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Astronomy in Antarctica – India's First Attempt

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1. Introduction

During the early part of 1989, the astronomers in India and the Indian Government mutually agreed to include the programmes related to Astronomy for the first time in the on-going Indian Scientific Expeditions to Antarctica. However, since the polar night, as seen from the approximately 70°S latitude of the Indian station in Antarctica, is filled with a long spell of twilight, it was considered to be not-dark-enough for any long term observations of stars or for that matter, any other night time celestial objects. This resulted in turning the attention to solar programmes so that the polar day may be used more fruitfully. At this juncture, though an experiment related to helioseismology which needs the long term continuous and stable observations of the Sun, was thought of as the most appropriate one, the time available for its preparation turned out to be too short. So, a simpler programme involving the study of the lifetimes of the solar surface supergranules was taken up. Further, this also offered a chance for a first hand assessment of the site for astronomical observations. Thus started the first ever Indian venture of carrying out an astronomical experiment in Antarctica that was included in the IX Indian Scientific Expedition which sailed off from India on 30 November 1989 on board the ice-class ship MV/Thuleland and returned on 27 March 1990.

2. Instrumentation and observational programme

The choice of an uncommon programme that required the continuous 24-hour tracking of Sun demanded some special features in its instrumentation. The heliostat which was designed exclusively for the latitude (70° 45′ S) of the Indian permanent station Maitri, incorporated two 6-inch (15-cm) flats as the first and the second mirrors along with a 4-inch (10-cm) achromat lens of 10-ft (300-cm) focal length to form a 28 mm image of the sun on the blue sensitive fine grain Kodak SO-115 film of 35 mm format. The first mirror was mounted on a wheel which could rotate freely over full 360° in order to track the sun continuously for a complete 24 hour period. A Ca–K line daystar filter with a passband of 1.2 Å was fitted just in front of the camera. It was carefully fabricated at the IIA workshops in such a way that it was totally manageable under the hostile weather conditions of Antarctica. The installation of the telescope, the maintenance and the upkeep of the instrument, the actual observations and all other related tasks were carried out by just the three astronomers on site – Jagdev Singh and G. S. D. Babu of Indian Institute of Astrophysics and Wahabuddin of Uttar Pradesh State Observatory, who happen to be the very first Indian astronomers to have set foot on the icy continent of Antarctica.

