A Note on the General Spectrum of the Night Sky as observed in India.

By

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(Plate XXX.)

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The presence of the green line 5577A due to neutral atomic oxygen may be considered to be established in the spectrum of the night sky in all parts of the world. But there is still considerable lack of knowledge regarding the general spectrum accompanying it. L. A. Sommer [1] from his examination of plates obtained at Gottingen, came to the conclusion that nitrogen bands are normally present in the night sky as in polar aurora, while Lord Rayleigh [2] has adduced strong reasons for the view that the spectrum of the normal night sky is essentially different from that of the polar aurora in as much as the former does not show the negative nitrogen bands which is a striking characteristic of the latter, and besides, shows two lines (or bands) which he calls X_1 and X_2 located at 4419 and 4168A. In a recent note, M. J. Dufay[3] has tabulated a large number of bands obtained

1 L. A. Sommer, Z. Physik, Vol. 57, p. 582 (1929).

2 Lord Rayleigh, Proc. Roy Soc.. A Vol. 131, p. 376 (1929).

3 J. Dufay, Comptes Rhndus, Vol. 193, p. 1106 (1931).

in the spectrum of the western night sky taken in France: although some of the bands are common to the aurora and the night sky, the two cannot be considered as being identical.

In view of the general interest of the question and the non-agreement of views between different investigators a few long exposure photographs of the spectrum of the clear night sky were obtained at Poona (lat. 18° 30′) in February and March of this year. Owing to the low latitude, we may be fairly confident that the spectra will not be affected by even faint auroral discharges. Some comparative spectra of zodiacal light were also obtained.

The spectrograph used[4] had a single flint prism, the collimator having a focal length of 12 in. and aperture 1·5 in. and the camera having a Dallmeyer lens of focal length 2 inches and aperture ratio F/1·5. The dispersion of the instrument was such that the distance between the green line 5577A and the H line of the solar spectrum on the plate was about 3·5 mm. The plates used were Extrema-Ortho or Finogran manufactured by the Mimosa A.G. of Dresden. This has a region of high sensitivity from 5400-5750 and 4800-3900 A.U. A good spectrum was obtained with an exposure of 25½ hours on five nights on clear moonless skies between the 11th and 15th February. The exposures were made with the collimator facing south-west at an angle of 25° with the horizon and the slit-width was 0·67 mm. As all the exposures were after 22 hs. 30 m., the spectrum would not be affected by the zodiacal light. Another good plate was obtained between the dates 28th February and 5th March with a slit of 0·47 mm., the total time of exposure being 36¾ hrs. For showing the lines or bands more distinctly in print, Fig. 1 was obtained by superposing the two long exposure night sky spectra and making an enlargement. The close

[4] K. R. Ramanathan, 'Nature,' February 20 (1932).

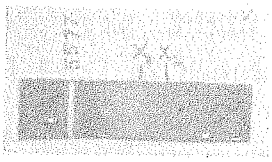
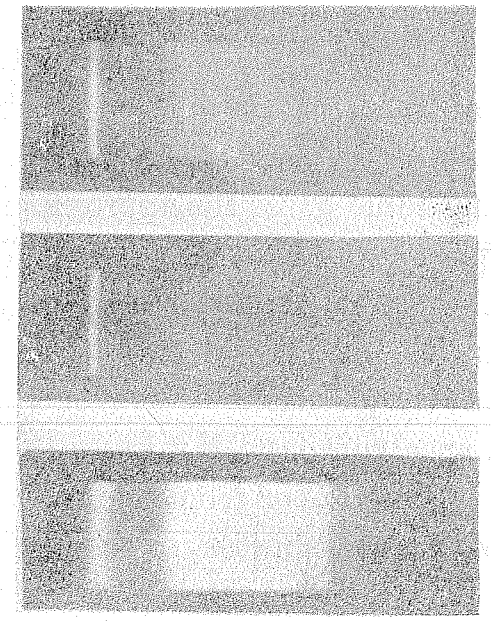


Fig. 1. Night sky spectrum; effective exposure 62 hrs.



