12. COMMISSION DE LA RADIATION ET DE LA STRUCTURE DE L'ATMOSPHERE SOLAIRE

Report of Meetings

PRESIDENT: R. Michard.
SECRETARY: Miss E. A. Müller.

First Meeting, 26 August 1964

The President opened the session by reminding the Commission of the loss by death of Prof. P. ten Bruggencate, a long-time and very active member of this Commission.

(1) DRAFT REPORT

The Commission adopted the Draft Report and the members were asked to communicate to the President or the Secretary possible small corrections or changes in the Draft Report which they might consider necessary. L. D. Delbouille and Miss G. F. Roland communicated to the Secretary that the tables of wavelengths and line identifications corresponding to their Solar Spectrum Atlas, λ 7498–12016 Å, will be published in the near future. These tables were prepared by Benedict, Mohler and Swensson. So far, Benedict had identified 2600 solar lines of CN in this spectral region. On account of the high resolving power the spectral atlas of the Sun in the region λ 3000–7500 Å being secured presently at the Jungfraujoch, is revealing considerable differences in comparison not only with the Utrecht Atlas but also with the recent Göttinger UV Atlas of Brückner. The Jungfraujoch observations are being registered in digital form for later reduction purposes.

(2) WORKING GROUP ON SOLAR ECLIPSES

It was decided to revise the memberships of the Working Group on Solar Eclipses which is headed by J. Houtgast. This Working Group is a permanent organism and not just constituted for one particular eclipse. However, for specific eclipses temporary members of the Working Group could be elected. The final list of members of the Working Group will be announced at the next session of the Commission.

(3) PROPOSAL ON STANDARD CENTRAL INTENSITIES OF FRAUNHOFER LINES

K. Pierce

In his report Dr Pierce stressed the importance of accurate determinations of the true intensities of the line centres, in particular of the strong lines. He first discussed the question of the instrumental profile which, as customary, is divided into the following components:

(A) General scattered light—undispersed and equivalent in spectral composition to that entering the spectrograph.
(B) Dispersed scattered light—light scattered along the line of dispersion and more than one angström from the kernel.
(C) Rowland ghosts and distant line structures.
(D) Kernel and satellites less than one angström away.

These factors making up the total instrumental profile are generally separated because it has been practical to evaluate each by different experimental procedures. A great deal of confusion has arisen from a lack of understanding of what has been, or what has not been, included in these factors.

Dr Pierce then described the various techniques which have been employed to observe central intensities. He pointed out that the best results will probably be obtained when corrections are small and the resolving power is high. Finally, he mentioned the problem of the reference continuum. In many places throughout the solar spectrum the continuum is very hard to define, and the problem must be looked into when the standards will be specified. In many cases it may be convenient to define a central intensity with respect to a nearby wavelength and then specify the intensity for that wavelength.

With all these difficulties in mind, Dr Pierce made the following proposal: It is suggested that a number of strong broad Fraunhofer lines and deep narrow lines be measured for central intensities by several observers. What is needed is:

(*a*) A list of well distributed lines.
(*b*) Measurements to be made for centre of disk, and/or integrated light.
(*c*) Reference wavelengths for the continuum measure.
(*d*) The question of stability of the central intensity.
  (1) Long time stability over sunspot cycle.
  (2) The effect of plages.
(*e*) List of observatories contributing to the programme.
(*f*) Adoption of final values.

DISCUSSION

Various members made brief remarks or comments concerning this proposal. In particular *J.-C. Pecker* reminded how the data differ depending on the resolving power which is an important factor to be considered. *C. de Jager* stressed the importance of correcting the observed line intensities for instrumental broadening even on high resolution spectrograms. In addition, he said that one must settle on an average value as a standard for a line, since the central intensities are apt to vary with the solar cycle. According to *K. Pierce* some lines, such as the sodium D lines, are more affected by the solar cycle than others and, therefore, lines which appear to be essentially independent of the solar cycle should be used as standards. These standards could then be used for evaluating the scattered light in one's instrument. *J. Evans* expressed the hope that some standards could be established which could serve other observers to calibrate their instrumentation.

The President then proposed to constitute a Working Group on Central Line Intensities which should be headed by K. Pierce. Members were asked to join this group if they were interested to collaborate in this project.

J.-C. Pecker and *R. N. Thomas* suggested that some theoreticians and not only observers should join this Working Group, whereas *R. G. Giovanelli* considered this group to be a purely observational one and theoreticians should be excluded from it. The following preliminary Working Group was then constituted:

A. K. Pierce (Chairman), L. D. Delbouille, G. Elste, J. T. Jefferies, V. A. Krat, M. Minnaert, L. Neven, F. Roddier, H. H. Voigt, and O. R. White.

At a later date during the General Assembly the President received a written proposal from V. A. Krat (who unfortunately was unable to attend the meeting) for the establishment of standard profiles of selected Fraunhofer lines. This proposal has been handed to the above Working Group for consideration.

The Group will hold its first meeting on 31 August 1964.

(4) SCIENTIFIC PAPERS

(A) The next item on the Agenda was a report by *H. Neckel* on Photo-electric Absolute Intensity Measurements of the Ultra-violet Solar Spectrum which he and *D. Labs* had recently carried out at the International Scientific Station, Jungfraujoch, Switzerland. This work completes the series of solar intensity measurements published by the same authors which extended over the visual and into the infra-red spectral regions. A grating double monochromator was used with a relatively high resolution of 0·1 Å. Since the continuum in the ultra-violet is undetermined, the intensity measurements refer to the integral under the spectral energy curve over 20 Å in width, at numerous selected wavelengths. The total number of measured integrals was 196. Taking broad bandwidths, permitted to neglect corrections due to the finite resolving power, since these corrections were always less than 0·1 per cent. On the other hand, the bandwidth of 20 Å was small enough to be inaffected by sensitivity variations within each band interval. Detailed computations showed that the influence of the combined wavelength dependence of the multiplier sensitivity, the blaze properties of the grating, the reflectivity of the optics, etc. would not change the results by more than 0·3 per cent in the worst case. In addition, the settings of the selected wavelength intervals could be made within an accuracy of 0·1 Å and, hence, the errors due to incorrect settings were also negligibly small.

Within each of the 196 spectral intervals the energy radiated by the Sun was compared with the radiation of a calibrated tungsten ribbon lamp. The entire photometric equipment (including the optical system, the monochromator and the multiplier) was mounted parallacticly and could be turned back and forth between Sun and lamp. This was done in order to get the intensity ratio Sun/lamp as directly as possible. The comparison lamp was placed into optical infinity by a collimating mirror which was used almost perpendicular. Its reflectivity was measured in the same position and with the same equipment as for the regular measurements. The extinction of the atmosphere was determined by observing the solar radiation in selected intervals of about 120 Å separation from early morning until noon and, in some cases, until sunset. The intensity ratio Sun/lamp (the Sun as seen through the atmosphere) was of the order of 10^4. Since this ratio is too large to be bridged by photo-electric means only, neutral filters placed behind the entrance slit of the monochromator reduced the solar radiation by a factor of about 100. Consequently the measured intensity ratios never exceeded 100. The filters were checked every day at the same positions and spectral intervals at which they were to be used. Furthermore, careful checks were made to ascertain that the sensitivity of the whole equipment was independent of the position of the telescope. H. Neckel and D. Labs believe that with all the precautions taken no systematic errors exist in their intensity ratios Sun/lamp along the entire length of the spectrum. Finally, Dr Neckel spoke about the accuracy of the absolute intensity of the lamp employed. The lamp was very carefully calibrated with standard lamps of the Happel Laboratory in Heidelberg and of the U.S. National Bureau of Standards. Dr Neckel concluded by stating that he and Dr Labs consider their solar intensity measurements to be accurate to within $\pm$ 2 per cent.

