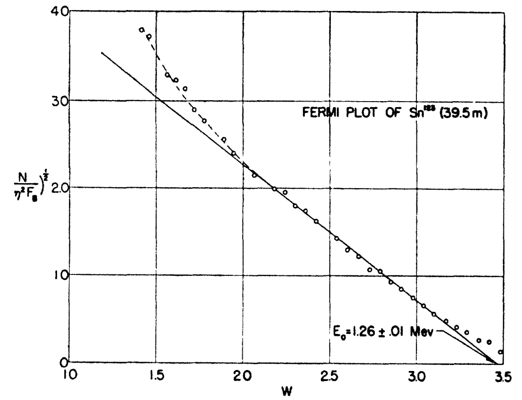

FIG. 2. Fermi plot of Sn^{123} data. F_B is the Coulomb factor calculated by means of Bethe's formula.

spectrum, there is the line of internal conversion electrons corresponding to a gamma-ray energy of 0.153 ± 0.005 Mev. The decay period of this line was followed and found to be 39.5 min. In a separate experiment, coincidences were observed between the internal conversion electrons and the beta-particles. The existence of such coincidences eliminates the possibility that the 0.153-Mev gamma-ray might correspond to a transition feeding the 130-day isomeric state of Sn^{123}. Instead, the gamma-ray apparently follows the beta-decay and corresponds to an undelayed transition to the ground state of Sb^{123}. Although some uncertainty exists because of absorption in the counter window and in the source, from the relative areas under the momentum distribution curve, one obtains for the ratio of internal conversion electrons to beta-disintegrations a value of 0.12. From the coincidence measurements, using a U_3O_8 standard to determine counter efficiency and geometry, the ratio was found to be 0.11.

Figure 2 shows a Fermi plot of the beta-spectrum of Sn^{123}. The deviation from a straight line at low energies arises from the use of a relatively thick source. The extrapolated end point is 1.26 ± 0.01 Mev. The data in the immediate vicinity of the end point would have to be corrected for the resolution in order to fall on the straight line.

The momentum distribution of the beta-rays of Sn^{121} is shown in Fig. 3. No internal conversion electrons were observed. Absorption measurements also indicated that there is no gamma-radiation present. It appears, therefore, that the beta-transition is directly to the ground state of Sb^{121}. Figure 4 shows a Fermi plot of the data obtained with two different resolutions of the spectrometer. The extrapolated end point is 0.383 ± 0.005 Mev. The fall-off at low energy is, of course, due to the absorption in the counter window.

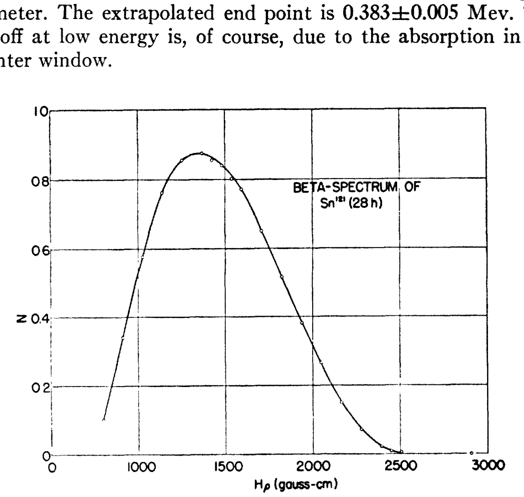

FIG. 3. Beta-spectrum of Sn^{121}.

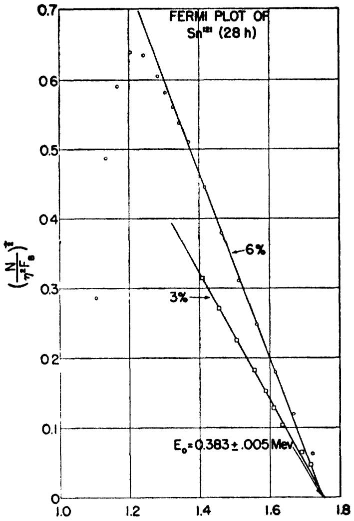

FIG. 4. Fermi plot of Sn^{121}.

