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Mass Spectrographic Identification of Radioactive Lanthanum Isotopes

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Two neutron deficient isotopes of lanthanum, one new and the other previously tentatively assigned, have been given mass assignments by the technique of dispersing the isotopes on a photographic plate with a mass spectrograph. These and other light isotopes of lanthanum were prepared and some of their radioactive characteristics determined by absorption methods and with a low-resolution beta-ray spectrometer.

In some experiments, pure $CsNO_3$ was irradiated with 30-Mev alpha-particles and this was followed by the isolation of the lanthanum fraction. The mass spectrograph showed a single radioactivity at mass number 135; and by following the decay of this line on the photographic plate through a slit arrangement, a 19-hour half-life was obtained. This confirms the mass assignment previously made by other methods.[1] Since this irradiation should have produced La^{136} and La^{134} as well as La^{135}, it was inferred that La^{136} and La^{134} have half-lives less than about 20 minutes since it required several hours to make the exposure on the mass spectrograph. The isotope La^{136} had previously been reported as a 2-hour positron emitter,[1] but the observed activity has since been shown to be F^{18} which partially went through the particular chemical separation employed. A search was made for La^{136}, and it proved to be the 10-minute period reported by Maurer[2] from

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[1] J. B. Chubbuck and I. Perlman, Phys. Rev. 74, 982 (1948).

[2] W. Maurer, Z. fur Naturforschung 2a, 586 (1947).

the irradiation of barium with deuterons. The assignment was made to La^{136} since the ratio of the 10-minute period to the 19-hour period increased with decreasing alpha-particle energy on cesium in the range below 30 Mev, as would be expected for the (α,n) reaction in relation to the $(\alpha,2n)$ reaction. Furthermore, the preparation of this activity in good yield by Maurer[2] using 5.8-Mev deuterons on barium would now point to La^{136} in view of the present knowledge of La^{138}, La^{137}, and La^{135}, unless one assumes the 10-minute activity to be a metastable state of one of these isotopes. Very recently Robertson, Carss, and Pool[3], using separated stable barium isotopes as targets, have definitely proved this period to be associated with La^{136}. The characteristics of La^{136} which we determined are a half-life of 9.5 minutes, positron of 2.1 Mev determined with the spectrometer, and x-rays in high abundance from which it is estimated that about 1/3 of the decay is by positron emission and 2/3 by electron-capture.

The irradiation of cesium with 50-Mev alpha-particles resulted in a new lanthanum activity of 4.0-hours half-life. This activity has positrons of about 1.2 Mev, a conversion electron line of 0.26 Mev determined with the spectrometer, a harder gamma-ray of 0.8 Mev measured by lead absorbers, and K x-rays in high yield. This activity apparently decays predominantly by electron-capture since the positrons were only a few percent as abundant as the x-rays.

The 4-hour period was assigned to La^{133} by the mass spectrograph method. Figure 1 shows the original photographic plate (A) and two transfer

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[3] E. E. Robertson, W. L. Carss, and M. L. Pool, Bull. Am. Phys. Soc. 24, No. 7, 14 (1949).

Figure 1: Mass spectrographic analysis of radioactive lanthanum isotopes by transfer technique. (Exposures for transfer plates T_1 and T_2 given in the text.)