(B) *J. Houtgast* reported on absolute intensity measurements made at the centre of the solar disk in the wavelength region λ 2980–4080 Å. The observations were made in 1960 with the Snow spectrograph of the Mount Wilson Observatory, using a calibrated quartz ribbon lamp for reference. Absolute intensities were measured with high spectral resolution at some 170 points between Fraunhofer lines. The extinction of the Earth's atmosphere was eliminated by means of records taken at different zenith distances of the Sun throughout the day for a number of wavelength regions. The 170 points were chosen such that on each sheet of the Utrecht Photometric Atlas and of the Göttinger Atlas of Brückner at least two points would appear. A plot of the measured intensities of the selected points as a function of wavelength clearly reveals various depressions of some tens of angströms width. The most conspicuous depression is that around λ 3700 Å.

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DISCUSSION

In connection with Dr Houtgast's communication, *H. Neckel* showed a slide of a similar plot of his and Labs's results pointing out that the scatter of the measured intensities along any smooth intensity-wavelength curve is about $\pm$ 10 per cent O. Gingerich expressed his interest in the absolute intensity measurements for deriving a model atmosphere. He reminded, however, that the Balmer discontinuity was not an observed quantity, inasmuch as here the metal continuum absorption begins to play a role. In this region one may not use a black body radiation for comparison on account of the complex metal absorption setting in. Answering *C. W. Allen*'s question, *H. Neckel* said that they had not yet added up the intensity measured from λ 3000 to 8000 Å for deriving the solar constant.

Second Meeting, 27 August 1964

The President invited Dr J. Houtgast to be the Chairman of this session, which was devoted to results from solar eclipses.

1. WORKING GROUP ON SOLAR ECLIPSES

The members of the Working Group were announced to be the following:

J. Houtgast (Chairman), R. G. Athay, R. L. Duncombe, M. N. Gnevyshev, J. T. Jefferies, H. Kristenson, A. P. Molchanov, G. Righini, N. V. Steshenko, Z. Suemoto, H. von Klüber and M. Waldmeier.

Temporary members (eclipse 1965): W. N. Arnquist and F. M. Bateson.

2. SCIENTIFIC COMMUNICATIONS

(A) *M. Waldmeier—Variation of the Sun's magnetic field from* 1961 *to* 1963, *as deduced from the slopes of the polar streamers*

In continuation of earlier measurements the corona was photographed during the eclipses of 1962 February 5 and of 1963 July 20 in order to measure the polar streamers. Let $\alpha(r, \theta)$ be the angle between the polar ray and the radial direction, r be the distance from the Sun's centre expressed in units of the solar radius and θ be the angular distance from the solar axis. The following results were obtained from measurements of the angle α at distances $r = 1{\cdot}1$, $1{\cdot}2$, $1{\cdot}3$, $1{\cdot}4$, and $1{\cdot}5$ along all observed polar rays: (1) α is independent of r; (2) α increases linearly with θ. A ray can be expressed by the differential equation $\operatorname{tg} \alpha = \frac{r\, d\theta}{dr}$. With $\alpha = k\theta$, the solution of the differential equation is

$$\log r = \frac{1}{k} \log \left[\frac{\sin (k\theta)}{\sin (k\theta_0)}\right]$$

Each individual ray is defined by its parameter θ_0 ($\theta (r = 1)$ being the point of contact of the ray with the solar surface). The shape of the polar magnetic field as a whole is given by the constant k. The observations so far seem to indicate that k varies with the 11-year solar cycle. The value of k is about 0·8 when the polar streamers begin to appear. Its value increases up to about $k = 1{\cdot}2$ at the time of minimum solar activity.

DISCUSSION

The Chairman wondered about the strength of the magnetic fields in the polar regions. *M. Waldmeier* replied that these observations only give the slope and the variation of the slope of the polar magnetic lines of force but not the value of the strength of the magnetic field.

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J.-C. Pecker would like to have a physical interpretation of these observations. But *M. Waldmeer* said that the physical interpretation is not yet known.

(B) *E. P. Ney—Balloon and ground based observations of the* 1963 *July* 20 *eclipse*

This work was carried out in collaboration with *F. C. Gillett* and *W. A. Stein.* The solar corona and the zodiacal light were photographed by cameras flown on balloons to an altitude of 110 000 feet during the eclipse of 1963 July 20. From these photographs it was possible to determine the absolute intensity of the light of the solar corona between the limb of the Sun and 70° elongation. In addition, from a ground based station at The Forks, Maine, the inner corona was observed at effective wavelengths of 4750 Å and 8300 Å, and its absolute brightness, polarization and direction of polarization were determined. Finally, as a result of photographs taken from the ground, from a jet aircraft at 40 000 feet over Canada, and from balloons at 110 000 feet, it was possible to determine the sky brightness during the eclipse as a function of atmospheric pressure in order to plan for future observations. The detailed paper is published in the *Astrophys. J.*, **140**, 292, 1964.

DISCUSSION

Several participants asked questions concerning more details in the measuring techniques. For the detailed description of the various techniques employed, *Dr Ney* referred to the published paper.

(C) *A. J. Deutsch—An airborne observation of the coronal spectrum at the eclipse of* 1963 *July* 20

This is a joint work together with *G. Righini.* During the total eclipse of 1963 July 20 the spectrum of the solar corona was photographed in the wavelength range λ 3700–4900 Å on board of a DC-8 aircraft. Besides the coronal continuum and the absorption lines, the spectrograms show a strong emission line at the wavelength of the K-line of Ca II. This emission line extends to a height of the order of one solar radius above the Equator at the east limb. Apparently it does not originate in the chromosphere or in an ordinary prominence and probably it is of coronal origin. The H line of Ca II is either altogether absent in emission or, when present, at least an order of magnitude fainter than the line at K. This work is published in detail in the *Astrophys. J.*, **140**, 313, 1964.

DISCUSSION

The Chairman remarked that the intensity ratio K/H which A. Deutsch and G. Righini found to be larger than a factor of 10 in the corona strongly depends on the calibration. To this *G. Righini* explained briefly how they calibrated their exposures with standard lamps before and after the eclipse and photographing the sky background during flight. He considers the calibration to be reliable. *G. Newkirk* wondered whether the observed K emission could not be a scattering effect in the optics. He described a simple calculation showing what emission intensity one would expect from some light scattered in the optics.

