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9*b*. SOUS-COMMISSION DE LA QUALITE DES IMAGES

PRÉSIDENT: Dr J. S. Hall, Director of the Lowell Observatory, Flagstaff, Arizona, U.S.A.

MEMBRES: Butler, Hewish, Keller, Redman, Rösch, A. G. Wilson, Zwicky.

INTRODUCTION

At the Moscow meeting of Commission 25*b* (now 9*b*) the following resolution was passed:

Resolution 19. La Sous-Commission 25*b* recommande que le voeu du Comité Belge d'Astronomie (point 13(*c*) de l'ordre du jour de l'Assemblée Générale) soit pris en considération, et qu'un Symposium sur les problèmes de recherche de sites d'observatoires soit organisé par l'Union Astronomique Internationale dès que possible.

Acting on this resolution the General Secretary, at the suggestion of the Executive Committee, sent a circular letter to interested astronomers on 4 February 1959 asking them if in their judgment the IAU should proceed to organize a symposium on site testing. Replies were received from twelve astronomers, the consensus of opinion being in favor of setting up a small committee to make a long-range study of the whole subject. Acting in part on the recommendations of the Presidents of Commission 9 and Sub-Commission 9*b*, the Executive Committee set up a temporary working group consisting of the following members: I. S. Bowen, A. Danjon, A. R. Hogg, G. Keller, O. A. Melnikov, J. Rösch (Chairman), and H. Siedentopf. This working group was to begin the study of the question at once and to continue in being at least until the Berkeley meeting in August 1961.

SEEING

Since the time of the Moscow meeting there has been significant work in this field.

A harmonic analysis of photographic records of image excursion by Ursula Mayer showed an increase in amplitude toward low frequency down to 0·2c/s (1). With increase of zenith distance, the r.m.s. values of the image excursion tend to approach a maximum value asymptotically. Little or no correlation was found between image excursion and scintillation.

Visual experiments carried on by I. S. Bowen at the 60-inch Mount Wilson reflector provided convincing observational evidence that much of the disturbance to the seeing can be caused in regions near the telescope (2). In this work he made use of a principle, first pointed out by

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Gaviola, that the shadow bands should disappear if the point on which the camera was focused and the disturbing layer are at conjugate foci of the telescope mirror. Measures on two nights indicated that most of the disturbance to the seeing came from layers within 200 meters of the telescope.

Rösch has placed in operation an automatic selector which is able to trigger a shutter when the sharpness of the image of solar granulation is optimum (**3**). The necessary information is obtained electronically through the use of a small arc of the photosphere.

Motion-picture photography of close double stars, made practical through the use of image tubes, has been employed at the Lowell Observatory with the 24-inch refractor (**4**). On these experimental photographs equal pairs $0''\cdot46$ apart show separate images. Pairs differing by three magnitudes have been separated on the photographic film at distances of $0''\cdot8$. Stars as faint as 8th visual magnitude have been observed.

Arsac, using first order theoretical developments of the seeing in a wholly homogeneous atmosphere has obtained good agreement with experimental results in both the optical and centimeter regions (**5**). He finds, however, that in the centimeter region his developments do not provide information on the statistical properties of the fluctuations in the refractive index of the atmosphere.

SCINTILLATION IN THE OPTICAL REGIONS

A final report entitled: 'Investigation of Upper Air Turbulence by the Method of Analyzing Stellar Scintillation Shadow Patterns' on the extensive program carried on at the Perkins Observatory has been written by Barnhart, Keller, and Mitchell (**6**). The auto-correlation method developed by Keller and Protheroe is used to obtain information about the location of turbulent layers responsible for the scintillation of starlight, motions in these layers and the persistence, size, and shape of the turbulent elements. The direction and speed of shadow-pattern motion is compared with upper-air data. Auto-correlation functions of shadow patterns were found by varying the telescope spacing in two directions with respect to the direction of the pattern motion.

Protheroe and Kwan-Yu Chen have summarized their work on 'The Correlation of Stellar Shadow Band Patterns with Upper Air Winds and Turbulence' in another extensive final report (**7**). Strong correlations between stellar scintillation and both wind speed and direction at the height of maximum vector gradient in wind velocity were found. The analogue computer used for determining auto-correlation functions at the Perkins Observatory is described. Also described is an optical Fourier Analyzer which was used to measure the motion and size of the characteristic elements of shadow-band patterns and their decay times.

