepelkin, Pettit, Rodés, Rowland, Royds, Sotome, Yamamoto.

RESEARCH WORK

Periodicity and new properties of the frequency curve. Bruno Hanisch uses the method of autocorrelation introduced by W. Pollack in geophysics for the discovery of periods in the frequency series of sunspots from 1794 to 1925. Dividing the whole interval into three sections he finds an eleven- and an eight-year period common to the three sections, whereas other periods found in the three sections differ widely from each other. The new method gives for the length of the main period 11.8 years for the interval 1880 to 1925. This result agrees strikingly with the revolution period of Jupiter (*Gerlands Beiträge zur Geophysik*, 46, 1935).

Max Waldmeier interprets the sunspot curve in a quite different manner (*Astron. Mitteilungen of the Zurich Observatory*, No. 133). The superposition hypothesis is physically inadequate to deal with latitude discontinuity between consecutive cycles or with the reversals of Spörer's law. The smoothed sunspot curve is a hump-shaped curve which starts from the time axis, rises to a maximum and then falls to zero ordinate again. The minimum of the spot-curve has no physical significance. The part of the curve near the so-called minimum is the resulting curve of the tail end of a hump-shaped "eruption-curve" for spots and of the beginning of the following curve. From the analysis of Zurich spot-numbers Waldmeier shows that the spot-eruption curves form a one-parameter system of curves depending only on the intensity of maximum R_M . The ascent time reckoned from onset to maximum decreases as R_M increases. The descent time increases with R_M . The area enclosed by the curve and the axis on the left of the maximum ordinate is roughly constant, whilst the area to the right of the maximum ordinate increases with R_M .

Variation of the correlations between solar activity and terrestrial magnetic activity with the phase within the solar cycle. In a paper published in the *Astron. Mitteilungen of the Zurich Observatory*, No. 133, W. Brunner gives the correlation coefficients between sunspot-numbers and Bartels magnetic activity-numbers for the successive years of the average eleven-year solar cycle for the interval 1835 to 1931. In the ascending phase and for two years afterwards the correlation coefficient is almost constant (0.90) and shows small mean errors. In the descending phase the correlation coefficient is decreasing, varies more and the mean errors are much greater.

Preponderance of new formations of spot-groups on the east side of the sun's disk. It seems a fact that the number of spot-groups formed on the east side of the central meridian is greater than those on the west side. Excluding the insignificantly small groups which did not exist more than one day, we have from Zurich observations for the last two years:

1936 E=122 W=96

1937 E=184 W=97.

These numbers refer only to the zone 70° east and west of the central meridian. To explain this fact W. Gleissberg presumes that it takes some time from the formation of a spot or of a spot-group till it is large enough for observation. For

a spot in the centre of the disk this time may be d days. For groups formed apparently on the east side the range of their real formation extends from $-70^{\circ}-13^{\circ}$ d. sec 70° to -13° d. and has therefore an extent of $70^{\circ}+13^{\circ}$ d. (sec $70^{\circ}-1$). For groups apparently formed on the west side this extent is only $70^{\circ}-13^{\circ}$ d. (sec $70^{\circ}-1$), whereby it is supposed that the spots are near the sun's equator and that the heliographic latitude of the centre of the sun's disk may be neglected (*Astron. Nach.*, No. 6289).

Properties of complexes of spot-groups. Based on the heliographic maps of the Zurich Observatory for the period 1926-36, Brunner-Högger, Assistant, tries to study the development of centres of spot activity over long intervals of time. He finds that neighbouring spot-groups were often developed from the same centre and thus form a complex of groups. There are complexes of groups extending after many rotation periods over nearly half the circumference. The groups of a complex are arranged along an axis inclined to the equator in the direction east-west. The two properties are due to large differences of latitude of the groups of the same complex and the rotation law. The places of new formations of group-complexes accumulate during several years on certain heliographic longitudes (*Vierteljahrsschrift der Astron. Gesellschaft*, 72, No. 4, 1937).

The long life of large complexes explains the facts to which F. Sanford calls attention ("On the Localisation of Sunspot and Floccular Activity on the Sun's Surface", *Publ. A.S.P.* 47, August 1935).

Intensity of sunspot radiation. Wanders has measured by spectrographic observations the ratio of intensity of sunspot to photospheric radiation in its dependence on the position of the spot on the disk. An investigation was made on the effect of light scattered by the sky and by the instruments, and a correction applied. Like most former observers he finds an increase of the ratio towards the limb. But he can show that the foreshortening is responsible for this effect and that for an apparently constant spot-surface there is no evidence of variation of the intensity-ratio umbra to photosphere across the disk. This result agrees with the hypothesis that the gases in the visible region of a spot are in radiative and not in adiabatic equilibrium. From Wanders' measurements results a mean effective temperature of 4510° for spot-radiation (*Zeitschrift für Astrophysik*, 10).

