

LUNAR HALO OF JUNE 24-25, 1915, AT RICHMOND, VA.

June 24, 8:15 p. m.—An indistinct lunar halo was observed in very thin cirrus clouds and persisted until about 8:45 p. m. At 9 o'clock the vague outline of a 22°-halo was observed. The cirrus in which it appeared was then thin and fragmentary. These cirrus clouds gradually thickened until the sky became milky in appearance and the 22°-halo became very distinct. In addition two arcs were observed on either side of the moon at a distance of about 7° or 8°. These arcs were apparently portions of equal circles. Although the halo was brightest on its eastern edge no coloring was observed. The arcs were whitish in appearance and bore no resemblance to a corona. They faded about 10 p. m., and were not observed by me again. The halo was observed until about 11 p. m., at which time my view of it became obstructed.—*Thos. R. Brooks.*

9:25 p. m.—A pair of halos of concentric appearance was visible at 9:25 p. m., formed on cirri of very usual appearance, with some traces of striation from northeast to southwest. The larger of the halos was approximately 22° in radius, while the smaller one seemed to have a diameter equal to the radius of the larger. The color of both rings was of poor definition, and the only portion of chromatic distinctness was at the upper, zenithward, edge of the outer circle where a reddish hue could be detected on the inner side of the arc. A colorless paraseleena, somewhat questionable, and of the shape of a luminous ear of corn, might be included in the description of the phenomenon. This was coincident with the righthand portion of the larger halo, and extended directly away from the moon.

Measurements could not be made instrumentally and the only check on size that the writer was able to establish was by comparison with estimated distances from the horizon to the lower edge and the zenith distance of the upper edge, which were 15° and 20°, respectively. The appearance at a later hour was not observed.—*C. G. Andrus.*

10:20 p. m.—An ordinary lunar halo of 22° with a distinct reddish tint on its inner side was observed at this time. The circle was nearly complete except for a small gap on its lower side. There was also at this time a well-defined corona but without pronounced colors. At 10:40 p. m. the halo was still visible.—*E. A. Evans.*

10:40 p. m. to 10:55 p. m.—When first seen the sky was practically clear, stars being visible outside of, but not within the outer circle, of which there were two. There were, however, some thin high clouds, but neither their form nor movement could be discerned with certainty. Occasionally light wisps, evidently much below the cirrus level, swept rapidly across the halo, but without taking on any iridescence or appearing in anyway to become involved with the halo.

The whole phenomenon consisted of an inner ring and an outer arc, the lower portion of which—that is, the part nearest the horizon—being missing. Both circle and arc were concentric. The general appearance of the phenomenon was a trifle lacking in definition. The disk of the moon was not sharply discernible and the outer and inner edges of the arc were somewhat blurred; especially was this true of the outer, which faded at a distance of about 1 degree from the reddish inner edge. The tint lining the arc was brightest above and to the left of the moon and there may have been a faint paraseleena at that place, but its presence is doubtful in the mind of the observer. Presumably this was an ordinary halo of 22°, but from a rough approximation made by

carefully sighting over a pencil and afterwards constructing the angle it appeared to have been slightly less. The inner circle measured in the same way and with as much accuracy as possible under the circumstances was considered to have been one of 9° radius and the band to have been ½° wide. This, excepting of course the moon, was the most pronounced feature of the display. Both inside and outside edges of the circle were reasonably clear cut and the circle was complete and of silvery whiteness. The whole phenomenon reached its full development at or before the time I first observed it at 10:40 p. m.; at least shortly after that time it began to dissipate, since at 10:55 p. m. only the outer arc, somewhat more blurred than before, was to be seen. At 1:00 a. m. of the 25th the large arc was again seen, this time through small wisps of clouds, possibly of the alto-cumulus or high stratocumulus type.—*J. H. Kimball.*

THE PENETRATING RADIATION PRESENT IN THE ATMOSPHERE.¹

By A. GOCKEL.

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The author briefly reviews the results obtained by other workers up to the present time, in various localities, under water, above water and ground, and at considerable heights in the atmosphere. The question of instrumental errors is taken up; the effects of changes of temperature and of humidity and of variations in barometric pressure are also considered. The author also avails himself of existing data, and those obtained from his own researches, in the endeavor to ascertain whether or not there are regular daily and also seasonal variations in the penetrating radiation. Experiments have been carried out by the author, with the aid of Wulf's "Strahler," as well as with an arrangement devised by himself, using Benndorf's electrometer (registration instrument). Measurements have been carried out at the Bodensee by balloons, above the ice of the Eiger and Grindelwald glaciers; on the Aletsch glacier, on the Eggishorn, on the snow of the Jungfrau ridge, in ice grottoes, as well as near the bare rocks; also in the proximity of grass land and gardens in Freiburg in Switzerland, together with other places. A few only of the results can be given here. The figures denote the production of ions per cubic centimeter per second. At the Bodensee, November 12, 1913—at 1 meter above water, 13.3; at 2 meters under water, 12.7; at 4 meters, 11.6; and at 6 meters, 10.6. In a garden at Freiburg, above the turf, 11.3 (dates not given); on the Aletsch glacier, at 2,800 meters, 10.7; near the gneiss rocks of the Trugberg, 19.6; and by the mica schist on the Eggishorn, 2,200 meters, 16.8. The strongest radiation observed by the author was that in the Lötschberg tunnel, through the granite, where the measurement gave 30 ions per cubic centimeter per second.

From his investigations the author draws the following deductions: (1) A depth of water of 3.5 meters is insufficient to absorb the radiation (cosmic?) coming from the atmosphere. (2) The observations on glaciers, as also with balloon ascents, show that there is an increase of the penetrating radiation with the height. (3) From solid crystalline rocks radiation is more intense than from cultivated alluvial soil. (4) A daily oscillation of the penetrating radiation is not noticeable in

¹ Phys. Zeits., Oct. 1, 1915, 16: 345-352.