(D) *J. L. Locke—Photo-electric measurements of coronal green-line and white light intensities during the eclipse of* 1963 *July* 20

The work was made jointly with *V. Gaizauskas.* Observations of the corona during the eclipse of 1963 July 20 were made by the Dominion Observatory from an aircraft flying at an altitude of 9000 meters along the eclipse path in northern Canada. Measurements of the equivalent width of the green coronal line (λ 5303 Å) and intensities in the neighbouring continuum were made using a photo-electric photometer which scanned the field surrounding the eclipsed Sun. The photometer employed interference filters to separate the line emission from the continuum. Isophotes of continuum emission have been plotted to a distance of approximately 4·5 solar radii from the centre. They indicate that the eccentricity of the corona (K + F) was greater at this distance than predicted by the van de Hulst model for a minimum corona. Coronal green line emission was absent over the poles. On the eastern limb the line emission was detectable to 2·5 solar radii, but on the western limb to only 1·5 solar radii, although coronagraph observations for that day show the emission at low levels to be stronger on the western limb. This is explained by the widely differing height gradients found for the line emission at the two limbs.

DISCUSSION

C. W. Allen remarked that from these various observations we learned that the east and the west side of the Sun may be quite different. It is not sufficient to study the variation of the line intensity with height in the corona, but one must do this for both the east and west limb separately.

3. RESOLUTIONS

The Commission was asked to express its opinion on behalf of the proposed resolution by M. Waldmeier concerning the disturbances caused to ground based eclipse observations by aircrafts flying in the neighbourhood of the eclipse path. A number of members expressed their opinion and took part in the discussion. Particularly it was felt that observations from high flying jet planes and from balloons which can reach the stratosphere are most useful for eclipse observations and, therefore, should be used in the future. On the other hand, one should make sure that during eclipses no jet trails will hamper the ground based observations. It was decided that three separate resolutions should be made: (1) encouraging eclipse observations with high flying airplanes, (2) supporting balloon flights, and (3) warning airplanes to avoid flying over ground based eclipse expeditions. After having heard the various opinions and proposals of the Commission members, the President asked a few members to help him in the formulation of the three Resolutions which then will be read to the Commission at the next session on 1 September 1964.

Third Meeting, 1 September 1964

1. RESOLUTIONS

The President read the final version of the three Resolutions:

Resolution 1. Observations of solar eclipses from airplanes flying at stratospheric or near-stratospheric altitudes can contribute important information about the Sun and the interplanetary medium. The dark sky background and the higher transmission of the atmosphere are favourable to many kinds of scientific studies. The increased duration of totality made possible by fast planes, especially for eclipses occurring in low latitudes, can also help in certain types of observation. Commission 12 of the IAU recognizes the importance of such eclipse observations and expresses the hope that facilities for airborne eclipse research will be made available to solar astronomers by appropriate companies and agencies.

Resolution 2. The past few years have demonstrated that balloon-borne telescopes are of the greatest use for observation of details of the solar photosphere, the chromosphere, and the corona. Since balloons can carry heavy equipment to stratospheric altitudes, they present great advantages: reduced extinction (particularly in the infra-red), highly improved image quality, and reduced sky background. The advantages are equally important for observations both during and outside of solar eclipses. Commission 12 of the IAU thus urges governmental and scientific agencies to give full support to the important balloon-borne experiments which are being planned for the next years.

Resolution 3. During total eclipses of the Sun, important scientific observations made from the ground by professional astronomers may be hampered, or even ruined, by the vapour trails from airplanes flying in the zone of totality.

Commission 12 of the IAU requests the competent authorities in the countries concerned, to regulate flights at the times and locations of total solar eclipses in such a way that their interference with scientific programmes be avoided. The necessary information for each eclipse will be provided sufficiently in advance by the relevant Working Group of Commission 12 to the General Secretary of the IAU.

The Commission adopted the three resolutions.

2. SCIENTIFIC COMMUNICATIONS

The scientific session was largely devoted to investigations on the Inhomogeneous Structure of the Solar Atmosphere.

(1) *Z. Suemoto—Turbulence in the chromosphere*

Chromospheric turbulence velocities from the base up to heights of about 10 000 km were derived from flash spectra observed at the 1958 eclipse. The grazing incidence method was used which reduces the angular size of the Sun by a factor of 5 in the direction parallel to the dispersion. Therefore, the spectral resolution was as small as $\pm$ 2 km/sec, in spite of the fact that the spectra were taken without a slit. For deriving the turbulent velocities the multiplet method was applied to those line pairs which are not optically too thick or too thin. The line pairs used were the H and K lines of Ca II for heights above 5000 km. For lower layers, line pairs of Mg I, Sr II, Al I, Ca I and Na I were measured successively. At the height of about 7000 km, the Ca II H and K lines are relatively narrow and appreciably shifted. The line widths suggest a turbulence velocity of less than about 6 km/sec within individual spicules or groups of spicules. In some cases the widths are relatively large, presumably because of overlapping of a number of spicules. The maximum width of these widened profiles yields velocities of nearly 20 km/sec which agrees reasonably well with the velocities obtained from the line shifts of the narrower profiles. This indicates that the line of sight component of the upward and downward motions in the spicules is approximately 20 km/sec.

At heights of 3000 to 4000 km, the Ca II H and K lines tend to show strong saturation effects which hamper the use of the multiplet method. Therefore, the Sr II and Mg I lines were employed instead. Below 3000 km the superposition of spicules becomes more and more serious and what one actually derives from the line widths is primarily the relative velocities between the spicules, i.e. the upward and downward motions. The velocities at these heights are again of the order of 20 km/sec. Extending the method to lower heights the turbulent velocities for the whole height range could be determined. The derived velocities may indicate a strong anisotropy in the sense that the horizontal velocity component is larger by a factor of over 3 than the vertical component. Instead of this interpretation, it is suggested that the average K line profile is composed of two kinds of spectra: one is an emission line spectrum from spicules in the broad sense, which are relatively narrow but are shifted by various amounts either to the violet or to the red within the velocity range of about $\pm$ 20 km/sec; the other kind is an absorption line spectrum from the inter-spicular regions originating in the photosphere or very low chromosphere. If this interpretation is correct then one would expect to observe, on high quality spectrograms, asymmetrical profiles in which either of the two K_2 components is missing. Such very asymmetrical profiles were observed at the Sacramento Peak Observatory this summer. Probably even more pronounced asymmetries will be observed on highest quality images taken outside the Earth's atmosphere. In this interpretation no K_3 reversal should occur

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on profiles observed beyond the limb. In fact, no flash spectra have, so far, revealed pronounced K_3 reversals. A slight K_3 reversal may occur, however, due to the shadowing of different kinds of spicules at the lowest levels of a few hundred kilometers.

