parity. This is an allowed transition and according to Nordheim's[9] rule number 3 should, in general, have values of log (ft) from 4.8 to 5.5. The experimental evidence presented in this paper indicate that the transition is allowed and that the value of log (ft) is 5.7. With the above spin assignments this is in good agreement with the predictions of the nuclear shell model. These spin assignments are in agreement with those given by Nordheim.[14]

The authors wish to thank Dr. W. W. Pratt and Mr. R. Lane for their assistance in obtaining part of the data.

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* Contribution No. 128 from the Institute for Atomic Research and Department of Physics, Iowa State College, Ames, Iowa. Work was performed in the Ames Laboratory of the AEC.

[1] E. P. Steinberg and D. W. Engelkemeier, Plutonium Project Report CC-2310, p. 31 (January, 1945), unpublished.

[2] Steinberg, Winsberg, and Engelkemeier, Plutonium Project Report CC-2379, p. 5 (November, 1944), unpublished.

[3] Mandeville, Woo, Scherb, Keighton, and Shapiro, Phys. Rev. 75, 1528 (1949).

[4] L. E. Glendenin, Nucleonics 2, No. 1, 12 (1948).

[5] Jensen, Laslett, and Pratt, Phys. Rev. 75, 458 (1949).

[6] W. J. Heiman, private communication.

[7] M. G. Mayer, Phys. Rev. 78, 16 (1950).

[8] Laslett, Jensen, and Paskin, Phys. Rev. 79, 412 (1950).

[9] L. W. Nordheim, Phys. Rev. 78, 294 (1950).

[10] Strandberg, Wentink, and Hill, Phys. Rev. 75, 827 (1949).

[11] J. E. Mack and O. H. Arroe, Phys. Rev. 76, 173 (1949).

[12] Geschwind, Minden, and Townes, Phys. Rev. 78, 174 (1950).

[13] J. E. Mack, Revs. Modern Phys. 22, 64 (1950).

[14] L. W. Nordheim, *Tables for β-Decay Systematics*, distributed privately.

On the Existence of a One-Mev Energy Level in C^{13}

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THERE has been considerable discussion recently in the literature concerning the existence of an energy state of C^{13} at 0.8 to 1.0 Mev. A level at 0.8 Mev was first reported to be observed in the $B^{10}(\alpha, p)$ reaction; more recently it was observed by Roy,[1] using polonium α-particles. On the other hand, Creagan,[2] using α-particles produced in the cyclotron, failed to observe such a level. The $C^{12}(d, p)$ reaction was studied in detail by Heydenburg, *et al.*,[3] and by Buechner, *et al.*,[4] the latter using magnetic analysis; but neither of them found any evidence of a C^{13} level in this region. Quite recently, however, Boyer[5] and Berlman[6] claim to have observed a level at 1 Mev in a $C^{12}(d, p)$ reaction, using deuterons of 10 and 14 Mev.

We have made a detailed search for this level in the course of a study of energy states of C^{13}, which will be published elsewhere. The levels were excited using 8-Mev deuterons from the Liverpool cyclotron, and the protons corresponding to the various states of excitation of C^{13} were observed by means of photographic emulsions. The target used was acetylene at a pressure of 10 cm, and care was taken to eliminate contaminations. Although large areas of the plates were scanned and several angles of emission studied, we could find no trace of a C^{13} level between the ground state and the 3.11-Mev excited state.

The observation of such level by other workers can possibly be explained as due to oxygen contamination. It is extremely difficult to get rid of traces of oxygen; even in our experiments, where a gaseous target was employed and the emulsions were evacuated for several hours to drive off the water, we still observe some tracks corresponding to the ground state and the 0.88-Mev excited state of O^{17}, from the reaction $O^{16}(d, p)$. This can be seen in Fig. 1, which shows a section of the histogram obtained at an angle of emission of 75°. Between the ground state and first excited state of C^{13} there are only a few tracks, and almost all of them can be attributed to the two states of O^{17} if we assume the presence of oxygen contamination at a pressure of ½ mm. Similar results were obtained for angles of emission 40°, 60°, 90°, and 120°; in each case the ratio of the numbers of tracks of the two oxygen groups agrees, within the statistical error, with that expected from the angular distribution of the protons from the $O^{16}(d, p)$ reaction.[7] The position of the supposed 1-Mev level is also indicated on Fig. 1. At larger angles of emission the group of protons corresponding to such a level will fall nearer the 0.88-Mev oxygen group which can, therefore, easily be mistaken for it. We conclude that if a C^{13} level exists in the region of 1 Mev, its probability of excitation in a (d, p) reaction is at least 200 times lower than that corresponding to the ground state.

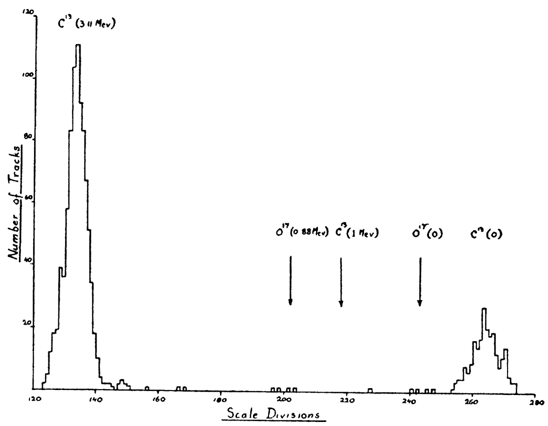

FIG. 1. Section of histogram of protons emitted at an angle 75°. One division = 1.73 microns.

[1] R. R. Roy, Phys. Rev. 75, 1775 (1949).

[2] R. J. Creagan, Phys. Rev. 76, 1769 (1949).

[3] Heydenburg, Inglis, Whitehead, and Hafner, Phys. Rev. 75, 1147 (1949).

[4] Buechner, Strait, Sperduto, and Malm, Phys. Rev. 76, 1543 (1949).

[5] K. Boyer, Phys. Rev. 78, 345 (1950).

[6] I. B. Berlman, Phys. Rev. 79, 411 (1950).

[7] Burrows, Gibson, and Rotblat, Phys. Rev. 80, 1094 (1950).

The Ratio of Electrons to Mesons 1100 Feet Underground*

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THERE have been experiments that apparently contradict the usual assumption that cosmic-ray energy is carried underground primarily by μ-mesons.[1] The present experiments on the absorption of the hard and soft radiation and on the nature of the soft radiation were designed to test whether or not there really are any contradictions with the assumption of μ-mesons. The results on absorption in large thicknesses of lead and cloud-chamber observations,[2] both of which support the assumption of μ-mesons, have been reported previously.

The radiation emerging from a salt layer ~150 cm thick that was 700 cm above the apparatus in a salt mine at a depth of 8.5×10^4 g/cm² was measured by coincidences between two trays of G-M counters. (Three trays were used in the auxiliary experiment to determine the effect of local radiation.) The low energy cosmic-ray particles were identified as electrons by comparison of the absorptions by lead and by carbon, and their energy distribution was determined from their range distribution in carbon.

The coincidence rates were converted to flux of particles through the apparatus by making small corrections for side showers, knock-on electrons produced in the material near the counters or in the counter walls, multiple events through the trays, and coincidences produced by gamma-rays from radioactive materials. Auxiliary experiments gave the data required for making the corrections.

The meson flux was subtracted from the total flux in order