AN UNUSUAL LUNAR SPECTRUM

PH. A. CONSTANTINIDES

Wright Junior College, Chicago, Illinois

A lunar spectrum was observed by the writer and two observers on the night of October 28, 1939 which is worth recording both because of its unusual form and the need for additional data on phenomena of this nature.[1]

The phenomenon was observed at 7:30 P. M. C. S. T. from a point about seven miles directly west of the Chicago loop. At that time, the altitude of the slightly gibbous moon was about 34° and its position a few degrees south of prime vertical[2] when, on the surface of cloudlets of alto-cumulous[3] type, lying at an angular distance of about 3 degrees from the moon and in the proximity of prime vertical was observed a brilliant lunar spectrum of about 3° in width. The spectrum at first, rather feeble was colored red *inside* and extended about 15° along a circumference whose center was at the moon and whose angular diameter was 6° approximately. In one minute the spectrum reached its maximum intensity and at that time appeared the red part of a second spectrum in an arc adjacent to the blue of the first. The spectral display was unusually pure and as seen against the background of a clear autumn night illuminated by an almost full moon, surpassed in intensity and beauty any optical phenomenon of meteorological nature that has come to the attention of this observer. The phenomenon lasted about five minutes during which interval the aspect of the sky around the moon was changing rapidly. The cloudlets disappeared and with them the lunar spectrum, while the region around the moon was covered by a haze of the common cirronebula form. Then, through this haze could be seen a circular corona of an angular radius of about 5° with the blue part of the spectrum next to the moon; the red outside and diffuse white in between.

Lunar meteorological optical phenomena, although rare, have been known since antiquity. Aristotle claims to be the first observer of lunar rainbows. Newton[4] had observed lunar halos and coronas while Fraunhofer and others confirmed experimentally Newton's ideas concerning the nature of the phenomena. Since then, solar and lunar optical phenomena have been more carefully studied and satisfactory explanations have been advanced for the more usual types.

It suffices here, to mention that these phenomena are divided into two classes according to the position of the observer with respect to the luminous ring and the source of light. In the phenomena of the first class, the observer is on the line joining the luminary and the center of the chromatic display; this class includes rainbows, anthelia, fog-bows, mist halos, and lunar rainbows. In the phenomena of the second class, the center of chromatic displays is between the observer and the luminary. To this class belong the coronas, halos, parhelia and paraselenae. Of these, coronas are of the most frequent occurrence. They are red on the outside and are due to diffraction produced by minute particles of water, ice, or dust suspended in the atmosphere. Coronas encircle closely the sun or the moon and their radii can vary considerably, while the halos are formed only at the definite angular distance of 22° and 46° from the center of the luminary, have the red on the *inside* and are caused by ice crystals in the atmosphere producing both reflection and refraction of light.

From the above brief review of the characteristics of coronas and halos, it appears that the spectral display described above cannot be clearly classified as belonging to either of the above classes because while its geometric characteristics are those of coronas, the succession of colors are those of halos. Again, coronas as seen through the haze display rather clearly only the blue or red or both at the edges, while their middle remains diffuse and whitish in color. In the phenomenon here described the intensity and purity of the spectrum was comparable to that obtained in the laboratory when parallel rays originating from an intense source are projected on a screen after their passage through a prism. For this reason the writer is inclined to attribute this phenomenon as caused by a rather simple type of refraction produced by spherical drops of water or needle-like crystals of ice through which the light of the moon passes. To the relatively small angular dimensions of the cloudlet involved as seen from the position of the observer, must be attributed the fact that the spectrum was obliterated very little by the overlapping of rays coming from the various parts of the refracting region. The second spectrum whose red part only was clearly visible at the fringe of the cloud and whose intensity was varying independently of the first, was conceivably due to raindrops or crystals of slightly different dimensions, or to repeated reflections and refractions.[5]

The writer in his search of the literature of optical meteorology found very little material of observational nature outside the classically established phenomena. Also, in his desire to compare his own observations with those of others he asked many persons with scientific training concerning their personal observations of solar and lunar optical phenomena; however, little information was available from those sources. The writer feels that much observational information concerning meteorological optical phenomena must be available before the explanation of the phenomena consistent with the physical theory of light[6] will be definitely established. Naturally, this will become possible only when a great number of persons with some training for this type of observations will be able to gather data for the appropriate organizations.

[1] J. Rouch, formerly head of the Meteorological Service of the French Army and Navy in his book *L' Atmosphere et la prevision du temps* (ed. 2, 1931) states "It is important that each time a somewhat different halo is observed that a record is kept of its angular and other characteristics, since the existing data are as yet very meager.

[2] Moonrise was at 5:15 P.M. C.S.T. Full moon Ohr. 42 min. C.S.T. October 28, 1939.

[3] Similar to that indicated in illustration Fig. 11 d p. 14. *The Drama of the Weather* Sir Napier Shaw (University Press, Cambridge, England, 1933).

[4] Newton: Optics, Book II part IV.

[5] Rainbow spectra of the third and fourth order due to three and four reflections are situated between the observer and the sun, but they are unobservable due to the brightness of the sun.

[6] In the sense the subject is treated in Humphrey's *Physics of the Air* or Pernter-Exner's *Meteoroligische Optik.*