The stellar H and K lines were studied on some 25 spectra of emission line stars at the coudé focus of the 74-inch telescope of the Okayama Observatory with a dispersion of 4 Å/mm. In most cases the H and K emissions of dwarfs are double-peaked. The depth of the K_3 reversal is difficult to estimate on account of the small dispersion. For giants and supergiants the K emission is much wider and, therefore, the dispersion is adequate to give full information about the emission profiles. The supergiants cannot be compared with the solar case, because they have absorption due to the circumstellar atmosphere. The K_3 absorption due to a circumstellar atmosphere appears to be displaced appreciably and is very sharp and deep. The K_3 absorption in most giants appears to be much shallower and more roundish and, therefore, may be assumed to be essentially the same as in the Sun. For these giants which do not seem to have circumstellar absorption the relative intensity ratios of the H_2 and K_2 peaks was close to 1:2 rather than 1:1, suggesting that the chromosphere is relatively thin. It is difficult to imagine that an optically thin cloud lying above the main body of the chromosphere can absorb so much light as is observed. Accordingly, this fact supports the proposed interpretation of the solar K line profile.

DISCUSSION

R. N. Thomas stressed his opinion that he could see no 'physics' in the suggested interpretation of the H and K line profiles. The recent progress of the physics of spectral line formation has made it clear that strong lines such as the Ca II H and K lines must show a self-reversal in any emission core—except when there is a high enough outward increase of T_e near $\tau_0 = 1$. In this exceptional case, the self-reversal becomes increasingly small. Dr Thomas worried about excluding physics from astrophysics by using a purely geometrical model for the H and K line interpretation. *The President* remarked that a sound geometrical model was one of the first steps to take in solving the H and K line problem. *L. Goldberg* encouraged Dr Suemoto to look for evidences of variations in the H and K line emission in stars similar to the Sun.

(2) *G. Elste—Micro- and macro-turbulence*

The question of the distinction between micro- and macro-turbulence was discussed for the solar photosphere using line profile observations. Weak and medium strong lines of Fe I with excitation potentials higher than 3 eV were observed at the centre of the solar disk. The relation between half widths and equivalent widths were measured and calculated for different models of the velocity field. The preliminary results indicate that the micro-turbulence velocity is probably less than 1 km/sec and that the macro-turbulence velocity is of the order of 1·5 km/sec. Further evidences for a separation between micro- and macro-turbulence can be obtained from the relation of the width at $\frac{3}{4}$ line depth with equivalent width, and from curves of growth of elements for which reliable *gf*-values are known for faint and stronger lines.

DISCUSSION

D. Mugglestone wondered whether the effects Dr Elste described could be attributed with certainty to turbulence and not possibly to somewhat questionable broadening parameters. He asked Dr Elste whether or not he had taken into account the contribution of the Stark effect in the determination of the broadening parameters. *G. Elste* answered that the van der Waals and Stark broadening parameters had been taken into account according to theory. Interaction constants C_4 were estimated from laboratory measurements.

In connection with Dr Elste's paper, *C. de Jager* communicated that he and *L. Neven* had investigated the profiles and their centre-limb variation of five C lines of the multiplet

$3s^3P^0 - 3p^3D$ near λ 10 700Å, observed at the Jungfraujoch station with the high dispersion Liège spectrograph. The line profiles were corrected for the influence of the instrumental profile by an exact point-to-point method, and they have a very high accuracy ($< 1\%$). The results of the investigation were the following: (*a*) Using the Goldberg-Unno method the widths of the central parts of the line profiles yield a line-of-sight micro-turbulence velocity component which increases from 1·5 km/sec at $\tau_{5000Å} = 0{\cdot}10$ to 2·3 km/sec at $\tau_{5000Å} = 0{\cdot}05$. (*b*) The lines show a small but distinct asymmetry which varies with depth in the line profile. This asymmetry indicates the existence of convective motions. The convection appears to stop at $\tau_{5000Å} = 0{\cdot}06$; at greater depths the convective velocity component, v_c, increases up to fairly large values. Assuming a two-column model (i.e. only hot and cold rising and descending elements) the v_c component is 2·5 km/sec at $\tau_{5000Å} > 0{\cdot}06$. If however, a three-column model is assumed (i.e. one-third of the photosphere consisting of stationary gases) then $v_c =$ 3·8 km/sec for $\tau_{5000Å} > 0{\cdot}06$.

As a general remark, Dr de Jager added that one should not assume the micro- and the macro-turbulence to be constant with depth. The profiles are influenced by a depth dependent turbulence. To this, *Dr Elste* answered that he had also tried out such models. The resulting differences, however, were small compared to the reported effects.

At this point *A. H. Cook* made a remark which concerned both Dr Suemoto's and Dr Elste's papers. He said that one should be very cautious in the interpretation of line profiles in terms of specific mechanisms. Spectra obtained by dispersion instruments (prisms, gratings, multiple path interferometers) are not able to distinguish between different types of broadening, Gaussian, Lorentzian, or self-absorption. In fact such a separation can only be made convincingly by a Fourier transform technique. This situation is very clear even in laboratory work where signal-to-noise is good compared with astronomical observations. Thus, Dr Cook thinks that it is risky to interpret observations of half widths in terms of a specific mechanism which happens to be under discussion, when in the circumstances it is almost impossible to check whether the line profiles are consistent with that mechanism or not.

(3) *L. Goldberg—On the emission reversals in the Fraunhofer H and K lines*

For the understanding of the proposed interpretation of the profiles of the Ca II H and K line cores, the process of autoionization and dielectronic recombination are briefly explained. It is then suggested that transitions from doubly excited levels may produce the emission reversal at the centres of the H and K lines. The transitions in question take place not in Ca II but in Ca I, between levels lying close to the respective series limits $4p\ {}^2P^0$ and $4s\ {}^2S$ of Ca II. More details of this suggestion are published in the *Astrophys. J.*, **140**, 384, 1964.

In collaboration with *R. W. Noyes* a preliminary attempt has been made to solve the transfer equation for the K line, assuming pure coherent scattering outside the line core and including the contribution to the source function of the Ca II $4pnl$—$4snl$ transitions. The effect of these transitions is to add an extra term to the so-called 'collisional term' in the equation for the line source function. This extra term depends on frequency through the ratio of the Ca I to the Ca II emission profiles, and except in the core of the line, is comparable to or greater than the collisional term. Qualitatively, the presence of this additional term causes the source function more nearly to approach the Planckian at frequencies where it is large.

The integral equation for the coherent scattering source function, containing the new term, has been solved numerically with the co-operation of *Dr E. H. Avrett* of the Smithsonian Astrophysical Observatory using techniques developed by him. The Pagel-Thomas-Athay model was used, but terminated at a height of 1500 km. Ca I $4snl$ and $4pnl$ levels up to n = 30 were considered with an assumed average autoionization lifetime of the upper level of $\tau =$ 3×10^{-12} seconds. The Ca I profile was taken to be a symmetrical pure damping profile with damping constant $1/\pi$. The quantitative discussion of the asymmetry of the emission peaks has been deferred until calculations and/or experimental determinations of the $4pnl$ energy levels are available. The results of the calculations reproduce reasonably well both the position and the magnitude of the emission peaks which are observed. Also, there is a tendency for the peaks to separate as the limb is approached, in qualitative accord with the observations.

The calculations seem to illustrate that we can produce the observed emission peaks in regions with temperatures as low as 6000°K in contrast to the higher temperatures required by other theories. However, it is as yet not possible to compare critically this theory with already existing ones. A more thorough study is being undertaken of the problem including thermal redistribution and the presence of lower levels of the Ca II ion.