REPORT ON BULLETIN FOR CHARACTER FIGURES OF SOLAR PHENOMENA (BRUNNER)

Since April 1934 this quarterly Bulletin has consisted of two parts. The first part gives the daily character figures for spot-activity, for calcium, bright and dark hydrogen flocculi for the whole disk and for a central circular zone, as well as figures for the ultra-violet radiation. Since 1936 the spot-numbers have also been recorded for the four quadrants divided from the north pole of the sun. Small index numbers beside the daily spot-numbers indicate the number of new formations of spot-centres in each quadrant. In addition monthly means of the Wolf's numbers are given separately for the north, south, east and west hemisphere. Co-operating observatories contributing to the first part are: Arcetri-Firenze, Cambridge (England), Catania, Coimbra, del Ebro, Ewhurst (Mr Evershed), Greenwich, Kiew, Kodaikanal, Kyoto-Kwasan, Lyons, Madrid, Meudon, Mount Wilson, Roma-Campidoglio, South Hadley, Stonyhurst, Tashkent, Tokyo, Wellington and Zurich.

The second part of the Bulletin has been giving since 1934 a list of bright hydrogen eruptions observed by the different spectrohelioscopes (see Report of

Commission 11). The results of these observations are collected by Mr d'Azambuja of the Meudon Observatory, who, after arranging them in chronological order and according to centres of activity, sends the lists ready for printing to Zurich. The first part of the Bulletin involves four pages regularly, whereas the second part has grown with the increasing solar activity from a quarter of a page (January-March 1935) to eight pages (1937).

The Bulletin for Character Figures has been published from 1928 onwards. Two special volumes issued in 1932 and 1933 respectively contain the character figures for the period 1917-28. Tables giving for the years 1917-33 the monthly, quarterly, half-yearly and yearly means of all the character figures for the various solar phenomena are added to Bulletin No. 24. These tables will be continued till the end of 1938 with the last Bulletin of this year. The Bulletin has been forwarded to an increasing number of observatories, institutions and individual investigators according to a list drawn up in co-operation with the International Unions of Astronomy, of Geodesy and Geophysics and of Radiotelegraphy.

The inclusion of the results of spectrohelioscopic observations has much increased the value of the Bulletin. It seems advisable to indicate this important enlargement by a more suitable title. Mr d'Azambuja suggests: "Quarterly Bulletin for Informations on Solar Activity" (*Bulletin trimestriel de Renseignements sur l'Activité Solaire*).

The chief purpose of the introduction of these character figures was to see whether other criteria for solar activity were better than sunspots and whether an improvement would be obtained by indicating character figures also for the central zone. As pointed out already in the last report, investigations made by Bartels and by me have shown that the new indices give practically no better correlation with magnetic character figures than the old sunspot-numbers and that the character figures for bright hydrogen flocculi and calcium flocculi follow very closely Wolf's numbers. They seem therefore not to be of more value than these (*Character Figures of Solar Phenomena 1923-28*, published by the Eidgen. Sternwarte, 1932).

What Prof. Chapman, then President of the Committee on Solar and Terrestrial Relationships, expected, when he wanted these daily character figures from us, was not a better general statistical result, but a possible correlation between individual daily records. The new daily character figures show, however, in individual cases, just as little detailed relation with geophysical phenomena as do the sunspot numbers. Possibly the new character figures would not have been introduced in 1928 if we had known then the obvious relation between bright chromospheric eruptions and radio-fadings. But at that time it was necessary to make the attempt, and now the time has come to decide whether they can still be of any use and whether the publication of these daily indices should be carried on. I discussed the matter with Mr d'Azambuja, who writes to me as follows: "Toutefois, maintenant que l'effort d'organisation de ce travail a été accompli, je crois qu'il y a intérêt à le poursuivre encore en vue de l'étude statistique des phénomènes, qui n'a peut-être pas encore dit son dernier mot. Mais je pense comme vous, que l'on peut supprimer les nombres relatifs à la zone centrale."

The whole matter may be discussed at the Stockholm meeting. In the first place I propose to omit in future the character figures for the central zone, but I suggest continuing the publication of all the numbers for the whole disk in view of the fact that these numbers may still be of some use for statistical research work. We may also consider the introduction of some entirely new character figures. Perepelkin has shown the variability of the intensity of the ratio H_c -line to H-line

of the prominence spectra due to the change of the extreme ultra-violet radiation, which can probably be referred to small regions in the photosphere. This variable intensity gives a very high correlation coefficient with the range of the diurnal change of magnetic declination and could serve perhaps as a solar index. But this index can only be of use for the extreme parts of the sun's disk, and it would not be an index easy to obtain. Other suggestions for new indices will be welcomed.

