Letters to the Editor

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The Beta-Spectrum of S^{35} and the Mass of the Neutrino

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April 23, 1948

USING sources prepared from high specific activity material obtained from Oak Ridge, the momentum distribution of the negatrons emitted by S^{35} has been investigated in a large, high resolution, shaped field magnetic spectrometer employing a 40-cm radius of curvature.[1] Measurements were made on sources of several thicknesses on backings of 0.5 mg/cm² Nylon and 0.03 mg/cm² Zapon. The Zapon counter window transmits electrons down to 2.0 kev.

Figure 1 shows a Fermi plot of the data obtained with three relatively thin sources. The significant fact is that these curves are all straight lines for all energies from $W=1.17$ mc² to the end point.

The deviations from a straight line for energies below 60 kev, which may be partly real[2] and certainly are influenced by source thickness and backing, will be discussed in some detail in a later paper.

The maximum energy of the negatron spectrum obtained by extrapolating the straight line part of the Fermi plot is $W_0=1.331$ mc², corresponding to a kinetic energy of 169.1 ± 0.5 kev.

The enlarged section of the Fermi plot in the immediate neighborhood of the end point shows the theoretical Fermi curves for an allowed transition calculated for assumed neutrino masses of zero, one percent, and two percent the mass of the electron. The equation for these curves includes a relativistic correction factor $1-\nu/WK$ where ν is the mass of the neutrino, W the electron energy, and K the neutrino energy. The sign in this factor conforms with the form of the theory as discussed by Pruett.[3] The inclusion of this factor makes the difference between the extrapolated end point and the theoretical, true end point equal to $\nu/2$. If this relativistic term is neglected as was done by Kofoed-Hansen,[4] this difference would be equal to ν. It is clear that within the limits of experimental error, one can say that the mass of the neutrino is less than one percent that of the electron.

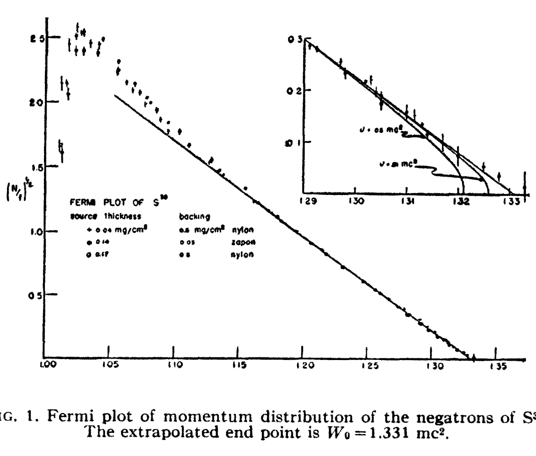

FIG. 1. Fermi plot of momentum distribution of the negatrons of S^{35}. The extrapolated end point is $W_0=1.331$ mc².

The work was supported by a grant from the Frederick Gardner Cottrell Fund of The Research Corporation and by the U. S. Navy under Contract N6-ori-48, T.O. 1.

[1] L. M. Langer and C. S. Cook, Rev. Sci. Inst. **19**, 247 (1948).
[2] C. S. Cook and L. M. Langer, Phys. Rev. **73**, 601 (1948).
[3] J. R. Pruett, Phys. Rev. **73** (1948).
[4] O. Kofoed-Hansen, Phys. Rev. **71**, 451 (1947).

Azimuthal Effect of Cosmic Rays at Bombay (Magnetic Latitude 9.5°N)

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April 8, 1948

IN 1939 Vallarta[1] pointed out that the measurements of the azimuthal effect at intermediate latitudes would determine the sign and the energy spectrum of primary cosmic radiation. One of us[2] undertook the study of the azimuthal effect of cosmic radiation for a fixed zenith angle of 60° at Lahore ($\lambda=22$°N). A similar experiment was carried out at Mexico City ($\lambda=29$°N) by Vallarta, Perusquía, and de Oyarzábal.[3] The results of Mexico City are in agreement with those of Lahore, giving 2.45 as the value of constant C of the primary spectrum K/E^C.

Recently we began to make a study of the azimuthal variation of cosmic-ray intensity at Bombay ($\lambda=9.5$°N) for a fixed zenith angle of 60°. Since for positive primary particles the penumbra bands are prominent in the N–W quadrant, we at first directed our telescopes towards this quadrant and the one opposite to it. Measurements were made for approximately forty hours at each interval of 10 degrees.

The apparatus consisted of twin counter telescopes, pointing in two diametrically opposite directions, mounted on a turntable so as to measure the intensity at the desired azimuth and zenith angle. The solid cone subtended by the telescope is 5.2° in zenith angle and 22° in azimuth.

Taking $C=2.45$, the value calculated[3] from the experiments at Mexico City and at Lahore, we determined the value of K to give the best fit. The energy in millistormers of the main cones were interpolated for each angle from Figs. 5–7 of Lemaitre and Vallarta.[4] Professor Vallarta very kindly gave us an estimate of the penumbra bands at $\lambda=10$°. In Fig. 1 are shown the calculated theoretical curve A and the experimental curve B. A x^2 test for the