On the Fine Structure Pattern of Cosmic Rays at Mexico City. II.

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March 15, 1941

THE survey of directional cosmic-ray intensity at Mexico City which was reported in a previous communication[1] has since been extended to include the four additional azimuths $\alpha=45°$, 135°, 225°, 315° (NE, SE, SW, NW). The resulting zenith angle intensity distributions $I(z, \alpha)$, together with those previously found, are shown in Fig. 1. From these eight curves it is now possible

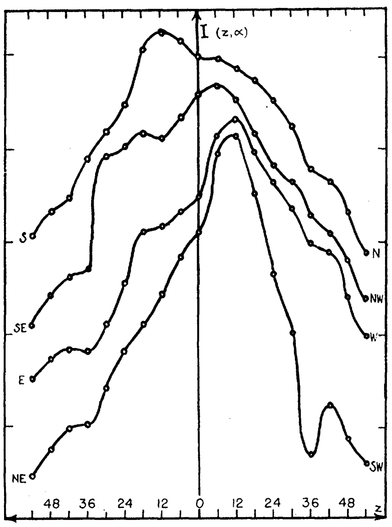

FIG. 1. Normalized directional cosmic-ray intensity $I(z, \alpha)$ at Mexico City, as a function of zenith angle z, for the eight azimuths S-N (top curve); SE, NW (second curve); E-W (third curve); and NE, SW (bottom curve). Each vertical scale division represents 25 percent of the vertical intensity. The average probable error is about 1 percent of the vertical intensity.

to deduce the principal features of the intensity pattern $I(z, \alpha)$, and to infer therefrom some interesting properties of the primary radiation.

First, the W and SW azimuths, together with their next neighbors, show the existence of an absolute maximum of $I(z, \alpha)$ at about $z=12°$, $\alpha=250°$ (20° S of W). Similarly, the E and SE azimuths and their neighbors reveal a second prominence at about $z=15°$, $\alpha=110°$ (20° S of E). Unlike the prominences observed in Missouri,[2] these two are isolated from one another, and do not join to form a continuous ring of prominences concentric about the zenith. With respect to position, they are very nearly mirror images of one another in the N–S plane. Their E–W positional symmetry is of the kind which has previously been considered by one of us,[3] and by reason of which it was concluded that the primary radiation contains positive and negative particles of the same e/m. The relative magnitudes of the western and eastern prominences are about 130 percent and 95 percent of the zenith intensity, respectively. If each prominence were due to primaries of but one sign of charge, these intensity values would give the relative abundance of the positive and negative primary particles concerned. The ratio 130/95 must be considered a lower bound for the positive-negative ratio of abundance, which actually may be appreciably greater.

A second observation, which correlates well with the preceding one, is that the intensity of the N–S plane falls off less rapidly at large zenith angles than the intensity in adjacent azimuths. This fact indicates that there is but a slight overlapping of the allowed cones for positive and negative particles, and that this overlapping occurs in the limited region to either side of the N–S plane, thereby producing the observed excess intensity in that region. It appears, therefore, that the spectra of positive and negative primaries both possess a band of low energies which falls off rapidly within an energy range in the vicinity of 0.42 störmer, or about 11 billion ev for electrons, corresponding to an allowed cone which, for positive particles, opens just to the east, and for negative particles just to the west, of the N–S plane. This observation does not, of course, exclude the existence of lines or bands in the primary spectra at still higher energies.

That such additional higher energy lines or bands do exist is indicated by the further observation that, in all the eight curves of Fig. 1 excepting the southern curve, there is evidence for a circular ring of prominences at $z=42°$, concentric with the zenith. This type of locus of prominences is similar to those observed in Missouri,[2] which have been explained in terms of atmospheric absorption of primary spectral lines or bands too energetic to be influenced by the earth's magnetic field.[4] On the basis of equal atmospheric path length, the position $z=42°$ of the ring at Mexico City corresponds quite closely to the position $z=7°$ of the innermost ring observed in Missouri when account is taken of the difference in altitude of the two stations. In the case of the 42° ring at Mexico City and the 7°, 20° and 35° rings in Missouri, all of which are insensitive to the earth's magnetic field, there appears, so far, no way of distinguishing the sign of charge of the associated primary particles.

The present survey is now being further extended in order to improve and interpolate the data shown here. We wish again to express our thanks for support from the Penrose Fund of the American Philosophical Society, the Rumford and Permanent Science Funds of the American Academy of Arts and Sciences, and from Washington University and the National University of Mexico.

[1] E. J. Schremp and Alfredo Baños, Jr., Phys. Rev. **58**, 662 (1940). In this reference φ designates azimuth angle, but henceforth α will be so used, in order to coincide in nomenclature with the Lemaître-Vallarta theory of the allowed cone.
[2] D. M. Cooper, Phys. Rev. **58**, 288 (1940).
[3] E. J. Schremp and H. S. Ribner, Rev. Mod. Phys. **11**, 151 (1939).
[4] Reference 3, p. 150.