DISCUSSION

R. N. Thomas expressed his reservation on this interpretation of the emission reversals of H and K, although he agreed that Dr Goldberg's suggestion is very stimulating. His reservation concerns the source function $S_{\mathrm{Ca\,II}}$ which refers to the $4s-4p$ transition of Ca II. We know that $S_{\mathrm{Ca\,II}}$ will by itself produce such emission peaks. If the emission peaks are to come from Ca I autoionization continuum, then a large value of $d\tau(\mathrm{Ca\ I})/d\tau(\mathrm{Ca\ II})$ is required in those atmospheric regions where the emission peaks originate, ($d\tau$ being the increment of optical depth). This is extremely significant for our understanding of the behaviour of lines from ions with two electrons.

Z. Suemoto asked (1) how the highly asymmetric profiles could be explained which he had shown earlier, and (2) how the wide range of the K_2 widths could be interpreted which are observed from dwarfs to supergiants. In reply to the first question, *Dr Goldberg* said that the explanation might be the Doppler effect. As to the second question it could as yet not be readily answered. *G. Elste* wondered whether all strong Fraunhofer lines showing a core structure similar to H and K could be interpreted by autoionization transitions. *Dr Goldberg* said that one does not know enough of the spectra, but that it may be so.

(4) *R. G. Giovanelli—The structure of the solar chromosphere*

Recent work by *Rawi Bhavilai* at Sydney has caused us to reverse our ideas on the identification of spicules on the disk. Filtergrams obtained in the Hα line with a $\frac{1}{8}$ Å tunable filter shows not only chains of dark mottles which are very obvious at ± 0·5 and ± 0·75 Å from the line centre (the chromospheric network), but also bright mottles which are more obvious in the core of the line. The latter are usually found in close association with chains or clusters of dark mottles. The bright and dark mottles can be traced from the centre of the disk to near the limb. Photographs of spicules at the limb obtained at different intervals out to 0·75 Å from the line centre have shown that the spicules can be traced down on to the disk, where they originate in the bright mottles, not in the dark as hitherto believed. Simultaneous filtergrams of the limb at Hα ± 0·75 Å often show line-of-sight velocities of the order of 20 km/sec in spicules. The sign of the velocity in an individual spicule has never been found to reverse during its lifetime, so that by inference the velocity is always inwards or always outwards (we do not know which) during the life of an individual spicule.

On the disk, filtergrams at Hα − 0·5 Å show that clusters of dark mottles have larger diameters and double chains of dark mottles are more widely separated than at Hα + 0·5 Å. From this, and from filtergrams near the line centre, it appears that the dark mottles often form loops in which matter rises from the Sun farther from the centre of a cluster or a double chain, and descends near the centre. Near the limb the dark mottles have an obvious vertical structure and extend through some 4–5 seconds of arc at Hα ± 0·75 Å. At the limb itself, they merge together to form the rough chromospheric limb, some 4–5 seconds of arc above the photo-

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spheric limb at this wavelength. Comparison of the positions of the bright and dark mottles near the limb shows that chains of bright and dark mottles are associated with one another, though even at the line centre the bright mottles lie just farther from the limb than do the dark mottles at Hα $\pm$ 0·75 Å. Thus the bright mottles originate quite low in the chromosphere, probably somewhere in the first 1500 km. Better resolution is needed for more precision. Between the mottle chains the material must be fairly transparent even in the core of the line for bright material to be seen at such depths. The bright mottles become fairly transparent at levels where the dark mottles are still opaque, though the bright mottles remain sufficiently bright beyond the limb to be seen as the spicules.

(5) *G. W. Simon—Calcium network and vertical velocities*

Previous studies of supergranulation did not reveal satisfactorily the existence of vertical motions in supergranules at the centre of the disk. Several time-series of spectrograms, obtained at the Sacramento Peak Observatory in July 1964, show clearly that vertical motions of 0·1–0·2 km/sec do exist at the disk centre, and correlate in position with the intensity of the Ca II $K_{2,3}$ line in such a way that brighter K emission corresponds to downward velocities. These spectrograms also demonstrate that it is the 300 second period oscillation which camouflages the supergranulation, and makes it almost invisible, unless one uses a time-series to smooth out the effects of the oscillatory motion.

(6) *C. J. Macris—Photometric study of chromospheric flocculi*

The following are the results obtained from photometric measurements of calcium flocculi.

(*a*) The mean intensity ratio of the flocculi to the underlying chromospheric background, reduced to the centre of the solar disk, is $I_{fl}/I_{cr} = 1{\cdot}32$. This corresponds to a temperature excess in the flocculi of about 120°.

(*b*) In the period 1953–61 no appreciable variation of the mean floccular intensity was observed between minimum and maximum of solar activity.

(*c*) The east-west variation of the intensity ratio I_{fl}/I_{cr} was studied and it was found that this ratio increases towards the limb of the Sun. At sin θ = 0·85 the ratio is higher by 0·06 than at the disk's centre.

(*d*) The lifetimes of the flocculi are greater than 9 hours and may reach 50 hours.

(*e*) The average size of the flocculi is of the order of 26 seconds of arc. A relatively close correlation seems to exist between the brightness and the size of the flocculi.

(*f*) The centre-limb variation, in an east-west direction, of the floccular sizes does not follow the cosine law, the sizes of the flocculi do not appear foreshortened. This can be explained by the apparent decrease of the number of flocculi towards the limb as an effect of perspective which causes the interfloccular regions to disappear. In fact, the apparent number of flocculi at 60–70° from the disk centre is only about half the number observed at 0–10°.

(*g*) The intensity ratio I_{fl}/I_{cr} is found to be the same at the centre of the disk and in the north and south polar regions at about 60° from the centre. However, near the limb in equatorial regions this ratio is found to be higher, i.e. $I_{fl}/I_{cr} = 1{\cdot}38$. This may indicate that at the equatorial limbs the temperature in flocculi is higher than near the poles or at the disk's centre.

(7) *J. M. Beckers—Hα- and K-line network*

A movie was presented of Hα– and K– line pictures which was secured at the Sacramento Peak Observatory with an 0·5 Å Hα filter and an 0·3 Å K filter. It shows (*a*) spicular type motions of the elongated dark mottles which have a diameter of the order of 1 second of arc; (*b*) brightness oscillations occurring everywhere on the solar disk in both Hα and K. These

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brightness oscillations, previously probably called flagellant motions, have periods of about 200 seconds. They are 180° out of phase in the blue and red Hα wings, indicating that they are caused by Doppler shifts.

DISCUSSION

Referring to Dr Giovanelli's report on the Hα structures near the solar limb, *O. R. White* mentioned some Hα and K spectra he had taken with a radial slit across the limb. These spectra show bright coherent structures crossing the lines as arches bowing towards the limb. These 'spectroscopic' arches are interpreted as vertical structures seen in projection and they are identified as the bases of the coarse mottles or spicular bushes. Heights inferred from spectra indicate that these structures extend to about 2000 km above the limb in K and Hα.

