NIGHTGLOW AND TWILIGHT IN THE ANTARCTIC*

Introduction

DR. ANTONIN MRKOS, the author of this article, is a member of the scientific group for the high atmosphere studies at the Chechoslovak Academy of Sciences and participated in the third Soviet Antarctic Expedition (1957-58) organized within the IGY research activities. Dr. Mrkos carried out his observation of the night sky at the Antarctic Observatory Mirny and also aboard the vessels Kooperatzia and Ob sailing across the Indian and Atlantic oceans in the regions between the two polar circles. The scientific programme planned out for his study dealt chiefly with researches of the high atmosphere by indirect methods. These comprised: (1) photoelectric measurements of the nightglow, (2) photoelectric measurements of the twilight and dawn, (3) observing, measuring and photographing of auroras, (4) photographing of auroral spectra, (5) observing of telescopic meteors, (6) observing of noctilucent clouds and noctilucent bands.

FIG. 1. The Mirny Observatory. In the background are the airfield and broadcasting station.

Instruments and Method

The measurements of the nightglow were made with a photoelectric photometer in four spectral ranges determined by the four Schott-Jena interference filters giving maximum transmission near wavelengths 5300 Å, 5577 Å, 5894 Å and 6300 Å respectively. The range of transmission about these maxima was 60-100 Å. The measurements were carried out exclusively in zenith. The instruments were installed in a small wooden house situated northerly from the Mirny Observatory on the cape Chmara on the coast of the Davis Sea (Fig. 1). The position of the instrumentation was 66° 33′ S. and 93° 01′ E. The house was electrically heated which permitted the equipment to be kept at a relatively constant temperature and also enabled work to be continued even during severe frosts and winds. The time accuracy of the observation was ensured by a chronometer as well as by a radio receiver which received the time signals from Washington, Tokyo and Honolulu. Anode batteries were used as source for the photoelectric multiplier FEU-17. The deflections were read on the Interflex mirror galvanometer. Measurements were made every hour both on bright nights and on moonless nights. The intensities of individual emissions transmitted by the interference filters were measured by substitution with an electric light source connected to the Wheatstone bridge. The conditions of measurements as well as the weather were more favourable in Mirny than in Central Europe. Between February 24 and October 12, 1958, a total of 134 night measurements were effected. Further, 30 night measurements were carried out aboard the ships.

FIG. 2. *Aurora borealis* over Mirny (its most frequent form).

From the end of April 1958, a systematic recording of the green emission of the nightglow at 5577 Å was made at intervals between the measurements. The recording was done by means of an electronic potentiometer EPP-09, with a sensitivity of 1 mV for the total range and record speed of 120 mm./hour, connected to the output of an electronic photometer. To further elucidate the information on the auroras, this recording was conducted also on nights with overcast sky and on clear moon nights. Experience showed that in Antarctica on moonless

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nights a full cloudiness—type cirrostratus, altostratus and altocumulus—does not prevent the recording of very weak auroras which otherwise would pass unobserved because of the cloudiness.

Summary of Results on Nightglow Intensities

1. The observed intensities of the nightglow varied abruptly from night to night, the variations being sometimes as great as 100%. The two oxygen emission lines 5577 Å and 6300 Å showed, at their abrupt fluctuations in brightness, a systematic decrease of intensity which was observable up to the end of June. This was followed by a moderate increase in brightness and subsequently a systematic decrease recorded up to the middle of October when the measurements were closed. The systematic decrease in intensity of the green emission during the Antarctic night 1958 corresponded relatively well with the decrease of the absolute ozone contents in the atmosphere during the same period. These abrupt fluctuations in intensity of both the emissions are likely to be caused by the activity of weak, visually unobservable auroras.

2. During a night, often several maxima and minima were recorded at individual emissions. A very striking minimum of the green emission 5577 Å took place close to the dawn. The evening decrease in intensity of the green emission 5577 Å was by far more abrupt than that in the red emission 6300 Å which, on the other hand, began to increase in the morning 1-2 hours before the onset of the astronomical dawn.

3. A violent decrease, often below the night average, of both emissional regions 5577 Å and 6300 Å occurred also immediately after the passing of bright auroral forms through the measured point of the sky, when the aurora lower down on the sky was still very active. This decrease was more pronounced in the region 5577 Å than in the region 6300 Å. Such local decrease in intensity of the nightglow emission has not been observed in middle latitudes.

4. In the integral nightglow a considerable increase in intensity with the geographical latitude was recorded in 1957. The average intensity of the nightglow in Mirny towards the end of February 1958 was three times as great as that in the tropical region at the position 20° 34′ S and 57° 13′ E. When these measurements were repeated in 1959, during the trip aboard the ship Ob between 70° S and 54° N, such a striking decrease of the nightglow towards the Equator was not recorded. In 1959 the nights in the equatorial region were far brighter than those towards the end of 1957 and at the beginning of 1958 when, for example, the *Gegenschein* could be observed every night. In spite of the same astronomic observational conditions this phenomenon was never recorded in 1959.

5. The relative increase of the red emission at 6300 Å before the start of, during and after the auroral displays, was far feebler in the latitude of Mirny than in middle latitudes. The time intervals between the onset of the increase of the emission before the aurora and the decrease after the aurora were far shorter.