(a) Night sky spectrum.
Slit 0·67 mm.; exp. 25½ hrs.

Fig. 2. (b) Zodiacal light and night sky.
Slit 0·67 mm.; total exp. 10 hrs.

(c) Twilight sky.
Slit 0·27 mm., 51 to 36 min. before sunrise.

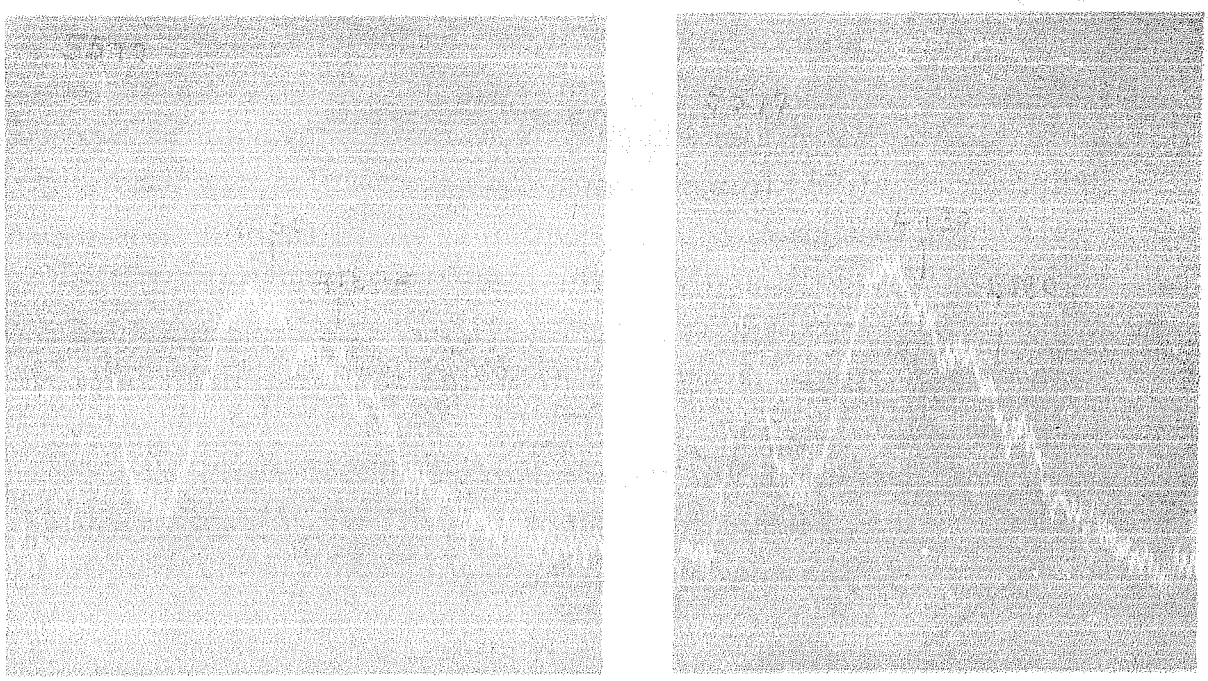


Fig. 3. Microphotograms of night sky spectra.

(a) Slit 0·47 mm., exp. 36¾ hrs. (b) Same as fig. 2 (a):

resemblance of this night sky spectrum with that obtained by Slipher (and reproduced in Lord Rayleigh's paper) shows that the occurrence of the general spectrum in the non-polar aurora is as much a world-wide phenomenon as that of the more conspicuous green line and is quite distinct from the polar aurora. The bright lines or bands referred to by Lord Rayleigh as X_1 and X_2 are marked in the figure. In order to convey an idea of the relative intensities of the bands, microphotometric traces of the plates are shown in Figs. 3(*a*) and 3(*b*).

The following table gives the approximate wave-lengths of the more conspicuous of the lines or bands as measured from these plates. The wave-lengths are calculated by using Hartmann's formula, the constants being determined from the measurements of the positions of hydrogen and helium lines in a comparison spectrum, and the known wave-length 5577A being made use of to go over from one spectrum to the other. Other plates with still shorter exposures also show some of these bands and wave-lengths obtained from them agree within the accuracy of measurement with those obtained from these two plates.