Thus a single identified spectral feature can appear at points separated by a distance of up to 2000 km in the plane of the sky, depending on the wavelength in Hα or K. Generally, at the line centre the feature will appear closer to the limb because of the combined projection effect and wavelength variation of the absorption coefficient.

Commenting on the same paper, *J. M. Beckers* pointed out that Dr Giovanelli's interpretation of the Hα spectroheliograms was completely opposed to his own one. Giovanelli's conclusions that spicules, when seen on the solar disk, are bright, is based on spicules which are seen crossing the solar limb. Dr Beckers said that he had secured similar observations a year ago and, although these observations were certainly of equal quality than those of Dr Giovanelli, he could not definitely conclude whether a spicule crossing the limb was dark or bright on the solar disk. The main difficulties are (*a*) the crowding of spicules due to foreshortening and (*b*) the presence of spicules with roots on the reverse side of the Sun. If Giovanelli's conclusions are right, then J. M. Beckers wonders what the dark elongated fine mottles are which he has described. Their width, length, lifetime, orientation, motion, numbers, optical depth and source function are such that outside the solar limb they must appear as structures similar to spicules. Trying to clarify these questions, *L. Goldberg* remarked that a spectroscopic feature seen bright at the limb may not necessarily appear bright on the disk. Observing at a specific wavelength off the line centre may correspond to a point in the wing of the line as viewed on most of the solar disk. When, however, the observation is made at the limb in the same specific wavelength then this may not correspond to a point in the line wing but rather to a point in the line core, since the spectral line strongly widens near the limb. Thus peculiar reversals in contrast may be produced. The discussion ended with everybody agreeing that observations close to the limb are extremely difficult to interpret.

(8) *J. W. Evans—Inclined inhomogeneities in the solar atmosphere*

Good spectrograms of undisturbed regions near the centre of the solar disk show a pattern of lengthwise threads representing granulation. In the wings of very strong lines the threads are visibly curved, as though the positions of granules along the slit vary with $\Delta\lambda$. The x-coordinate of threads (perpendicular to dispersion) have been measured in detail on spectrograms showing Fe λ 4384 and Ca II λ 3968 (H-line), and in less detail in one showing Mg λ 5184 (b_1-line). The width of the spectra correspond to 135 000 km on the Sun. The measurements show the following characteristics of the threads:

(*a*) The x-displacements are symmetrical about the line centre, having the same sign and magnitude at $+\Delta\lambda$ and $-\Delta\lambda$. The signs of the displacements of successive threads along the slit are at random.

(*b*) For Fe λ 4384, between $\Delta x = \pm 0{\cdot}2$ Å and the continuum, 58 bright threads were measured. The r.m.s. displacement was 500 km, and maximum displacement was 1200 km. For Ca II λ 3968, 53 threads between $\pm 0{\cdot}5$ Å and the 'continuum' at λ 4000 Å showed r.m.s.

displacements of 990 km, with maximum displacement of 2700 km. For Mg λ 5184, 64 threads between $\pm$ 0·2 Å and the continuum showed r.m.s. displacements of 610 km, and maximum displacement of 1100 km.

(*c*) In approaching the centre of Ca II λ 3968, the displacements of about 15 per cent of the threads went through a maximum and then decreased towards line centre.

(*d*) The r.m.s. displacement of threads (from their positions in the continuum) in the wings of Ca II λ 3968 as a function of distance from line centre were as follows:

$\Delta\lambda$(Å) :	0·5	1·0	2·0	3·0	4·0	5·0	6·0	7·0
σ_x(km) :	1000	910	780	570	430	280	180	110

(*e*) In the neighbourhood of Fe λ 4384, the threads are displaced in all Fraunhofer lines. The measured displacements at the centre of 19 lines in any single thread are very strongly correlated with the central intensities of the line.

(*f*) The sharpness of a thread may vary with $\Delta\lambda$, but there is no systematic relation between sharpness and $d\Delta x/d\Delta\lambda$.

The interpretation of this behaviour is that a curved thread represents a columnar inhomogeneity in the solar atmosphere which is sharply inclined along the slit direction in the solar atmosphere. At different $\Delta\lambda$'s (or at the centre of weaker lines) we see cross sections of the columns at different heights and hence at different x-positions. Allowing a very liberal 500 km for the total height range in Fe λ 4384 and Mg λ 5184, and 1000 km in Ca II λ 3968, the statistics indicate that inclinations of about 45° are the normal thing for bright inhomogeneities. This ignores the uncomfortable fact that the observed displacements occur at $\Delta\lambda$'s in excess of 5 Doppler widths, where we might expect to traverse an exceedingly small height range, and to find practically no height discrimination with $\Delta\lambda$. This can, as yet, not be explained.

DISCUSSION

To *G. Elste's* question, *Dr Evans* answered that the observations were made exactly at the disk's centre. *O. Namba* reported that he had observed very similar structures in facular spectra secured in Utrecht in 1961, though the geometrical resolution of the solar spectrograph was poorer.

(9) *P. N. Edmonds Jr.—Statistical analysis of photospheric inhomogeneities in spectrograms*

Some results were discussed from a joint analysis with *R. Michard* and *R. Servajean* of a time sequence of 60 spectrograms taken by J. Evans at Sacramento Peak Observatory of a low-lying carbon line (λ 5052·16). Fluctuations were measured for continuum brightness, radial velocity (for the carbon line and two other lines formed at higher levels), and for the central intensity and equivalent width of the carbon line. Power spectrum analyses are being performed for each type of measurement, and coherence and phase analyses between various pairs of measurements. Both temporal analyses (at Meudon) and spatial analyses (at University of Texas) are involved and the desirability of bi-dimensional analyses is being investigated.

Continuum-to-carbon-line velocity spatial coherences when compared with previous analyses (four Pic-du-Midi spectrograms, the Richardson and Schwarzschild measurements, and a McMath-Hulbert spectrogram) show (*a*) that coherence is less than 0·5 for $\Lambda \gtrsim$ 8000 km and decreases with increasing Λ, thereby suggesting that thermally driven convection seems to play a role of decreasing importance with increasing Λ; (*b*) that for $\Lambda \lesssim$ 8000 km significant coherence $>$ 0.5 exists when reasonable allowance is made for resolution and similar effects and, hence thermally driven convection seems to play an important role for $\Lambda \lesssim$ 8000 km. An

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important limitation to accepting these results is that different analyses differ markedly in the computed coherences which raises the question of whether these differences are due to uncertainties in the analysis or to differences in the different samples of the Sun's surface. An attempt to evaluate the analysis uncertainties more realistically is underway, and tentatively the results just stated are validated, and differences on the Sun's surface seem to exist.