REPORTS AND SUGGESTIONS OF MEMBERS

I. ARCETRI-FIRENZE (Abetti):

The usual figures for K_2 and $H\alpha$ (bright and dark flocculi) deduced from the observations at the solar tower have been sent regularly to Zurich. In estimating the figures we make use at Arcetri of the scales of Meudon and Mount Wilson from 0 to 5, and half values. I suggest that from all the co-operating stations the two said scales and the figures 0 to 5, with half values, should be generally adopted. I suggest also that, beginning in 1939, the figures for the "central zone" should be omitted from the Bulletin as I believe that it is proved from the experiences of the past years that they do not add much information and that they are not of great value for the purpose of the Bulletin. I tried to prove (*Public. Arcetri*, Fasc. 54, p. 19) how the periodic recurrence of solar and terrestrial phenomena gives no better result for the central zone. That this zone is not a preferential one is also proved by correlations, particularly investigated during this maximum, of solar eruptions with the radio-fadings.

There is no doubt that the Bulletin is of general use and interest, and it has to be continued, but with the omission of the data for the central zone. As a further improvement one could perhaps embody in monthly maps (of the kind of those given by Madame d'Azambuja in the *Bulletin de la Société Astronomique de France*) all the characteristic phenomena of the solar activity including eruptions and limb-prominences. Proper scale and signs for the various phenomena, their frequency and intensity, should be carefully studied.

2. DEL EBRO (Rodés):

The Ebro Observatory has continued the photographic registration of sunspots during the last three years, and the results have been published regularly in the *Boletín mensual*. Following the suggestion made by this Commission, and approved at the 5th General Assembly of the International Union held in Paris, 1935, data for the single quadrants N.S.E.W. have been given separately in our monthly Bulletin. A synoptic study of the solar activity, as registered at the Ebro Observatory during its first twenty-five years of continuous work, was undertaken by the writer and published in fasc. 1, *Heliofisica*, of the general Resumen 1910-34, attached to volume 25.

Special attention has been given to the so-called earth effect; there cannot be any doubt, at present, that there is something real in it. The number of spot-groups which, according to our entries, have formed on the east side of the central meridian during a period of twenty-five years, are 73 per cent. against 27 per cent. on the west side. By using the data published in the volume *Character Figures of Solar Phenomena*, edited by the Eidgen. Sternwarte in Zurich, which, starting from 1923, indicates where new formations of groups have been detected, we found that for the last fourteen years (1923-36) there are 80 per cent. groups formed on the east, and only 20 per cent. on the west; the difference is persistent, without exception if

we take single years, and continues also, with only very few exceptions, if we take single months. The results of del Ebro, although of the same order, have thus been emphasized by tabulating the data given by a more accurate and complete registration of solar activity, such as those published by the Zurich Observatory.

No adequate cause for this conspicuous and persistent excess of newly formed spot-groups on the east side of the solar meridian can be indicated; an inclination of the axis of the vortex towards the west, with respect to the sun's radius, and the subsequent projection effect would give a maximum visibility of the spots and, consequently, a maximum probability of being registered on the east side, but this explanation, the only one occurring to the writer at present, seems quite insufficient to explain the facts, at least quantitatively; nor does it explain, at all, the preponderance of new formations on the invisible hemisphere.

The writer hopes to present at the next meeting of the Commission a short communication under the title: "The facts about the so-called earth-effect and their possible explanation."

3. GREENWICH (Newton):

The measurement of positions and areas of sunspots and faculae derived from the Greenwich-Cape series of photographs has been continued in the usual manner; occasional gaps in the series have been filled by photographs from Kodaikanal. Observations made with the spectrohelioscope of the radial velocity of dark $H\alpha$ -markings associated with sunspots have also been published in the *Greenwich Photoheliographic Results*.

A list of the largest sunspots seen between 1875 and 1935 is published in the *Journal of the British Astronomical Association*, 46, 106, 1936, and some of their characteristics are briefly discussed.

A compilation of magnetic storms recorded at the Greenwich magnetic station at Abinger is kept up to date by annual lists published in *The Observatory*.

