Letters to the Editor

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Nuclear Isomers of Ba^{133} and Ba^{135}*

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THE 28.7-hr γ, ϵ^- activity of barium has been identified by Robertson and Pool[1] with Ba^{135}, and has been shown[2] to arise from an isomeric transition of approximately 300 kev. The 39-hr γ, ϵ^- activity of Ba^{133} was first observed by Cork and Smith,[3] and was shown to be associated with an isomeric transition of 276.4 kev. In the present note we give further results concerning these very similar transitions.

Samples of $BaCO_3$ enriched[4] to 51 percent in Ba^{134}, but containing only 0.08 percent of Ba^{132}, were activated in the heavy water pile at the Argonne National Laboratory. Spectrographic analysis using a 180° focusing instrument showed the presence of lines caused by the K- and L-conversion of a 269±2-kev γ-transition. These lines, from which an N_K/N_L ratio of ~2 was estimated, decayed with a half-life of approximately 30 hr. Using a NaI scintillation counter of determined efficiencies for the γ- and x-radiations, a value of 3.5±1.5 was obtained for the K-conversion coefficient of the 269-kev transition.

The Ba^{133m} sources were obtained by chemically separating barium from $CsNO_3$, bombarded by 10-Mev deuterons. Spectrographic analysis showed the presence of K-, L-, and M-conversion lines from a 275.5±1-kev γ-transition, in good agreement with Cork and Smith's value. A scintillation counter experiment gave for this transition a K-conversion coefficient of 3±1, which may be compared with Cork and Smith's value of 1.8.

The lifetimes of both isomers agree extremely well with the theoretical values[5] for magnetic 2^4 transitions, *viz.*, 45 hr for Ba^{135m} and 42.5 hr for Ba^{133m}. Although one would expect the more energetic transition of Ba^{133m} to be shorter lived than the transition in Ba^{135m}, the agreement between calculated and experimental lifetimes is well within the uncertainty factor of $10^{\pm 2}$ arising from the lack of knowledge of matrix elements.

The observed K-conversion coefficients, although not deciding unambiguously between magnetic 2^4 and electric 2^5 transitions, also favor the assignments of magnetic 2^4 transitions. The theoretical values[6] are 3.9 and 3.5, respectively, for magnetic 2^4 transitions in Ba^{135m} and Ba^{133m}, and are 2.1 and 1.87, respectively, for electric 2^5 transitions.

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[1] B. E. Robertson and M. L. Pool, Phys. Rev. **76**, 1409 (1949).
[2] Weimer, Pool, and Kurbatov, Phys. Rev. **63**, 59(A) (1943); F. Yu and J. D. Kurbatov, Phys. Rev. **74**, 34 (1948).
[3] J. M. Cork and G. P. Smith, Phys. Rev. **60**, 480 (1941).
[4] Separated isotope obtained from Y12 Plant, Carbon and Carbide Corporation, Oak Ridge, Tennessee.
[5] Weisskopf formula.
[6] M. E. Rose, *et al.*, "Tables of K-Shell Internal Conversion Coefficients" (unpublished).

Transition Effect in Pb of the Star-Producing Radiation in the Stratosphere. I*†

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THE behavior in Pb of the star-producing radiation in the stratosphere has been investigated at geomagnetic latitude 56°N by measuring star frequency *versus* depth. Previous studies had shown a weak transition effect in Pb for small stars at mountain altitudes,[1] and a stronger effect in the stratosphere.[2] The latter investigations were limited to depths of 4 cm at most.

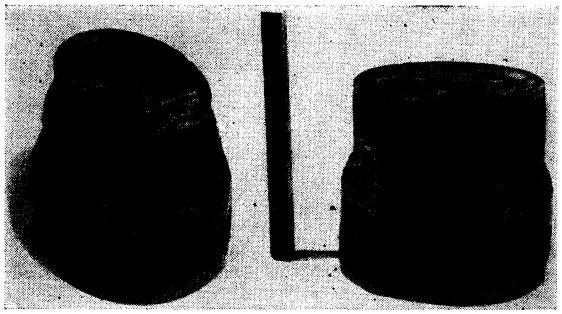

FIG. 1. Two views of Pb absorber. Elliptical in cross section near the top, with axes 10 and 15 cm, it widens toward the base. Total depth, 15.5 cm. At left, complete assembly, upper slab in place. At right, view before insertion of emulsions, showing vertical aperture. Stars were collected only from the central portion of the slot, near the axis.

It is not clear why transition maxima appear at depths of the order of 2 cm, whereas the absorption mean free path in Pb of the incident star-producing radiation[3] is about 28 cm. It seemed worth while, therefore, to explore this phenomenon with better depth resolution, under greater thicknesses of absorber, and using the ultrasensitive emulsions which had become available. Since 1949, we have exposed Pb-covered photoplates in several "Skyhook" balloon flights, and examined some 5000 stars. We report tentative results from two of these flights in Minnesota in which the balloons floated for 6.5 and 5 hr, respectively, at average pressure altitudes of 1.6 and 1.0 cm Hg.

Ilford G.5 emulsions, 15×7.5 cm, and 400μ thick, were inserted into a narrow vertical aperture in a Pb block (Fig. 1); the slot was then covered with a ½-cm Pb slab. Other plates at the surface provided a zero-depth reading. With this absorber, the range of depths was considerably extended.[2,4] Moreover, the vertical orientation of the photoplates enabled us to measure star frequency as a continuous function of depth, where this seemed desirable. In scanning horizontal strips of emulsion, we stayed close to the vertical axis of the absorber; the average distance of a star from

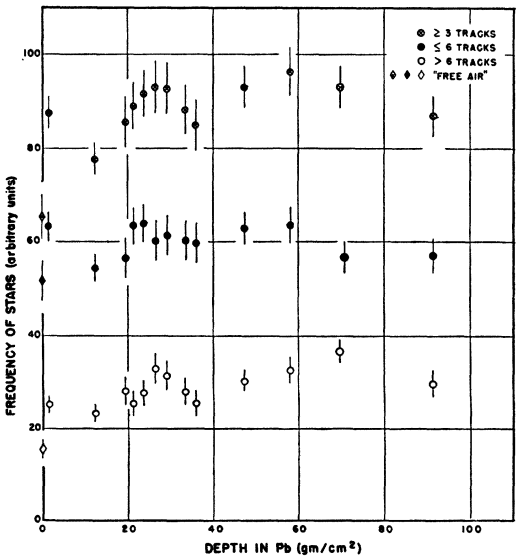

FIG. 2. Star frequency versus depth for all 3565 stars, for small stars, and for large ones. The diamond-shaped points refer to "free air" emulsions. Probable errors, based on counting statistics alone, are shown throughout.