Temporal power spectra of the carbon line and lines formed at higher levels indicated that the fractional power of oscillatory fluctuations of periods of about 300 seconds is 0·86 at $\tau = 0{\cdot}03$, 0·66 at $\tau = 0{\cdot}08$, and 0·55 at $\tau = 0{\cdot}5$, which would indicate the dominance of such fluctuations at $\tau \sim 0{\cdot}01$ and their importance in the continuum forming and convective levels $\tau \geqslant 1{\cdot}0$. Hence, oscillations are probably an important cause for only moderate coherence ($\leqslant 0{\cdot}7$) between continuum brightness and radial velocity fluctuations. The inclination of inhomogeneities found by Evans (previous paper) could also be important, though the small vertical distances involved is a difficulty. Contribution curves for the measurements have been computed and show that the carbon line layers are less than 50 km above the continuum layers while the layers for other lines are less than 200 km.

Two other interesting results are (1) time variation of a single point show slow changes ($>$ 5 min) upon which the shorter fluctuations are imposed and which differ considerably over dimensions $\leqslant$ 5000 km; (2) whereas line centre fluctuations of most photospheric lines cross-correlate with the velocity fluctuations, those of the carbon line (only about 100 km deeper) cross-correlate with the continuum fluctuations, another rapid change over a very short vertical distance.

DISCUSSION

E. A. Spiegel wondered about the effects of instrumental resolution and seeing. *Dr Edmonds* replied that the most important limitation is probably the integration of seeing effects over the exposure time of several seconds. While this probably restricts useful analysis to $\Lambda \gtrsim 2000$ km, there is still a useful range covered by the results.

R. J. Bray asked what the significance was to analyse the large scale Richardson-Schwarzschild measurements. *Dr Edmonds* explained that the larger scale of the Richardson-Schwarzschild measurements means that the high ($\sim 0{\cdot}8$) coherence extending to relatively small wavelengths may be significant if the resolution of the spectrogram is high. However, the limited number of measurements probably means that any such significance will be masked by large uncertainties in the analysis. The carbon line spectrograms seem to have comparable resolution. *R. Michard* stated that the half width of the continuum autocorrelation curve is around 1000 km for the material under discussion.

(10) *P. R. Wilson—Information content of centre-limb variation of solar fluctuations*

A columnar model for the source function in the photosphere of the form $S(xy) = S_0(y) + S_1(y) \cos lx$ was investigated. The calculated relative r.m.s. intensity fluctuations for a wide variety of models are found to be inconsistent with Edmonds's measurements of centre-limb relative r.m.s. intensity fluctuations obtained from Schwarzschild's 1957 photographs. It is noticed, however, that while the shape of $S_1(y)$ has only a marginal effect on the calculated distribution, the structure size has considerable effect. As the structure size is increased the maximum in the distribution occurs at larger values of the heliocentric angle. For a structure size of 1400 km a maximum of the required magnitude occurs at 63°; with a structure size of 1140 km, the maximum occurs at approximately the observed heliocentric angle but in this case the magnitude is too small. It is concluded that Edmonds's observations are inconsistent with any of the models which have been investigated. A detailed account is to appear in the October 1964 issue of the *Astrophysical Journal.*

DISCUSSION

R. J. Bray asked whether one-dimensional photometric traces were adequate for a comparison between observations and theory. *Dr Wilson* replied that similar approximations must be made in the theory as in observations where one simply measures along a line across the solar disk.

(11) *G. Brückner—Hα-polarization measurements in the chromosphere*

With the aid of a photo-electric polarimeter the polarization of Hα was measured in the chromosphere. A brief description of the equipment was given which is constructed in such a way that three recorders register the three Stoke parameters. The polarimetric device placed in front of the spectrograph consists of a rotatable half wave plate, a calcit column, and a quarter wave plate. The following results can be derived from observations made 1964 July 23 and July 29:

(*a*) The degree of polarization is strikingly different in the southern and in the northern hemisphere.

(*b*) The maximum value of the degree of polarization appears in the southern hemisphere and is 0·8 per cent. The minimum value of the degree of polarization is found in the northern hemisphere and is 0·04 per cent which is still detectable.

(*c*) In the southern hemisphere the highest degree of polarization is found right near the south pole; in the northern hemisphere the minimum value is found near the north pole, the degree of polarization increasing towards lower solar latitude.

(*d*) In the southern hemisphere the angle of the direction of polarization to the radial direction is small, not exceeding 25° except for a zone of local disturbances which affects the polarization. The polarization decreases with increasing angle of direction.

(*e*) Taking the direction of polarization to represent the direction of the magnetic lines of force in the chromosphere, one recognizes a dipole field in the northern hemisphere, whereas such a dipole field is not observed in the southern hemisphere. In the southern hemisphere all magnetic vectors have a weak inclination in the same direction both in the east and in the west part. One may therefore conclude that, at this time, no general magnetic field exists in the southern hemisphere, or, if it does exist it must be very weak.

(*f*) The zone of local disturbances observed at the east limb of the southern hemisphere at about 60° solar latitude extends over about 15° in latitude. Since the same zone appears to be disturbed on both observing days (July 23 and July 29), i.e. 6 days apart, the disturbance must have extended over 70° in solar longitude, or two different disturbances appeared at the same latitude one shortly after the other.

DISCUSSION

In reply to *R. G. Giovanelli*'s question, *Dr Brückner* said that the observations were made at a distance of 5 seconds of arc above the solar limb. *F. W. Jäger* pointed out that when comparing these results with earlier observations of polar streamers one must conclude that the magnetic field has changed quite rapidly. *L. Goldberg* asked how these polarization results compared with magnetograph measurements. *P. R. Wilson* answered that it was difficult to compare these two sets of measurements. On magnetograms one gets the strength of the field whereas the polarization measurements of Dr Brückner give the shape of the field. All what can be said is that regions where no field is observed on magnetograms coincide with regions where no polarization is detectable.

In this connection, *Y. Öhman* drew attention to a somewhat similar physical process, to the resonance fluorescence of emission lines producing partial polarization as described by Dr

Brückner. The process he was thinking of and which also produces polarization, is the excitation by electronic impact of a stream of parallel electrons. In discussions with Dr J. Rundgren of the Royal Institute of Technology in Stockholm it has become evident that the emission of light is completely polarized when negative hydrogen ions are formed by electron impact. In fact, the effect is clearly understood from the theoretical work by Williamson (*Astrophys. J.*, **96,** 438, 1942) and Henrich (*Astrophys. J.*, **99,** 59, 1943). It would be very interesting to check by satellite observations whether or not the electron velocities in the solar wind are at random. If they are not at random the effect might appear also in various other celestial light sources, such as solar surges, Crab nebula, etc.

(12) *R. Tousey—Observations of the Sun's corona from a rocket*

Photographs of the solar corona from $R_0 = 4$ to $R_0 = 10$ were obtained between 130 and 204 km altitude from a rocket on 1963 June 28, by M. J. Koomen, J. D. Purcell, R. T. Seal, and R. Tousey. The instrument was a Lyot coronagraph with objective of 30 cm focal length and 25 mm diameter, shaded with an external occulter at 50 cm distance, whose edge was formed of teeth which directed the diffracted light away from the objective. The photographs, made in white light, show one streamer from 4 to 8 solar radii. Brightness values of the F + K corona, determined from the photographs were twice as great as values measured at solar minimum during solar eclipses. This is taken to indicate that there is material above the 200 km level (in the region partly or wholly shaded by the Moon during an eclipse) in sufficient quantity to double the apparent brightness of the F + K corona when it is illuminated by full sunlight and scatters at 1° to 2° from the forward direction. Many tracks of particles were recorded on the photographs, some close to the coronagraph, and others several hundred feet away.