4. KODAIKANAL (Narayan):

Sunspots. In accordance with the daily programme, photoheliograms of the sun, showing sunspots and faculae, on a scale of 8 inches to the sun's diameter, were taken daily, using a 6-inch object glass and green colour screen, and the sunspots were sketched in their daily positions on a sun chart of 8 inches diameter and the position of faculae marked on it. The sunspots observed at Kodaikanal are numbered serially from the commencement of the observatory's records. Photoheliograms were supplied to the Astronomer Royal to fill up gaps for the *Greenwich Photoheliographic Results*. The sunspot regions were also visually examined with a spectroscope for reversals and displacements of the $H\alpha$ -line and for dark reversals of D_3 . Observations are also made in $H\alpha$ with the spectrohelioscope.

Character Figures of solar phenomena for the whole disk and for the central zone of a circular surface of a semidiameter of the sun's disk were supplied every quarter for $H\alpha$ -bright and dark flocculi on a scale of 0 to 5 referring to both areas and intensities of the flocculi.

I notice that there are still discrepancies in the values observed by different stations. It seems to me that it is necessary to investigate the cause of these variations so as to eliminate them. In the light of the experience we have gained during these years, it should be possible now to improve the standard scale and I would suggest that in doing so representative spectroheliograms from all the observatories co-operating in this work be selected.

5. MOUNT WILSON (Nicholson):

Character figures of solar phenomena have been estimated and reported as in the past.

The number of spot-groups and the number of nuclei are counted on our daily photographs and reported weekly to *Science Service* for publication in their *Research Aid Announcements*.

Since January 1936 these counts have been made from the photographs instead of visually as before that date, and nuclei have been counted instead of spots in order to make our system more nearly like that used in obtaining the sunspot relative numbers at Zurich. Large differences occur in these counts due to the seeing, and it seems to me that the daily values could be improved if a factor similar to k were used to correct the counts to some standard quality of seeing. Such a factor is being studied here and will probably be applied in the near future.

The U.S. Naval Observatory has been publishing in the *Monthly Weather Review*, with their measured areas, the Mount Wilson number of each group. It is proposed to include in that table the number of nuclei in each group. This would furnish data from which a relative spot-number could be derived for any position on the sun.

It seems to me that a character figure based on the number and intensity of the bright chromospheric eruptions observed per hour each day would be very useful. Such a suggestion is being made to the President of Commission II.

6. ZURICH (Brunner):

The sunspot statistics based on Wolf's relative numbers have been carried on as formerly. The provisional sunspot-numbers have again been published regularly at the end of each quarter in the *Meteorologische Zeitschrift* and at the end of each month in the *Journal of Terrestrial Magnetism* and *Monthly Weather Review*. The following observatories have regularly sent us their series of spot countings: Catania, Greenwich, Kiev, Lyons, Madrid, Roma-Campidoglio, Sonneberg (Germany), South Hadley, Stonyhurst, Tsinan, Tokyo and Wellington. The final sunspot-numbers are the result of the Zurich/Arosa observations supplemented by these series. The spot-numbers have been determined for each day for the whole disk, for the central circle zone, as well as for the four quadrants of the sun's disk divided from the north pole of the sun. For the years 1935-37 they have been published in the *Astron. Mitteilungen*, Nos. 134-36, of our observatory and in the *Bulletin for Character Figures of Solar Phenomena*, Nos. 29-40. Brief remarks as to times of passage of spot-groups across the central meridian and entrances of spot-groups are added to these numbers. The number of new formations of spot-groups in each quadrant are indicated against the daily spot-number. The series of Zurich daily sunspot-numbers are without gaps since 1849, and monthly means are available back to 1749.

The publication of our synoptic heliographic maps illustrating all the spot- and faculae-groups observed during each rotation period of the sun has been continued in the usual manner for the years 1935-37. From these maps one can see for any moment which centres of activity were on the visible hemisphere and what position and importance they had. To these maps is attached a list of co-ordinates for the spot-groups, a short description of the development of each group and a list of dates on which each group has been observed.

SUGGESTED AGENDA

I. *Change of title of the Bulletin for Character Figures.*

In view of the lists for bright chromospheric eruptions which the Bulletin has for some years been giving, in addition to the usual character figures for the different solar phenomena, the presidents of Commissions 10 and 11 find it advisable to alter the title for the Bulletin. They propose as a more suitable title: "Quarterly Bulletin for Information on Solar Activity" (*Bulletin trimestriel de Renseignements sur l'Activité Solaire*).

II. *The question of continuation of the publication of the character figures for bright hydrogen flocculi and calcium flocculi for the whole disk and for the central zone.*

The president, seconded by Abetti and d'Azambuja, proposes in future to omit the data for the central zone, but to continue publishing those for the whole disk for the time being as they may still be of some use for statistical research. (For further details see the president's report on the Bulletin.)

III. *Discussion of different suggestions and Miscellaneous.*

W. BRUNNER

President of the Commission