Telescopic Meteors

A systematic study of the telescopic meteors, up to the limit magnitude of 9 *m*, on every clear moonless night proved that during the Antarctic night 1958, the hour frequency of the meteors in a given instrumentation was twice as low in Antarctica as in Central Europe.

The influence of this frequency on the emission intensity of sodium 5894 Å was studied and it was noted that on nights with increased intensity of telescopic meteors the absolute emission intensity of 5894 Å also increased. A similar increase of sodium emission was also observed during the nights when noctilucent bands occurred on the sky.

The results of the systematic recording of the variations in intensity of the green emission 5577 Å during the auroral displays (Fig. 2) were compared with the records of the variations of all components of the geomagnetic field, telluric streams and ionosphere vertical soundings. It appeared that (1) in the period of intensive outbursts of the green emission at 5577 Å, the vertical ionograms showed a diffuse reflection occurring at the heights of 150–180 km. It is the sporadic E layer of *a* or *q* type. (2) The large variations of all components of the telluric stream corresponded exactly both in time and in relative changes with the fluctuations in intensity of the recorded green emission 5577 Å. (3) The same correlation has been noted in the records of the variations of the geomagnetic field in almost all components. The above correlations were maximum in case of the auroras passing through the magnetic zenith and far feebler when the auroral displays were located at a distance of more than 20° from the magnetic zenith.

Twilights

131 twilights were measured in Mirny. The measurements of the twilight started usually on the solar depression of 5° and terminated

on the depression of 18°. The analysis of these measurements has not been made as yet.

During the measurements of the twilight, a phenomenon of particular interest was recorded. Nearly every day, before the end of the astronomical twilight, from the solar depression of 14° up, weak-rayed auroral display took place on almost the same spot of the sky showing South-North direction in the evening and East-West direction in the morning. In the evening the brightest rays usually passed through the point located at a distance of about 8° WNW from the zenith. The brightness of these auroral displays was mostly very faint and, without photometric measurements, unobservable. These auroras persisted usually for more than 1-2 hours at the end of the astronomical twilight. From the middle of March to the end of June the start of these auroras progressed by 5 hours in the evening whereas in the morning it delayed by 4 hours. No effect of these auroral displays on the recording of the geomagnetic field and telluric streams has been recorded. From the temporal variation in the start of these auroras in the course of the year as well as from their form and colour it may be concluded that these are special types of auroras appearing mostly during the daytime and caused by other processes of solar activity than those which cause the nocturnal auroras which have a steady maximum in Mirny at about 18 hours UT.

Noctilucent Clouds and Bands

The noctilucent clouds were observed twice during the period of study in Mirny. For the first time they appeared on 28th March 1958 at 13 hr. 35 min. UT, showing considerable motion in ESE direction. Their estimated height was 82 km., and the real velocity of these clouds was 350 km./hour. The same day, a stratospheric jet-stream in the same direction and of the same velocity was measured by the aerometeorological group of Prof. Bugajev in Mirny. For .the second time, the noctilucent clouds were observed on 13th May 1958 at 11 hr. 30 min. UT in zenith, being this time nearly stationary, with only a slow motion to SSW. In other respects, these noctilucent clouds did neither in colour nor in form differ from those observed in Central Europe.

On several nights, the noctilucent bands were observed in Mirny during 1958. They were usually brighter than those in Central Europe and were radially disposed on the sky with the radiation points from N to ES. The region of their maximum frequency in Mirny was that of SE. The noctilucent bands were observed also during the author's trips aboard Kooperatzia and Ob. Their first appearance in the southern hemisphere was recorded at 37° S. They were never observed in the tropical region.

Conclusion

The measurements of the instrumentation, filters and photomultipliers were conducted in the Astronomical Institute of the Czechoslovak Academy of Sciences and the measured intensities of the nightglow have been converted into absolute rayleigh units. By the end of this year, the values of the green emission 5577 Å are to be analysed and forwarded to the corresponding World Centres. Thanks to the support of the geophysic group III, SAE, the author's instrumentation was amplified by the spectrograph SP-47 1 : 1 with a dispersion of 200 Å/mm. and by the recording electronic pctentiometer EPP-09. The chief of this group also permitted the use of the records of the vertical ionosphere soundings, telluric streams and variations of the geomagnetic field.

DEFENCE ELECTRONICS CONVENTION

A DEFENCE Electronics Convention, first of its kind in the country, was held in Bangalore from September 28 to October 1, 1959. Over 350 delegates representing 42 different major organisations got together for an intensive three-day discussion and interchange of views on the applications of electronics to Defence needs. Coinciding with the Convention, an electronics exhibition was also organised.

Inaugurating the Convention, Major-General B. D. Kapur stressed upon the growing application of electronics to the Defence equipment and the need to evolve our own standards for evaluation of equipments suited to Indian conditions.

Over 40 significant papers were read and discussed during the technical sessions, ranging from problems in Development and Production of Electronic Equipment, Effects of Environmental Hazards on Electronic Equipment, Guidance and Control Systems, Automation, Instrumentation, Reliability Problems, and Education and Training of Electronic Engineers.

Highlights of the whole programme were two talks one by Sir C. V. Raman on 'Infra-Red Radiation' and the other by Major-General B. D. Kapur on 'Career Prospects for Scientific and Technical Personnel in the Ministry of Defence'. Prof. M. S. Thacker delivered the Distinguished Guest Speaker's Address.