(13) *G. Newkirk—Observations of the intermediate white light solar corona outside of eclipses*

A brief report was given on the observations of the white light corona made on 1964 March 5, by means of a balloon-borne externally occulted coronagraph ascended to an altitude of 30 km. During the $5\frac{1}{2}$ hours of observing time, 118 photographs of the streamers were obtained in white light (effective wavelength λ 8300 Å) from 1·8 to 5·25 solar radii from the centre of the solar disk. On the pictures shown, the corona has the typical shape of a sunspot minimum corona. Two complex streamers are observed at the east limb, while the west limb is dominated by a single equatorial streamer extending to the limit of the field. This streamer on the west limb appears to have been associated with the recurrent geomagnetic storms and high energy interplanetary nuclei observed during the early months of 1964.

Details of the last two communications were given during the IAU Symposium no. 23 held in Liège one week before the IAU General Assembly in Hamburg.

Since no further comments nor discussions were made, the President adjourned the meeting, thanking all the speakers and those who contributed to interesting discussions during the sessions of this Commission.

WORKING GROUP ON CENTRAL LINE INTENSITIES

Report of Meetings

CHAIRMAN: A. K. Pierce.

(1) At the first organizational meeting it was proposed that an informal Newsletter be distributed twice a year. This would keep all interested persons informed of the needs and progress of the Working Group.

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(2) A provisional list of observatories with equipment suitable for the problem of determining the central intensities of Fraunhofer lines was assembled. It is hoped that others who are interested will make known their capability.

(3) A résumé of the problem of determining the instrumental profile and scattered light was given by *L. D. Delbouille* which formed the basis of the scientific discussion. He pointed out that ghosts, scattered light and other contributors far from the line centre can be nearly eliminated by double pass. The remaining corrections are 0·1 per cent or less. The components of the instrumental profile near the centre are much more important, since the corrections by convolution amount to 1 to 3 per cent. Thus there is a need for a number of accurately known sharp emission line profiles in order to determine accurately the instrumental profile.

(4) It was agreed that:

(*a*) The central intensities shall be obtained for the centre of the solar disk. Further definition of the latter will be required.

(*b*) Values be obtained for 10 to 20 lines yet to be selected.

(*c*) A number of techniques be used.

(*d*) The help of Commission 14 be requested for emission line profiles at several wavelengths, and that lasers be considered.

(*e*) Other questions are the dependence of the central intensities with time; granulation; faculae; the effect of spectrograph polarization.

WORKING GROUP ON SOLAR ECLIPSES

Report of Meetings

CHAIRMAN: J. Houtgast.

SECRETARY: Z. Suemoto.

First Meeting, 26 August 1964

Members present (* guests): W. N. Arnquist, G. Elste*, R. G. Giovanelli, J. Houtgast, H. Kristenson, Lambert*, L. Larmore*, G. Righini, R. N. Thomas, M. Waldmeier.

W. N. Arnquist described various details of the APEQS (Airborne Photography of the Eclipse of the Quiet Sun) 1963 project and the present status of the 1965 project. Questions were asked for more details.

The Working Group agreed to propose a resolution at the second session of Commission 12 on 27 August on behalf of airborne observations of eclipses. Furthermore it was decided that lists of the 40 proposed plans for the 1964 APEQS project should be made available to all members of the Working Group before the next session.

Second Meeting, 27 August 1964

Participants: Members of the Working Group and those who were interested to make observations both from the ground and the air at the total solar eclipse of 1965 May 30, in the South Pacific.

(1) *R. F. Haupt* spoke on behalf of the U.S. Naval Observatory, mentioning that detailed local informations of the eclipses are available for future eclipses of 1971 to 1975 in Circular no. 101,

and that in Circular no. 102 informations will be given concerning the 1965 May 30 eclipse. Anyone interested in receiving information should write to

Dr R. L. Duncombe, Director
Nautical Almanac
U.S. Naval Observatory
Washington 25, D.C., U.S.A.

(2) *W. N. Arnquist* of the Douglas Aircraft Company described again the APEQS 1963 and 1965 projects. Questions and comments were made on observing windows and stability. A list of proposed observations for the 1965 project was distributed to all members present.

(3) *F. M. Bateson* described in full detail the Manuae Island where most of the ground based observations will be located for the eclipse of 1965 May 30. He explained the requirements for the entry permit, transportation and landing, the living and the weather conditions, etc. He also mentioned that the island is owned by a private company, and some compensations should be made. It is important to approach the company as early as possible giving detailed information as to the total area needed and the sites the observers would like to have. In order to meet this request a small group meeting consisting of the representatives of the national expeditions was scheduled for 1 September 1964, which was to deal with the Manuae Island expeditions only.

Third Meeting, 1 September 1964

This was the special meeting of the Working Group dealing exclusively with ground expeditions during the 1965 May 30 eclipse (and limited to the Manuae Island expeditions).

CHAIRMAN: R. G. Giovanelli.

SECRETARY: Z. Suemoto.

Participants: W. N. Arnquist, F. M. Bateson, G. Elste, Y. Fujita, R. Fleischer, G. Godoli, J. Houtgast, H. Kristenson, Lambert, D. H. Menzel, E. R. Mustel, A. K. Pierce, F. Schmeidler.

F. M. Bateson was asked to lead the discussion. The following items were discussed:

(1) Limitation on the size of each expedition. The New Zealand Government requires the number of a single national party to be kept smaller than 25 members. Both U.S. and U.S.S.R. parties agreed to meet this requirement.

(2) Liaison officer for each expedition party. During the expedition this requirement will be met. However, before that time it would be more beneficial to all parties concerned if Dr Bateson would act as liaison officer. Therefore, the Working Group appointed Dr Bateson as liaison officer on behalf of all the national parties concerned for the period prior to the expedition. He will be entitled to negotiate with the company in the Cook Island as regards the selection of sites, compensations, etc.

(3) Problems of small expeditions. The New Zealand–United Kingdom party and the Japanese party have almost definite plans for having their own ships. These, however, are supposed to be for transportation only. The U.S.A. and the U.S.S.R. expeditions will try to have their own ships, and it is still not known whether or not the ships will be stationing at the island. Australia, Canada, Germany, and Switzerland will not use ships. Since the New Zealand Government requests that all ships must go directly to Manuae, it was considered necessary to get a permit from the Department of External Affairs of New Zealand in order to be able to go first to Rarotonga by way of commercial transportation and then to charter a ship there for Manuae. The Working Group decided that F. Schmeidler should make applications for this permit on behalf of Australia, Canada, Germany and Switzerland by a formal

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letter to Dr Bateson; follow-up letters would be sent by the interested parties through diplomatic channels.

(4) Areas required and expenses. At present, no evaluation of the expenses can be made. Informations on the required areas were collected by Dr Bateson.

(5) Facilities. It was confirmed that each party should be completely self-supporting.