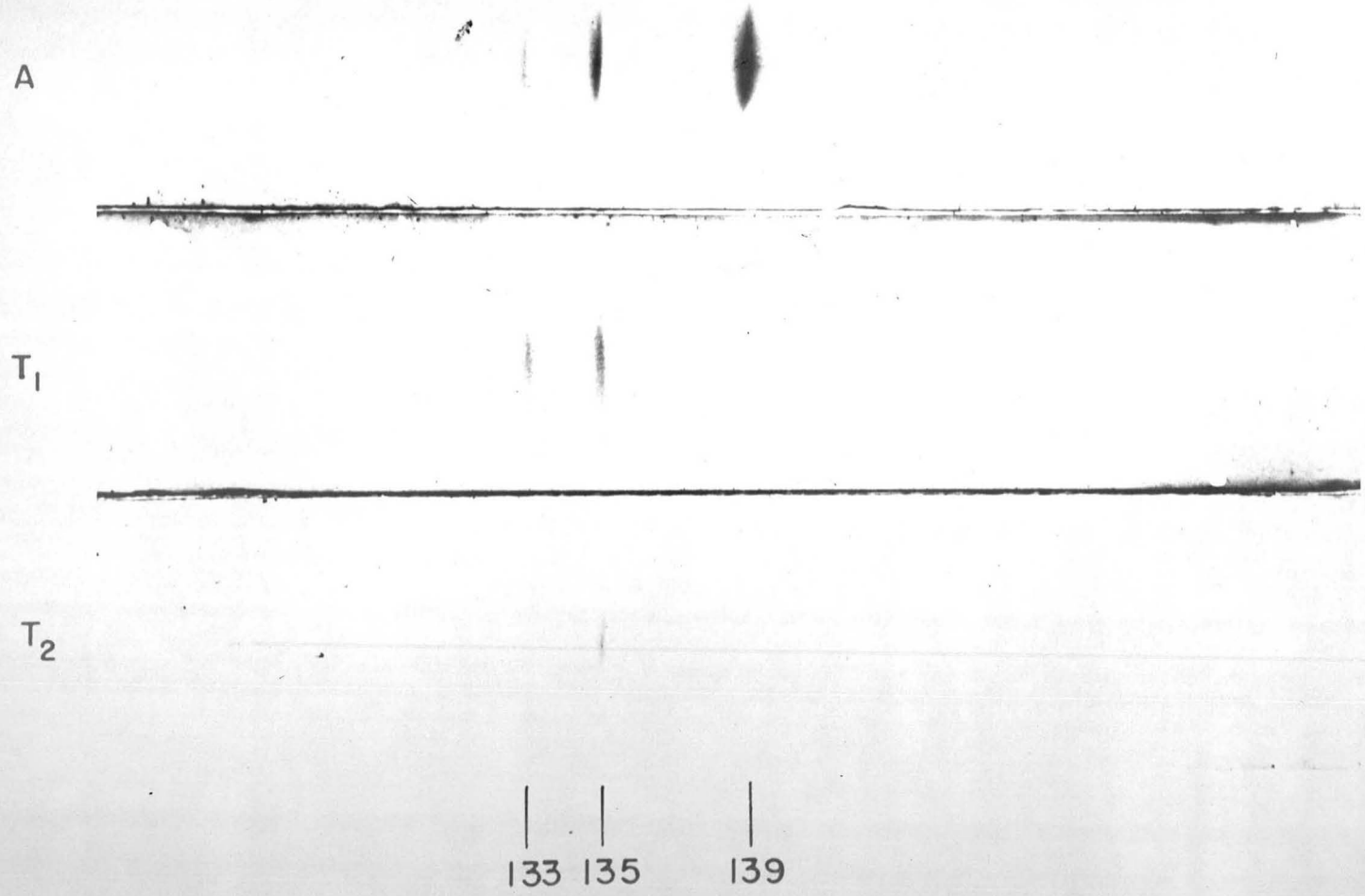

FIG. 1

plates (T_1 and T_2) made by exposing successively blank photographic plates with the receiver plate. The upper picture, A, shows the receiver plate with the line for stable lanthanum at mass number 139 (actually measured as the singly ionized oxide), and two other lines at 135 and 133. The middle plate, T_1, is the first transfer plate exposed for 24 hours after analysis showing that the lines at 133 and 135 are due to radioactivities. The bottom plate, T_2, made by a 72-hour exposure following the first one, shows only the 19-hour La^{135} since the 4-hour La^{133} had decayed.

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