Zhukova published a report of his work on 'The Registration of Stellar Scintillation by the Photo-electric Method'. Graphs and tables are presented showing the observed scintillation at different zenith distances, different times of the year, and in different wavelengths (**8**). He has also made a study of scintillation of stars by photographing their spectral trails (**9**). Photometric measurements in the region λ 5800 Å to 3800 Å showed no correlation between variations in brightness in different spectral regions for $Z \geqslant 75°$.

Tatarsky, Gurvich, Kallistratova, and Terentyeva have made an experimental investigation of the scintillation of a distant terrestrial source under different meteorological conditions (**10**). A high correlation coefficient (0·92) was found between scintillation and the vertical gradient of the mean temperature. This they found to be in good agreement with theoretical considerations.

Two monographs describing theoretical studies on wave propagation have been published by the U.S.S.R. Academy of Sciences. One by L. A. Chernov (1958) is entitled 'Wave Propagation in a Medium with Random Inhomogeneities'; the second by V. I. Tatarsky (1959) is on the 'Theory of Fluctuation Phenomena for Wave Propagation in a Turbulent Atmosphere'.

Scheffler has made a theoretical investigation of the change in direction and lateral displacement of radiation transversing a medium with statistically distributed fluctuations in refractive index as a four-dimensional Markoff process (**11**). He finds it possible, in the case of small scattering angles, to obtain the distribution of the intensity fluctuations at the bottom of the turbulent layer, and also the correlation function of the space structure of the intensity fluctuations in the plane perpendicular to the incident radiation.

In a review article by Elsässer on the 'Scintillation of Stars', the data on the brightness and directional scintillation of stars is discussed together with telescopic and atmospheric parameters (**12**). He concludes that the whole atmosphere contributes to the effect and that the present theory which involves a thin disturbing layer only is untenable.

SCINTILLATION IN THE RADIO REGION

Chivers has made a comprehensive study of radio star scintillation covering the frequency range of 26 Mc/s to 408 Mc/s by making several simultaneous observations at two frequencies (**13**). He found that under extreme conditions the theoretical relations governing the frequency dependence of scintillation amplitude and rate are not valid. Under the most intense conditions a net attenuation of the source is observed. He found no significant cross-correlation between records obtained simultaneously on frequencies differing in the ratio of 3 to 1.

Radio measures at C band (2700 Mc/s), with the Sun as a source, were made by Costelli, Aarons, Ferioli, and Casey (**14**). Atmospheric scintillation for periods ranging from $0^{s}\cdot5$ to 90^{s} were recorded. At high elevation angles the scintillation amplitudes rarely reached 10% and were generally less than 1% of the antenna signal temperature. Scintillation at low elevation angles ranged from 2% to 20%.

Scintillation measurements of radio signals from satellites have been recorded by Yeh and Swenson (**15**). Marked diurnal effects were observed, scintillation being much more frequent at night. Night-time scintillation correlates with the occurrence of ionospheric 'spread F' and apparently occurs at heights of about 220 kilometers and at latitudes greater than 40° N. Daytime scintillation seems to originate in smaller regions below 220 kilometers and is more widely distributed in latitude.

INVESTIGATIONS OF ASTRO-CLIMATE

Russian astronomers have been making extensive investigations of the astro-climate in the U.S.S.R. Melnikov and Kutcherov have taken an active part in this work. Both theoretical and observational results of these studies have been published in the Transactions of the 'Conference on Star Scintillations and Wave Propagation in a Medium with Random Inhomogeneities', U.S.S.R. Academy of Sciences, Moscow-Leningrad, 1960 (edited by Melnikov). Papers have been published by Zhukova (**16**), Demidova (**17**), Demidova and Bystrova (**18**), Beruchka (**19**), Bystrova (**20**), Darchia, Schmeel, and Darchin (**21**), Dadaev (**22**), Tartarsky (**23**), Tartarsky and Zhukova (**24**).

RECENT PUBLICATIONS

A chapter on 'Astronomical Seeing' by J. Stock and G. Keller (**25**) and a second chapter on 'Astronomical Seeing and Observatory Site Selection' by A. B. Meinel (**26**) have recently been published. Bart J. Bok has written a paper (**27**) on 'A Search for New Observatory Sites in Australia'. N. V. Bystrova and A. N. Demidova have published a series of joint papers on seeing as related to solar observations (**28**). Recently published papers on the 'Theory of Astronomical Scintillation' have been written by Elsässer and Siedentopf (**29**) and by Elsässer (**30**).

JOHN S. HALL
President of the Sub-Commission

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