Azimuthal Asymmetry of Cosmic Radiation

Since the curves of latitude against ionization due to cosmic radiation start to dip at geomagnetic latitudes 40 to 45, it is of interest to determine whether the azimuthal asymmetry reported[1] at lower latitudes can be detected in the above region. Observations were made at four elevations: (1) at the Mt. Wilson Observatory Laboratories, Pasadena, elevation 855 ft.; (2) on Mt. Wilson, elevation 5800 ft.; (3) at the Lowell Observatory, Flagstaff, Arizona, elevation 7250 ft.; and (4) on Doyle Saddle, San Francisco peaks, Arizona, elevation 11,280 ft. Stations (1) and (2) are at geomagnetic latitude about 41°; while (3) and (4) are at 43°.

Geiger counters and a circuit, previously described,[2] automatically recording coincidental discharges were employed. The counter cylinders were 9 cm long, 2 cm in diameter, and spaced 11 cm between axes. The individual counting rates varied from 50 to 160 per minute, depending largely on the altitude.

The coincidence counting rates were observed with the axes of the counters determining a plane which could be oriented east or west of the magnetic meridian. The arrangement could be rotated about a vertical axis, and readings were made alternately east and west in order to eliminate effects due to secular changes in sensitivity. The plane determined by the axes of the two counters was set at altitude angles 22, 45, 55 and 67° above the horizontal.

The counting rates east and west at equal angles were found to be equal within the experimental errors of about 3 percent. Since, however, the high altitude observations showed a systematic variation only a little smaller than the probable error, these are tabulated in full in Table I.

TABLE I. *Counting rates and probable errors observed at 11,280 ft. Counters 35° from vertical. Geomagnetic latitude 43°.*

Run	Direction	Rate	W/E	Probable error, percent
1	E	3.32		
1	W	3.36	1.012	3.16
2	E	2.60		
2	W	2.65	1.019	3.50
3	E	3.31		
3	W	3.37	1.018	2.96

The mean rates were 3.001 east and 3.060 west. It will be seen that the systematic variation is in the direction of a west excess of about two percent; but that in view of the probable error this is not to be regarded as conclusive. At the lower elevations the statistical fluctuations gave in general an east excess as often as a west excess. The probable error was computed in the usual manner from the residuals.

This result may be interpreted on the basis of the Epstein-Lemaître-Vallarta theory as follows: If the magnetically deviable component of the primary radiation lies in the band suggested by Compton, $x=0.45$ to 0.35, (energies 8 to 12×10^9 e.v.) we should expect at geomagnetic latitude 43 an asymmetry not greater than about two percent, as observed. If a large fraction of the rays were softer, $x=0.2$ to 0.3, we should expect an effect larger than was observed. Johnson's[3] recent results at Swarthmore indicate that, on the basis of the theory here under consideration, a small fraction of the rays have energies as low as $x=0.2$. This fraction is smaller than the experimental uncertainty of the Arizona observations, and the experiments are consequently in agreement. Moreover it is clear that very few particles of energies less than 4×10^9 volts can reach the surface of the earth after passing obliquely through the atmosphere, even in those latitudes where they would not be swept out by the earth's field. The observations consequently assign a lower limit to the energy of the deviable component of about 8×10^9 volts. If we may trust the theoretical curves, this limit is accurate within 10 percent, since it was observed just on the border of the "equatorial belt." This conclusion is further strengthened by the observations of Stearns and Bennett[4] who find no appreciable west excess at Denver, some three degrees north of Flagstaff.

The above interpretation assumes that there are incoming charged particles which would follow the paths calculated in the theory. It must be remembered that the experiments of Anderson[5] and Kunze[6] have shown only a negligible number of particles in the energy bands postulated above. The possibility of some other explanation of the observations must consequently not be overlooked.

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[1] T. H. Johnson, Phys. Rev. **43**, 834 (1933).
[2] S. A. Korff, Phys. Rev. **44**, 130 (1933). (Abs.)
[3] T. H. Johnson and E. C. Stevenson, Phys. Rev. **44**, 125 (1933).
[4] J. C. Stearns and R. D. Bennett, Phys. Rev. **43**, 1038 (1933).
[5] C. D. Anderson, Phys. Rev. **41**, 405 (1932).
[6] P. Kunze, Zeits. f. Physik, **79**, 203 (1932).