We should like to thank Mr. R. J. S. Brown and Mr. L. M. Baggett for assisting with the measurements.

* This document is based on work performed under government contract number W-7405-Eng-36 for the Los Alamos Scientific Laboratory of the University of California.
** University of Illinois, Urbana, Illinois.
*** Indiana University, Bloomington, Indiana.
[1] Data to support the isotopic assignment of the periods will be published later by Duffield and Knight.
**** The separated isotopes used in this investigation were obtained from the Y-12 Plant of the Carbide and Carbon Chemical Corporation on allocation from the U. S. AEC.

The ν_3-Fundamental of Nitrous Oxide

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August 31, 1949

THE infra-red spectrum of the previously unresolved ν_3-fundamental of nitrous oxide has been recorded with a self-recording grating spectrometer which was operated in a vacuum. High resolution of the rotational fine structure was obtained using a 10-centimeter cell with the gas at a pressure of 2 centimeters of Hg.

The line frequencies were determined and combination relations used to evaluate the band center and rotational constants. The band center was found to be 2224.4 cm^{-1} and the difference between the rotational constants, $B'-B''$, was evaluated as -0.00343 cm^{-1}. Combination relations also yielded a value of 0.4200 cm^{-1} for B''.

The intensity pattern of the spectrum was uneven. This unevenness was thought to be caused by the superposition of an upper stage band, i.e., one which arose from absorption by molecules which were initially in the energy level $v_2=1$.

Two Kinds of Very High Energy Cosmic-Ray Stars

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WE shall describe two very characteristic nuclear cosmic-ray stars obtained at high altitude (about 100,000 feet) with Ilford G5 emulsions. Stars with relativistic prongs have already been observed at various heights.[1-3] Each of the stars described here has more than 50 prongs, and the energy involved is larger than 12 Bev. However, the explanation is very different in the two cases.

Star No. 1 (Fig. 1). This star has 27 ionizing prongs, corresponding to the usual type of nuclear fragments (protons, α-par-

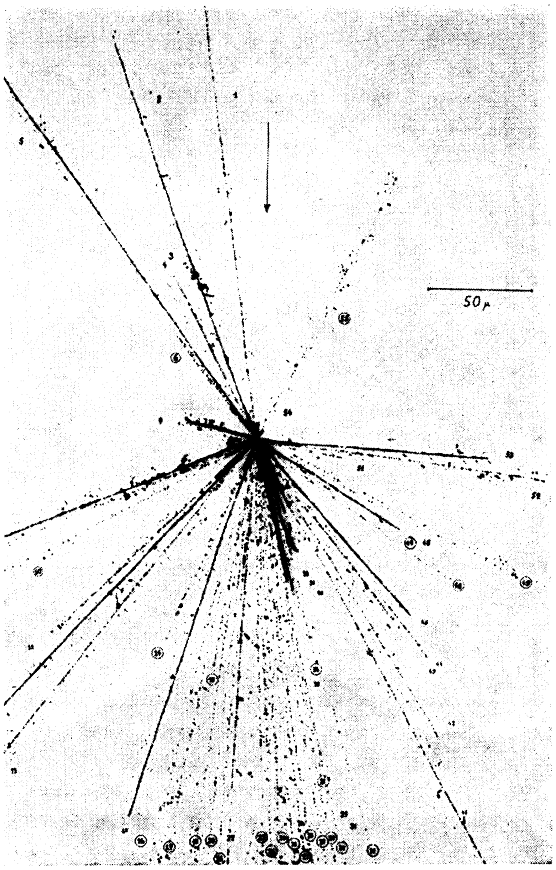

FIG. 1. Star No. 1. No incident primary particle has been observed.

