the mass separations on the calutron were performed by Keith Pierce.

This paper is based on work performed under Contract No. W-7405-eng-48, with the Atomic Energy Commission in connection with the Radiation Laboratory, University of California.

[1] J. M. Cork and R. W. Pidd, Phys. Rev. **66**, 227 (1944).
[2] Delsasso, Ridenour, Sherr, and White, Phys. Rev. **55**, 113 (1939).
[3] L. N. Ridenour and W. J. Henderson, Phys. Rev. **52**, 889 (1937).
[4] F. A. Heyn, Physica **4**, 1244 (1937).

The Latitude Effect of the Hard Component as a Function of Altitude

Piara Singh Gill,* Marcel Schein, and Victor Yngve
Department of Physics, University of Chicago, Chicago, Illinois
September 3, 1947

EIGHT counter-coincidence sets were installed in a B-29 plane for the purpose of measuring the vertical intensity of the penetrating component through 8, 14, and 20 cm of lead, and for studying the production of mesotrons by non-ionizing rays in 2 cm of lead. The measurements were made up to an altitude of 40,000 feet at a geomagnetic latitude of 40° N and at the equator. The geometry of the counters is shown in Fig. 1. The upper three and the lower three counters were each connected in a threefold coincidence. This arrangement is very similar to that used by Schein, Jesse, and Wollan.[1] The coincidence circuits had a resolving time of 5×10^{-6} second. As a consequence, accidentals were negligible at all altitudes reached. The upper coincidence set registered particles passing through 20 cm of Pb, while the lower one recorded particles through 22 cm of Pb, plus those produced by non-ionizing radiation in the upper 2 cm of Pb. All coincidence pulses were recorded on a rotating film. This paper deals only with the data obtained with 20 and 22 cm of Pb. The quantitative measurements with smaller thickness of lead will be reported at a later date.

It was found that at altitudes up to 40,000 ft. the upper and lower threefold coincidence set gave the same counting rate within a precision of 3 percent. It should be mentioned here, however, that this was not the case with smaller thicknesses of lead between the counters. In particular, with a lead absorber of 8-cm thickness a considerably higher counting rate was registered in the lower threefold set than in the upper one at altitudes above 25,000 feet. This leads to the conclusion that a considerable fraction of the penetrating particles produced by non-ionizing rays is capable of traversing 8 cm, whereas it is absorbed by 22 cm of Pb. Since most of the particles passing through large thicknesses of lead were found to be mesotrons, it follows that in the upper 2 cm of Pb only mesotrons of momenta smaller than 3.8×10^{8} ev/c are produced with a large cross section by non-ionizing radiation. This result is in agreement with data obtained in balloon experiments[2] up to an altitude of 80,000 ft.

In Fig. 1, curves *A*, *B*, and *C* represent the latitude effect of the hard component as a function of altitude. Curve *A* refers to the equator, curve *B* to a geomagnetic latitude of 40° N, and curve *C* to balloon data obtained at 52° N by using 18 cm of Pb between the counters.[3] The curves show very clearly that the latitude effect of the hard component increases very considerably with elevation. At 33,000 ft. the difference between 40° N and 0° is 30 percent, which is in satisfactory agreement with recent measurements of Swann.[4] On the other hand, Bhabha and his collaborators[5] found a somewhat smaller latitude effect. This might be due to the fact that the latitude curves given in their paper were deduced from experiments in which the geometry of the counter assembly was not the same at the various latitudes.

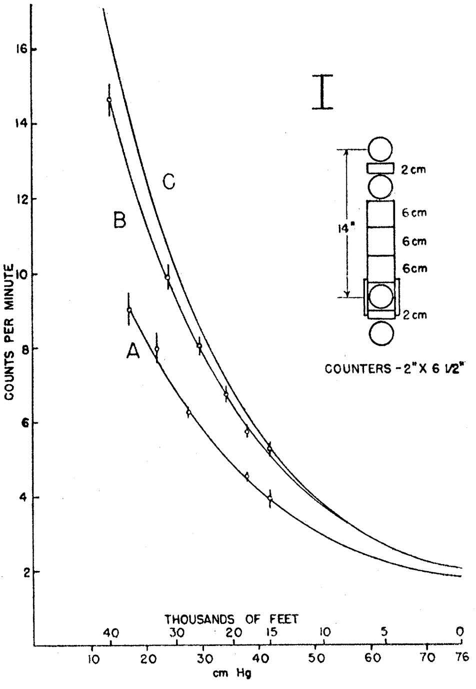

Fig. 1.

It is obvious from Fig. 1 that the difference between curves *C* and *B* is considerably smaller than the corresponding difference between *B* and *A*. This fact strongly indicates that the large majority of the mesotrons present at altitudes below 35,000 ft. are produced by primaries of energies considerably higher than 5×10^{9} ev (magnetic cut-off energy at 40°).

We wish to express our sincere appreciation to Dr. Urner Liddel from the office of Naval Research for his valuable assistance in securing a B-29 plane. We are also greatly indebted to Commander Bollay for his cooperation during the flights and to Major Boyse for piloting the plane.

* Now at the Tata Institute of Fundamental Research, Bombay, India.
[1] Marcel Schein, William P. Jesse, and E. O. Wollan, Phys. Rev. **57**, 847 (1940).
[2] Marcel Schein and D. J. Montgomery, *Problems in Cosmic Ray Research* (Princeton University Press, Princeton, New Jersey, 1946).
[3] Marcel Schein and F. A. Allen, private communication.
[4] W. F. G. Swann and Peter A. Morris, Phys. Rev. **71**, 462 (1947).
[5] Bhabha, Chandrashekhar Aiya, Hoteko, and Saxena, Phys. Rev. **68**, 147 (1945).