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An Attempt to Measure the Latitude Effect of Extensive Cosmic-Ray Showers

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Measurements of large cosmic-ray shower intensities have been made on the Pacific Ocean. Because of the statistical fluctuations of the experimental results, no positive conclusions regarding the latitude effect for these showers can be reached.

AUGER[1] and his collaborators have reported the discovery of very extensive showers of cosmic-ray particles. They have also estimated the average density of the particles in these showers and thus obtained a measure of the energy of the primary particles responsible for these events. This energy is of the order of 10^{14} ev for showers of 10^4 square meters in extent. Clearly, if this interpretation of the phenomenon is correct, the earth's magnetic field can exert no effect on these primary particles, and no latitude effect for such showers should be observed. In an attempt to check this hypothesis, the latitude effect for large showers was measured on the Pacific Ocean between Vancouver and Sydney.

The apparatus consisted of a triple-coincidence Geiger counter unit. The counters were of the "fast" type, about 3.7 cm in diameter and 15 cm in length. They were assembled in three trays with 32 counters in parallel in each group. The pulses from the counters were fed into three-stage amplifiers and were so shortened that the resolving time of the apparatus was about 10^{-6} second. Hence the accidental triple coincidences could be completely neglected.

The counters and amplifiers were set up in a small tent on the boat deck of the *S. S. Niagara*. At first, the tent was in a space near some of the ship's superstructure. Iron ventilators were within about 2 meters of the counters. Later, a more open location was used and the counting rate was found to decrease about 15 percent. For the data shown below the counters were in this second location. The three counter trays were placed in a horizontal plane (Fig. 1), so that the separation from center to center of the outside trays was 106 cm. The minimum separation of the extreme rays forming the shower could be about 75 cm.

The results obtained are given in Table I.

To obtain a correction for the barometer, a value of 2 percent per 0.1″ was used. It should be pointed out that the result will depend consider-

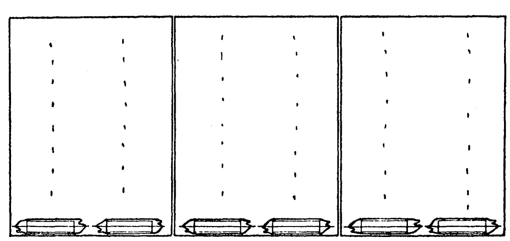

FIG. 1. Arrangement of counter trays.

[1] Auger, Maze, Ehrenfest and Freon, J. de phys. et rad. **10**, 39 (1939).

TABLE I. *Shower intensity as a function of magnetic latitude.*

Mag. Lat.	No. Counts	Min.	Rate	Barometer	Corr. Data
23°N	1282	1092	1.173	29.98	1.192
19	1783	1513	1.179	29.90	1.179
13	2020	1679	1.203	29.82	1.184
6	1601	1420	1.128	29.80	1.106
0	1678	1458	1.150	29.74	1.113
12°S	1667	1375	1.212	29.75	1.176
16	892	724	1.232	29.77	1.200
29	1011	907	1.113	29.88	1.108
34	1838	1534	1.198	29.94	1.208
38	1734	1576	1.101	30.03	1.130
41	4246	3436	1.234	29.89	1.232

ably on this correction because the barometer was low in the region of the magnetic equator. Because of the statistical fluctuations in the data these have been analyzed by dividing them into two groups with those readings taken at latitudes greater than 20° forming one group and those taken at latitudes smaller than 20° the other group. The averages of the corrected rates for these two groups are:

At latitudes greater than 20°
1.190 ± 0.012 counts/minute
At latitudes smaller than 20°
1.158 ± 0.011 counts/minute.

The mean errors have been computed from the total number of counts in the two cases.

The results seem to show a small latitude effect for these showers, but since the effect is only slightly larger than the statistical errors we do not feel that the experiments establish its existence with any certainty.

For the small showers emerging from a lead plate Neher and Pickering[2] report a latitude effect on the Pacific Ocean of about 6 percent.

If one considers the average area of the showers measured in this experiment as one square meter, and the particle density as 30 per square meter, as given by Auger, then the number of particles per shower is about 30. To produce such a shower at sea level by the cascade process, the primary energy would be of the order of 10^{12} ev. If, on the other hand, one considers that the energy loss per particle in penetrating the atmosphere is 3×10^9 ev, the primary energy is still about 10^{11} volts. Hence, even for showers of this area, there should be no latitude effect.

We wish to express our grateful appreciation to the Carnegie Corporation of New York for making these experiments possible. We are also indebted to the Canadian-Australasian Line, and especially to the officers of the *S. S. Niagara* for the cooperation they rendered, even while under the stress imposed by the present international situation.

[2] H. V. Neher and W. H. Pickering, Phys. Rev. **53**, 111 (1938).

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The Scattering of Alpha-Particles by Carbon and Oxygen*

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The scattering of alpha-particles by carbon and oxygen has been observed at large scattering angles, with solid targets and RaC′ as a source. The results show resonances in carbon at energies of 5.5, 5.0 and 4.4 Mev and indicate that the angular momentum quantum number of the compound nucleus O^{16} is probably 2 for the highest level, and greater than zero for the others. Two resonances have been observed in oxygen at energies of 6.5 and 5.5 Mev. These indicate excited states of Ne^{20} whose angular momentum is probably unity. These two levels correspond very closely with those found by Bonner in the disintegration of fluorine by deuterons.

THE process of alpha-particle scattering by carbon and oxygen nuclei has some unusual features which make it relatively amenable to theoretical treatment and favorable for experimental investigation. These features arise from the fact that the spins of all nuclei concerned are zero and that at alpha-particle energies below 8 Mev the competing processes of proton

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