AN INVESTIGATION OF THE $Sn^{112}(\gamma, n)$ *AND* $Sn^{124}(\gamma, n)$ *REACTIONS*

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The yield curves for the (γ, n) reaction in Sn^{112} and Sn^{124} were measured by means of the induced radioactivity. The peaks of the cross section curves for the reactions $Sn^{112}(\gamma, n)Sn^{111}$ and $Sn^{124}(\gamma, n)Sn^{123}$ are located at 16.0 ± 0.5 and 15.5 ± 0.5 Mev, respectively. The corresponding integral cross sections are 1.82 ± 0.10 and 1.56 ± 0.08 Mev-barn.

1. The (γ, n) reaction in different isotopes of the same element has hitherto been investigated almost exclusively for light nuclei, where the total cross section for γ-ray absorption includes additional important contributions from (γ, p), (γ, np) and $(\gamma, 2n)$ reactions. For medium-weight and heavy nuclei, where the (γ, n) reaction furnishes ~ 90% of the entire giant-resonance cross section, we have only the data obtained by Katz and Cameron[1] for antimony. A surprisingly large difference was found between the integral cross sections for the (γ, n) reaction in Sb^{121} and Sb^{123}.

It was of interest to obtain data on the integral cross section and the resonance energy and width of the (γ, n) reaction in isotopes of a single element with greatly different numbers of neutrons. For this purpose the two extreme isotopes Sn^{112} and Sn^{124} were selected.

2. Both reactions were investigated through the activity induced by synchrotron-generated γ rays ($E_{\gamma max}$ = 30 Mev). In the case of the $Sn^{112}(\gamma, n)Sn^{111}$ reaction ($T_{1/2}$ = 35 min) a 29.3% enriched sample of Sn^{112} was used,* while for $Sn^{124}(\gamma, n)Sn^{123}$ ($T_{1/2}$ = 40 min) chemically pure natural tin was used. The (γ, n) yield was measured relative to $Cu^{63}(\gamma, n)Cu^{62}$ at energies above the threshold of the latter reaction, and relative to readings from an integrating ionization chamber in the case of lower energies. Residual β activity was registered by means of two BFL-25 end-window counters in an anticoincidence scheme, with ~ 0.55 registration efficiency. The scalar output was fed to a time discriminator. The scale of the energy stabilization system of the synchrotron was calibrated by means of the thresholds of $Cu^{63}(\gamma, n)$ (10.75 Mev) and $C^{12}(\gamma, n)$ (18.72 Mev), as well as the bend at $E_{\gamma max}$ = 17.15 Mev in the $O^{16}(\gamma, n)$ curve. The relative yield curve for $Sn^{112}(\gamma, n)$ includes a correction for 0.9% content of Sn^{124}. The yield from $Sn^{124}(\gamma, n)Sn^{123}$ takes into account ~ 7% of activity from Sn^{112}. For $E_{\gamma max}$ > 20 Mev an ~ 8-min activity also appears, which at $E_{\gamma max}$ = 24.0 Mev amounts to ~ 10% (assuming the same number of nuclei) of the 40-min activity of Sn^{123}. The self-absorption of Sn^{123} and Cu^{62} β rays for the given experimental geometry was obtained by irradiating samples of different thickness.

3. The yields Y of the reactions $Sn^{112}(\gamma, n)$ and $Sn^{124}(\gamma, n)$ are shown in Fig. 1. The $Sn^{112}(\gamma, n)$ threshold is 10.2 ± 0.2 Mev, which differs considerably from the binding energy 11.1 Mev given in reference 2 for a neutron in Sn^{112}.

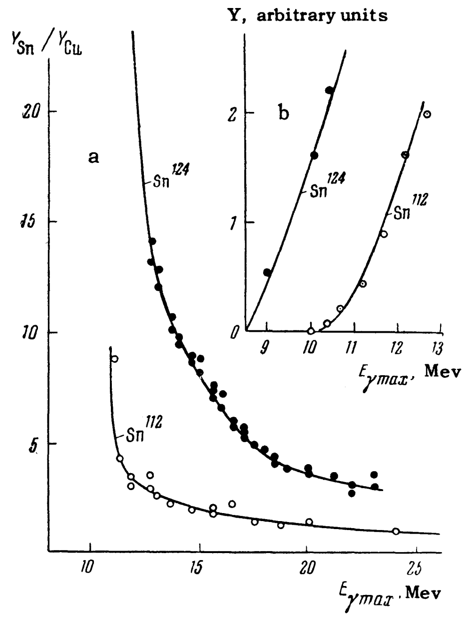

FIG. 1. a – Yields of the reactions $Sn^{112}(\gamma, n)$ and $Sn^{124}(\gamma, n)$ relative to the yield of $Cu^{63}(\gamma, n)$ as a function of $E_{\gamma max}$; b – yields of $Sn^{112}(\gamma, n)$ and $Sn^{124}(\gamma, n)$ as a function of $E_{\gamma max}$ near threshold.

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The reaction threshold 8.5 ± 0.3 Mev obtained for $Sn^{124}(\gamma, n)$ agrees with mass data.[2] The (γ, n) cross sections were plotted from the relative yield curves and the $Cu^{63}(\gamma, n)$ cross section by the method described in reference 3. Corrections were introduced that take account of the Sn^{111} decay scheme[4] and the contribution from $Sn^{124}(\gamma, n)Sn^{123*}$. Irradiation at $E_{\gamma max} = 19.0$ Mev for the purpose of measuring the 126-day activity of Sn^{123*} showed a 0.24 ± 0.09 yield ratio for final-nucleus formation in the isomeric $(I = 9/2)$ and ground $(I = 3/2)$ states, respectively. This indicates a high probability for transitions with small spin change.

Figure 2 shows the energy dependence of the $Sn^{112}(\gamma, n)$ and $Sn^{124}(\gamma, n)$ cross sections, for which we have the following results:

	$Sn^{112}(\gamma, n)Sn^{111}$	$Sn^{124}(\gamma, n)Sn^{123}$
Peak energy, Mev	16.0±0.5	15.5±0.5
Cross section peak, mb	340±40	300±30
Half-width, Mev	5.0±0.5	5.0±0.5
Integral cross section, Mev-barn	1.82±0.10	1.56±0.08

The $Sn^{124}(\gamma, n)$ cross section peak agrees with values obtained for a natural tin isotope mixture. A comparison of data for the two isotopes must take into account the considerable difference between the $Sn^{112}(\gamma, n)$ and $Sn^{124}(\gamma, n)$ thresholds, 21.0 and 14.0 Mev, respectively. This evidently accounts for the very close peak energies and integral cross sections for γ-ray absorption by Sn^{112} and Sn^{124}, as would be expected from the sum rule.

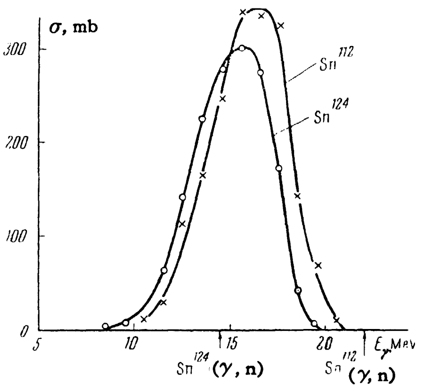

FIG. 2. Cross sections for the reactions $Sn^{112}(\gamma, n)$ and $Sn^{124}(\gamma, n)$. Thresholds are indicated by arrows.

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