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NEUTRON DEFICIENT ISOTOPES OF IODINE

by

Luis Marquez
I. Perlman

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University of California
Radiation Laboratory

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Luis Marquez and I. Perlman
Radiation Laboratory and Department of Chemistry
University of California, Berkeley, California

ABSTRACT

The iodine isotopes I^{123}, I^{122}, I^{121}, and I^{120}(?) have been made by bombarding antimony with α-particles. Their characteristics are summarized and evidence for mass assignments presented.

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During the course of some investigations of abnormal change in nuclear charge following irradiation with high-energy particles, some of the nuclides encountered proved to be light isotopes of iodine which had not been reported previously. The main study will be reported at a later date while the present communication describes some work done to characterize and identify the iodine isotopes. The mass number region of interest is that below I^{124} as higher isotopes are well known.[1]

Four new isotopes of iodine have been identified with mass assignments and decay characteristics as indicated in Table 1. The method of making mass assignments for some of these was to compare shapes of excitation curves of (α,xn) reactions on antimony in which known iodine activities were produced from the Sb^{123} and the new ones to be assigned from the Sb^{121}. The excitation functions as shown in Figure 1 are fairly crude as the only objective was to compare shapes in order to assign mass numbers. The experimental procedure was to irradiate antimony (57% Sb^{121}, 43% Sb^{123}) with helium ions of different energies, to isolate the iodine by a method in which the chemical yield could be measured, and then to resolve the iodine decay curves into the several components making use of distinctive radioactive properties.

<u>13-hr. I^{123}</u>.-- A 13-hr. component was assigned to I^{123} since its excitation function paralleled that for 56-day I^{125}, both curves being of the shape that would be expected for (α,2n) reactions; in this case, on

[1]For summary of data see: G. T. Seaborg and I. Perlman, Rev. Mod. Phys. <u>20</u>, 585 (1948).

Sb^{121} and Sb^{123} respectively. The yields as shown include corrections for natural abundances of Sb^{121} and Sb^{123}, and are based on the assumption that both the 13-hr. I^{123} and 56-day I^{125} have one K x-ray per disintegration, and assuming one percent counting efficiency in the argon-filled Geiger tubes. The 13-hr. I^{123} has conversion electrons of 150 $\pm$ 15 kev energy as determined with a low-resolution beta-ray spectrometer and by absorption in beryllium. Gamma-rays corresponding to this energy were also observed. This activity with similar half-life and radiation characteristics has been reported recently by Mitchell, Mei, Maienschein, and Peacock.[2]

<u>4.5-day I^{124} and 13-day I^{126}</u>.-- The curves for both of these isotopes using normal antimony as a target are shown as appropriately labeled solid curves in Fig. 1. The curve for I^{126} is characteristic of an (α,n) reaction as is the low-energy part of that for I^{124}. The upswing beyond 30 Mev in the I^{124} curve is due to the $(\alpha,3n)$ reaction on Sb^{123}. The points shown for the broken line projection of the I^{124} curve were obtained from the irradiation of separated* Sb^{121} from which I^{124} can be formed only by the (α,n) reaction.

The discrepancy in yields at 20 Mev between I^{126} and I^{124} is not explained; but it may be remarked that in other cases such as the fission of bismuth[3] and the (γ,n) reaction on iodine[4], the measured yield of I^{126} has been much lower than expected, making it appear that not all of the decay events take place through the 1-Mev beta-particle upon which the yields are based.

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*The sample of separated antimony consisting of 99.3% Sb^{121}, 0.7% Sb^{122} was obtained from the Isotopes Division of the U.S. Atomic Energy Commission.

[2]A. C. G. Mitchell, J. Y. Mei, F. C. Maienschein, and C. L. Peacock, Phys. Rev. 76, 1450 (1949).

[3]R. H. Goeckermann and I. Perlman, Phys. Rev. 76, 628 (1949).

[4]M. L. Perlman, Phys. Rev. 75, 988 (1949).

The half-life of I^{124} was measured as 4.5 days and the β^{+}-energy as 2.1 $\pm$ 0.1 Mev. It is estimated from the yield of K x-rays that this isotope decays only about 30% by positron-emission and 70% by electron-capture.

4-min. I^{122}.-- In experiments in which an hour was consumed in chemical separation, no activity appeared which followed the excitation function of that part of the 4.5-day I^{124} curve produced by the (α,3n) reaction. It was therefore assumed that I^{122}, which would be formed by the $Sb^{121}(\alpha,3n)\ I^{122}$ reaction, is short-lived. More rapid chemistry showed a 4-min. iodine activity, and a single yield determination at 45 Mev showed it to be in the expected range as indicated in Fig. 1. The positron has an energy of 2.9 $\pm$ 0.1 Mev, and it is estimated that there is some electron-capture branching.

The assignment of this activity to I^{122} is also based on the fact that it was the only new activity beyond I^{123}, I^{124}, I^{125}, and I^{126} to appear at 45 Mev. A 1.8-hr. activity assigned to I^{121} (from α,4n reaction) did not appear at this energy.

1.8-hr. I^{121}.-- An activity with 1.8-hr. half-life with a 1.2-Mev positron and conversion electrons of 185 kev appeared in irradiation of antimony with 60-, 100-, and 360-Mev helium ions. Its decay is followed by the appearance of 17-day Te^{121} in approximately the proper yield for a parent-daughter relationship.

