Intensity and Polarisation of Skylight at Sunrise and Sunset.

It is now well-established that the illumination of the clear day-sky at high-level stations is almost entirely due to molecular scattering by the atmosphere. The remarkable changes in the character of sky-illumination which take place when the sun approaches and gets below the horizon have been the subjects of study of a number of investigators and in recent years, particularly of Profs. Dorno[1] and Gruner.[2] Some of the phenomena, as for example, the changes of colour and polarisation of skylight and the appearance of the earth-shadow, occur in the clearest of weathers and at such high-level stations that their origin cannot be attributed to anything other than molecular scattering. Gruner has, indeed, shown that the observed changes of colour of skylight when the sun is near the horizon can be explained by scattering by a pure atmosphere.

The writer has recently calculated the intensities of sky illumination due to molecular scattering when the sun is on the horizon at a place 2 km. above sea-level for the wave-lengths 0·45 μ, 0·55 μ, and 0·65 μ by a method somewhat different from that of Gruner, and as some of the results obtained are new, they may be of general interest. The light from the sky when the sun is on the horizon has a much smaller proportion of the shorter waves than the normal daylight sky. In the zenith, where the relative proportion of the short waves is the largest, the ratio of blue (0·45 μ) to red is only 1·3 while, according to the inverse fourth-power law, it would be 4·3. As we move from the zenith to the horizon, the proportion of blue decreases still more, the ratio becoming 0·48 at a zenith distance of 80° in a direction perpendicular to the sun's rays, and 0·45 at the same zenith distance on the side opposite to the sun. The calculated absolute values of intensity are also of the same order of quantities as the values observed by Dorno at Davos (1·6 km. above sea-level), but there is a tendency for the observed values to be larger in the quadrant of the sky containing the sun.

The way in which different layers of the atmosphere contribute to the illumination is also interesting. The proportions of the total light of wave-lengths 0·45 μ and 0·65 μ coming from different layers of the zenith sky are as follow:

Height.	Wave-length.	
	0·45 μ.	0·65 μ.
2-10 km.	8 per cent.	38 per cent.
10-20 ,,	47 ,,	44 ,,
20-30 ,,	33 ,,	15 ,,
30-50 ,,	12 ,,	4 ,,

The single kilometre layers from which the maximum percentages come are 17 to 18 km. for the shorter wave and 9·5 to 10·5 km. for the longer.

In the calculations mentioned above, only primary scattering has been taken into account. But observation shows that complete neglect of self-illumination is not justifiable. For example, even in the clearest weather during the winter months at Simla (1·9 km. above sea-level), when the light from the zenith sky is analysed by a double-image prism and nicol, the weaker component is found to be richer in blue than the stronger, due, no doubt, to the self-illumination being greater for the shorter waves.

The effect of self-illumination may be expected to be a minimum, if confining our attention to the longer

[1] C. Dorno, "Himmelshelligkeit, Himmelspolarisation und Sonnenintensität in Davos, 1911 bis 1918," *Veröffent. des Prüssischen Meteor. Instituts, Abhandlungen*, Bd. 6, 1919.

[2] P. Gruner, "Beiträge zur Physik der freien Atmosphäre," Bd. 8, pp. 1 and 120 (1919).

Nature 118, 337–338, 1926.

waves, we observe in a direction perpendicular to the sun's rays but at a zenith distance of 70° to 80°, where the absolute intensity of the primarily scattered longer waves is greater and the greater part of the radiation comes from a comparatively thinner layer nearer the surface of the earth. Observations at Simla show that the polarisation for the red in these directions often reaches values so high as 30 per cent., which may be compared with 91·6 per cent., the value of the polarisation of the light transversely scattered by pure air.

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Colaba, Bombay, June 25.