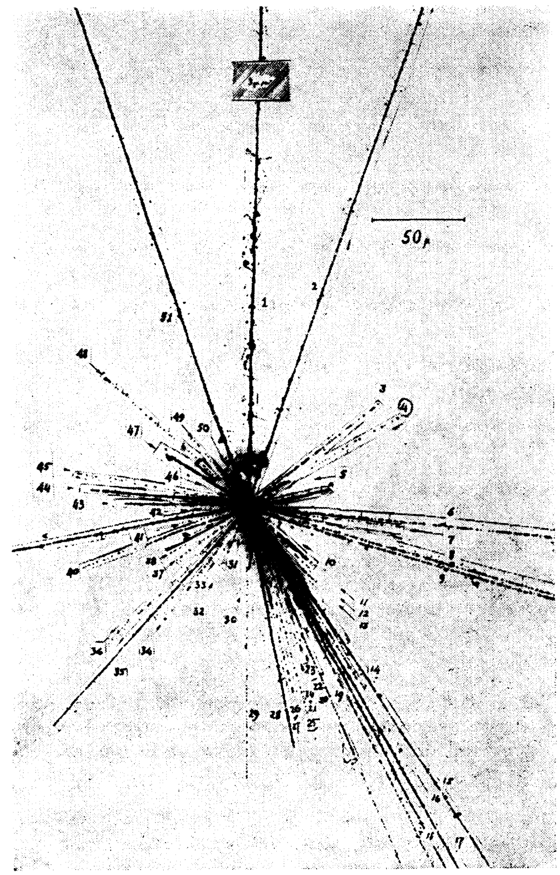

FIG. 2. Star No. 2. Produced by a heavy primary with Z between 14 and 20.

ticles, etc.). It also has 27 relativistic prongs which are well collimated. Sixteen of these prongs are emitted within a cone of 30°; the others, except for three, within a cone of 60°. No incident ionizing primary particle has been observed.

The first question is the nature of the 27 relativistic particles. Our conclusion is in favor of a mixture of mesons and energetic protons. We are led to this conclusion by the following considerations:

A first hypothesis, that all the relativistic particles are mesons created in a single act during a nucleon-nucleon interaction process, can hardly be acceptable. This follows if we consider the relation between the maximum of the half-angle of the meson shower and the number of mesons created.[4] This conclusion must be modified, however, if the most scattered relativistic particles are protons ejected by the primary from the silver nucleus after the shower production.

A second hypothesis is that approximately five to eight mesons are created in a first multiple production, followed by a small number of other processes in the same nucleus involving fewer multiplicities of mesons. This hypothesis of plural-multiple production of mesons involves the ejection of a certain number of fast nucleons, the number of which will increase if the multiplicity becomes less, and the direct ejection of some fast nucleons by the collision. The discussion[5] leads us to divide the 27 relativistic tracks into ten protons and 17 mesons.

The hypothesis of such a process seems in good agreement with the result of Butler[6] (large proportion of positive relativistic particles in penetrating showers observed with his experimental set-up). It also agrees with the theoretical results of Lewis, Oppenheimer, and Wouthuysen,[7] if one considers the mesons to be pseudoscalar.

Star No. 2 (Fig. 2). A heavy primary nucleus produces the star of 51 prongs, 17 of which are relativistic. The heavy track is visible on four neighboring plates; it is nearly at the minimum of ionization. Its charge can be determined by the method indicated by Bradt and Peters[8] and by Freier *et al.*,[9] and is found to be between 14 and 20 while its energy is more than 12 Bev. The relativistic prongs are not well collimated.

If we assume that the charge of the incident particle is 17 and that the star corresponds to the total disintegration of a silver nucleus, and if we take into account the proportion of α-particles observed and the fact that a small number of relativistic particles can escape observation, we must consider the star as being due to the total disintegrations of the incident heavy particle and of the struck silver nucleus. No mesons, or a very small number of mesons, are produced; the probability of meson production is quite small, for the energies of the nucleons of the incident nucleus are only 0.5 to 1 Bev.

Stars produced by heavy nuclei have already been observed by Bradt and Peters,[8] and by Freier *et al.*[9] We see that these two stars correspond to very different phenomena which have one characteristic in common: Their energy is more than 12 Bev.

[1] Brown, Camerini, Fowler, Muirhead, Powell, and Ritson, Nature **163**, 47 (1949).

[2] Cosins, Dilworth, Goldschmidt, Occhialini, Schönberg, and Vermaezen (private communication).