30-min. I^{120}(?).-- In the higher energy irradiations (100 and 360 Mev) a 30-min. activity appeared, having a hard positron of 4.0 Mev. The decay of the iodine containing this activity was followed by the appearance of a tellurium activity which could not be resolved uniquely but which does have a half-life of several days. It is possible that this activity is 4.5-day Te^{119}. This would indicate that I^{119} was present. However, the observed positron energy of the 30-min. period is in better agreement with the prediction for I^{120} which may mean that I^{119} was also present but unobserved.

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TABLE 1

Mass No.	Half-Life	Radiation	Energy
124	4.5 days	K, β^+	$\beta^+ = 2.1 \pm 0.1$ Mev
123	13 hr.	K, γ, e^-	$e^- = 150 \pm 15$ kev
122	4 min.	β^+ (K, γ?)	$\beta^+ = 2.9 \pm 0.1$ Mev
121	1.8 hr.	K, β^+, γ, e^-	$e^- = 185 \pm 10$ kev
			$\beta^+ = 1.2 \pm 0.1$ Mev
120?	~30 min.	β^+, γ (K?)	$\beta^+ = 4.0 \pm 0.2$ Mev

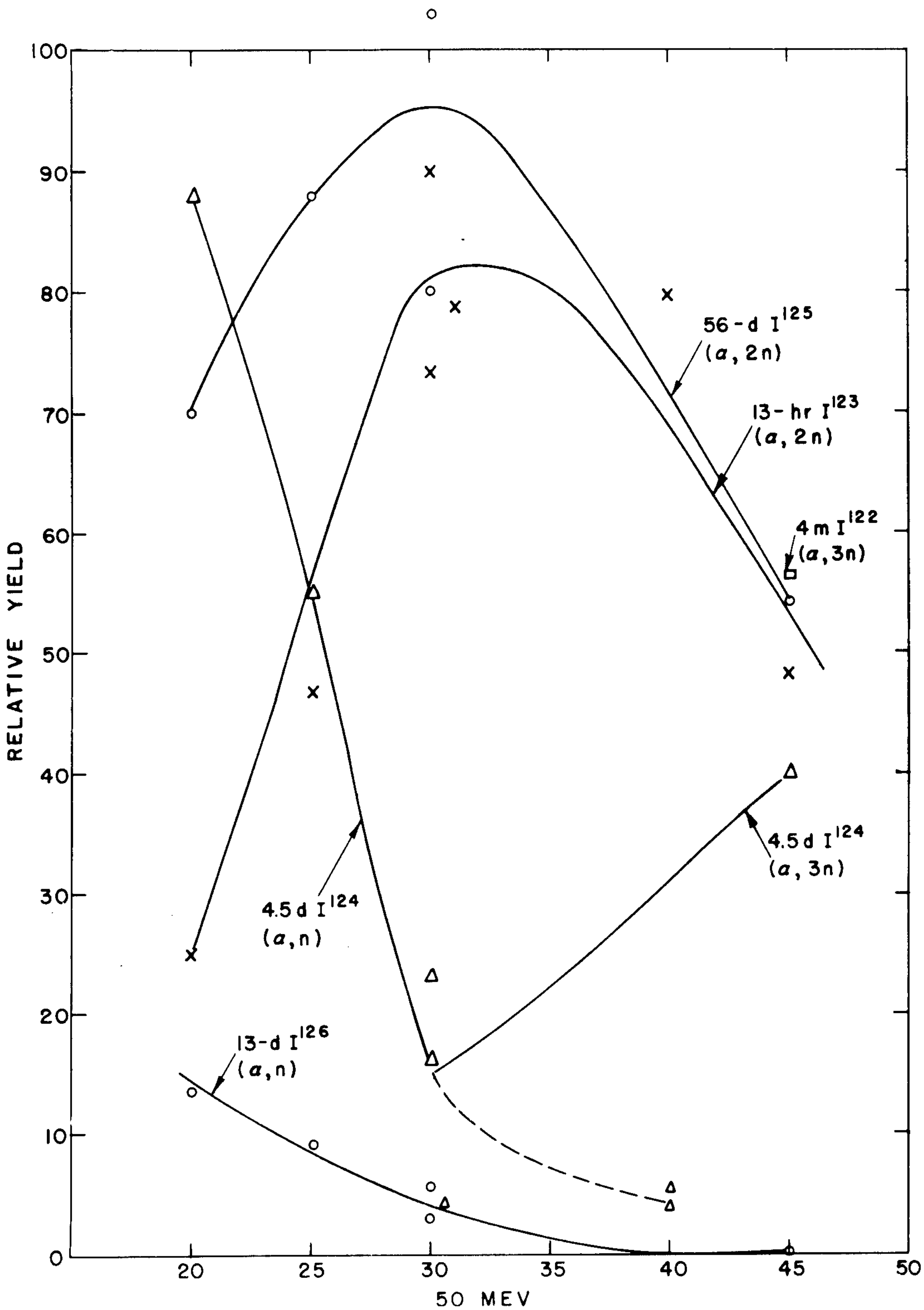

Figure 1

Excitation functions for α, xn reactions on antimony.

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