There are many other lines listed by Sommer and Dufay but, with the limited range of sensitiveness of the Mimosa plate and the low dispersion employed, more lines could not be definitely identified in my plates.

It is interesting in this connection to recall the old observations of Mr. E. A. Fath[5] on the integrated spectrum of the Milky Way who, with an exposure of 65 hs. 13 m., obtained a spectrum which showed a bright line at 416$\mu\mu$ and "faint additional absorption lines at 411, 421 and 448$\mu\mu$." He also noted that the line G was very broad. From his description of the spectrum and its reproduction in the paper, it shows great resemblance to the spectrum of the night sky. As both Fath

[5] E. A. Fath, 'Astrophys. Jour.' Vol. 36, p. 362 (1912).

TABLE I.

Positions of Lines or Bands in the Night Sky Spectrum.

	1	2	3	4	5
	Observed at Poona	Observed by Lord Rayleigh	Observed by Sommer	Observed by Dufay	Observed by Slipher in the Zodiacal light
1	5577A	5577	5577	5577	5577
2	4555	—	4552	4554	—
3	4430	4419	4457 4422	4449 4422	4424
4	4270		4270	4268	4280
5	4180	4168	4166	4172	4175
6	4090		—		4080
7	4040		—	4044	—
8	3960		3976 3946	3984 3951	—
9			3916	3914	3916

and Lord Rayleigh have assumed, it is possible that there is a background of continuous spectrum with the Fraunhofer lines on them. In that case the last of the "lines" in the above table would correspond to the bright region between the H and X lines and the last "gap" to the K line, but with the low dispersions so far employed we cannot be very certain about the identity of the lines. Kaplan[6] has suggested that X_1 and X_2 are emitted by singly ionized oxygen atoms with wave lengths 4416·97 and 4169·23A, but the reason why these two lines should be selected is not at all evident. While

[6] J. Kaplan, Phys Rev., Vol. 38, p. 1048 (1931).

there seems to be little doubt that 4275 and 3916 are to be identified with negative nitrogen-band heads, the securing of better resolved spectra of the night sky and a more precise determination of the wave-lengths involved are necessary preliminaries to tracing the origin of the lines.

There is nothing to indicate that the nights should be exceptionally bright in order to show the general spectrum other than the green line. Whenever sufficient exposure has been given, the spectrum has come out with similar characteristics. The relative intensities of the bands do not however remain constant. This can well be seen by comparing the microphotograms in Figs. 3 and 4. The wave-lengths 4430 and 4180 are comparatively weaker in Fig. 4. As Lord Rayleigh has pointed out, some exceptionally bright nights do occur. For instance, a four-hour exposure on the night of 11-4-31 from the roof of the Indian Association for the Cultivation of Science at Calcutta brought out the bands more clearly than many exposures of much longer duration.

In order to show the difference between spectra of the zodiacal light, the light of the night sky and the twilight sky, photographs of these are given in Fig. 2. Fig. 2 (*b*) is really a composite of zodiacal light and night sky, the exposures being towards the west sky from the end of evening twilight to midnight and towards the east from midnight to moonrise, the total time of exposure being 10 hours. The intensity of the zodiacal light falls off rapidly on the shorter wave-length side of 4400A. The Fraunhofer lines G and H can be identified in it and the line 5577A comes out strong. Some of the other peaks of intensity in it correspond to bands in the night sky spectrum, but it requires further study to say whether these are due to the background of the night sky or are characteristic of the zodiacal light. Slipher[7] has recently

[7] V. M. Slipher, Lowell Obs Circ. February 20 (1931), reported in Popular Astronomy, Vol. 40, p. 439 (1932).

reported the finding of emission lines or bands near 5577A, 4424A, 4280A, 4175A, 4080A and 3916A in the spectrum of the zodiacal light. It will be seen from Table I that the first five of these agree within the accuracy of measurement with the bands listed in Table I.

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