[3] H. Bradt and B. Peters, Phys. Rev. **75**, 1179 (1949).

[4] Peyrou, d'Espagnat, and Leprince-Ringuet, Comptes Rendus **228**, 1777 (1949).

[5] Leprince-Ringuet, Bousser, Hoang-Tchang-Fong, Janeau, and Morellet, Comptes Rendus **229**, 163 (1949).

[6] Butler (private communication).

[7] Lewis, Oppenheimer, and Wouthuysen, Phys. Rev. **73**, 127 (1948).

[8] H. Bradt and B. Peters, Phys. Rev. **74**, 1828 (1948).

[9] Freier, Lofgren, Ney, and Oppenheimer, Phys. Rev. **74**, 1818 (1948).

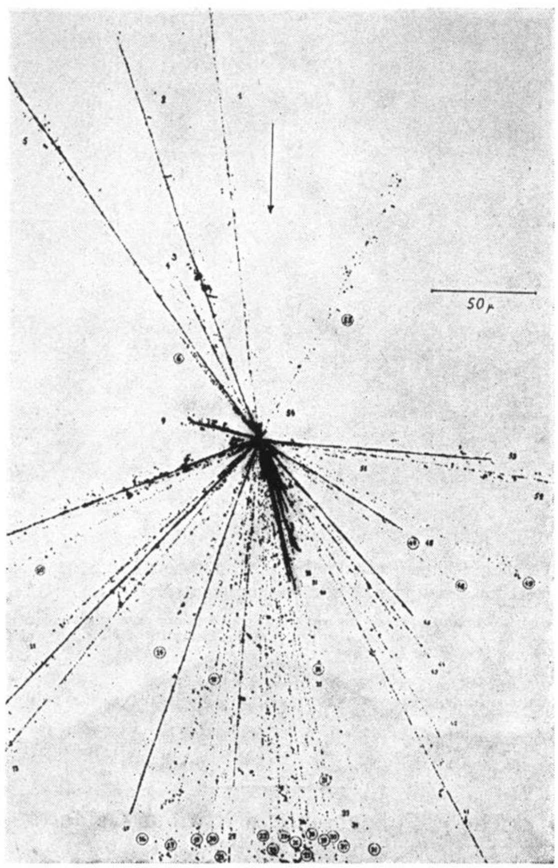

FIG. 1. Star No. 1. No incident primary particle has been observed.

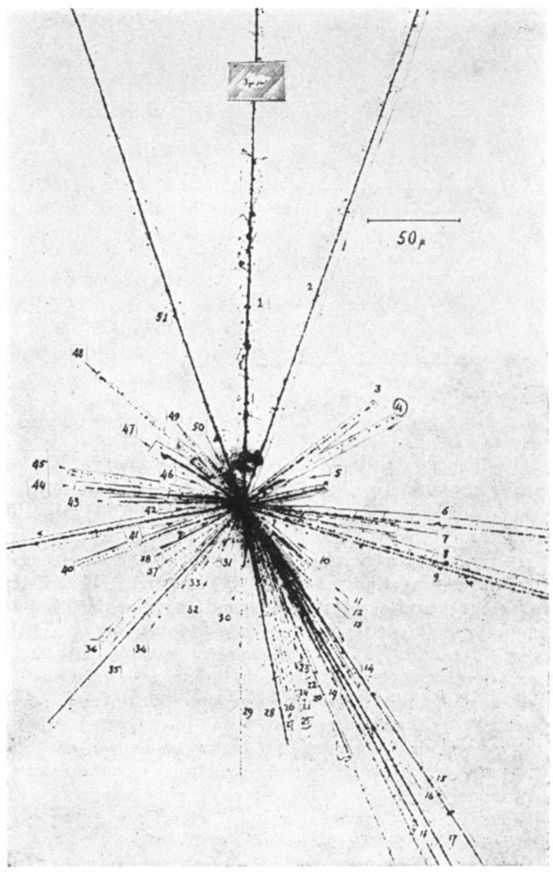

FIG. 2. Star No. 2. Produced by a heavy primary with Z between 14 and 20.