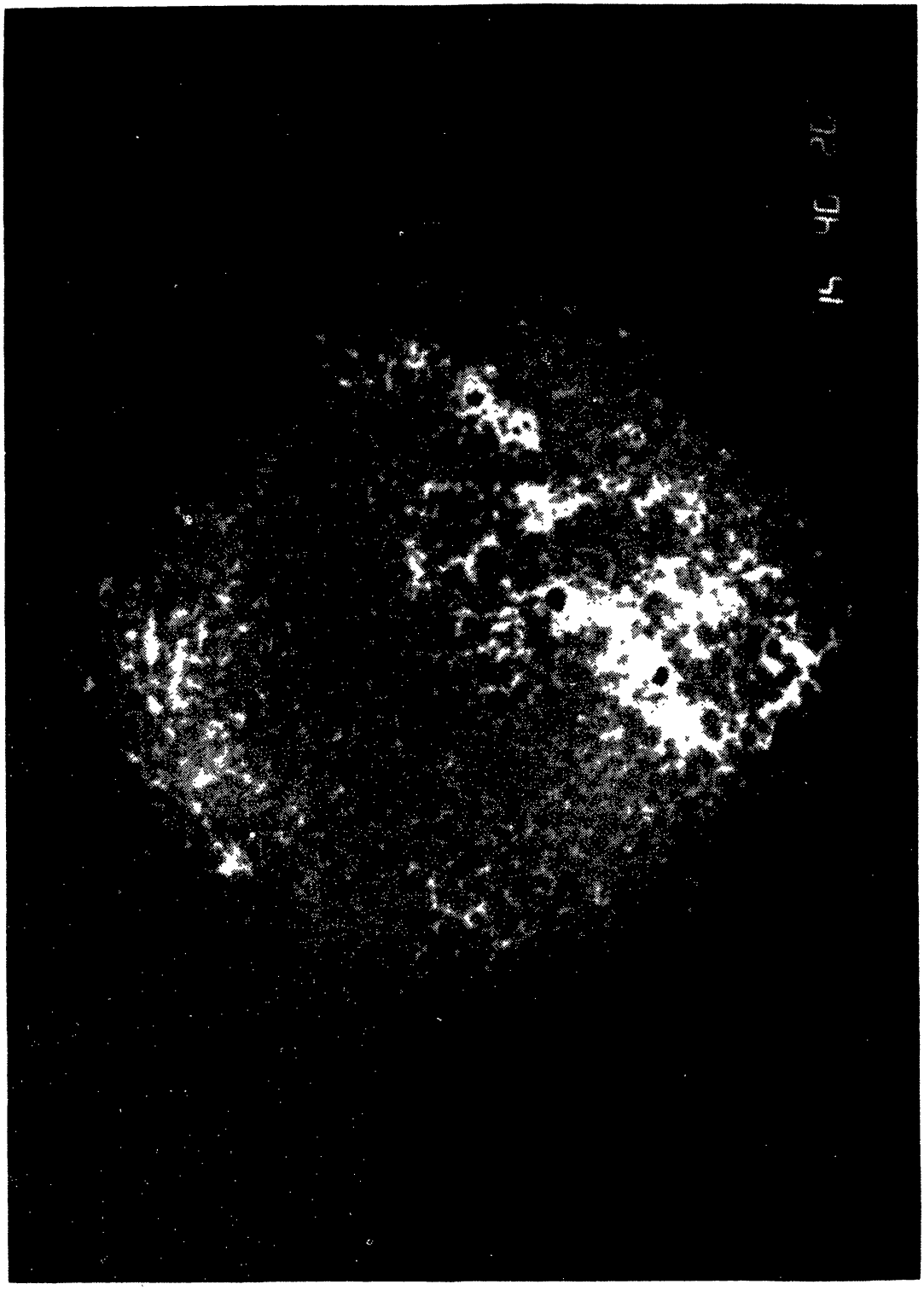

Figure 1. An example of the Ca–K line filtergram of the sun, taken on 8 January 1990 from the Indian permanent station Maitri in Antarctica using the IIA made heliostat. The network pattern can be seen clearly alongwith other features associated with solar activity.

Each frame of the sun's picture was carefully photographed after ascertaining that the image was properly centered onto the aperture of the filter and thereby on the film that was loaded in the camera having the date/time facility. Exposures of adequate timings were taken at intervals of 10 minutes over a period of about 100 hours that remained continuously clear during the second week of January 1990. Some photographs were taken at very short intervals also for studying the evolution of flares.

It is known that besides many other features, the convective flow in the solar atmosphere gives rise to supergranulation. This phenomenon was discovered in 1959 by Leighton and others at Mt. Wilson Observatory in the dopplergrams of the sun's photospheric surface. The counterparts of these convective cells can be more easily observed in the chromospheric level, where they can be seen conspicuously in the monochromatic photographs of the sun, like the ones obtained in this programme. In these photographs, a network pattern can be seen all over the solar surface, which in turn bears a one-to-one correspondence with the supergranulation cells. Presently, these photographs are being analysed to study the temporal features of the convection cells in order to obtain their lifetimes. This is an important parameter in the evolution and decay of these cells for an understanding of their dynamics. In addition, the data acquired also contain enough material for studying the organisational processes of active regions on the sun.

3. Sky conditions and other related aspects

During the period of observations, which was summer in Antarctica, the temperatures at the Indian station Maitri ranged between $-5°C$ and $-30°C$. Only occasionally it crossed over into the + ve side. But whenever the wind speed increased, the wind chill factor brought down the temperatures effectively upto a very miserable $-40°C$ and below. However, as the acclimatisation to the low temperatures was fairly complete, the members of the expedition could easily work outdoors as long as the wind chill factor was not too bad.

Bad weather in Antarctica generally means a blizzard, with heavy drifting of snow along with winds upto about 100 to 200 km/hr speeds. Sometimes, the pre-blizzard period may be for about a week or so during which time the sky will remain mostly overcast. There are also times when a blizzard sets on within one day of cloudiness. Each blizzard would last for a few days, sometimes extending upto a week. Then the sky slowly clears and the clear sky would continue for some days. This is almost cyclical, but not necessarily at regular intervals. But whenever there are no clouds, the transparency of the sky appears to be excellent. During the period of observations, the sun's image was generally very stable and on many occassions the sharp demarcation of the solar limb could be clearly seen.

The moisture content in the Antarctic air is very less. It does not rain in Antarctica and the snow fall is minimal. With no other pollution in the atmosphere, the region is perhaps more suitable for infrared and millimeter wavelength observations. However, some specific programmes in the optical region like the location dependent events of eclipses, occultations and so on may be worth taking up.

4. Conclusions

The first ever attempt of conducting an astronomical experiment in Antarctica by the Indian astronomers was a part of the IX Indian Scientific Expedition during the

southern summer of 1989–90. The pioneering three Indian astronomers who were included in the expedition installed a heliostat at the Indian permanent station Maitri and with that instrument observed the sun continuously for about 100 hours in Ca-K line in order to study the evolution and lifetimes of the solar surface supergranules.

The sky conditions in Antarctica are intermittently good for astronomical observations, giving excellent transparency during the cloudless spells. The humidity is very low and there is no pollution in the atmosphere. The prevailing conditions appear to be more suitable for IR and mm wavelength observations. Some location dependent events like eclipses, occultations, etc. may be taken up in the optical region in addition to any short-term phase dependent programmes.

Acknowledgements

India's astronomy programme in Antarctica was first conceptualised by the Late Prof. M. K. V. Bappu. Then, it was Prof. J. V. Narlikar who took the initiative and continued the efforts in this direction. The eventual inclusion of astronomy in the on-going Indian Expeditions to Antarctica owes its origin to him. The opportunity of carrying out this first astronomical programme was given to the Indian Institute of Astrophysics by the Department of Ocean Development (DOD) of the Government of India. The programme was most efficiently co-ordinated by Prof. J. C. Bhattacharyya and Prof. K. R. Sivaraman of IIA.