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V. N. LEVKOVSKII

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Abstract

Full Text

PHYSICS

V. N. LEVKOVSKII

CROSS SECTIONS OF THE REACTIONS Cd(n,p)Ag AT A NEUTRON ENERGY OF 14 MeV

(Presented by Academician V. N. Kondrat'ev, 23 XI 1956)

The cross sections of the reactions Cd (n, p) Ag were calculated by comparing the β -yield of these reactions with the yield of the reaction Cd¹¹² (n, α) Pd¹⁰⁹, whose cross section had previously been found to be $(1.35 \pm 0.27) \cdot 10^{-27}$ cm² (1).

(Figure: Fig. 1. Decay curve of radioactive silver separated from a cadmium target irradiated with 14-MeV neutrons)

Fig. 1. Decay curve of radioactive silver separated from a cadmium target irradiated with 14-MeV neutrons

Cadmium nitrate samples were irradiated for 0.5–1 hour with 14-MeV neutrons, dissolved, and palladium was separated from the solution with a carrier by precipitation with dimethylglyoxime. In the filtrate, silver with a carrier was precipitated in the form of AgCl. The precipitate was reprecipitated from ammonia, and its activity was measured with a standard cylindrical Geiger counter (44.5 mg/cm²). The activity of the palladium precipitates was measured under identical geometrical conditions.

Figure 1 shows a typical decay curve of the activity of the silver precipitate; Fig. 2 gives the results of graphical analysis of the curve in Fig. 1. The half-lives obtained—24 min, 3.2 h, 5.3 h, and 7.5 days—are in good agreement with the literature values of the half-lives of Ag¹⁰⁶, Ag¹¹², Ag¹¹³, and Ag¹¹¹.

Table 1 presents the absorption-measurement data for the β -radiations of Ag¹⁰⁶, Ag¹¹¹, Ag¹¹², and Ag¹¹³, obtained as a result of measuring

the activity of silver separated from the cadmium target, through aluminum filters of different thicknesses, and subsequent graphical analysis of the complete decay curves. The table also gives absorption-measurement data for the radiation of Pd¹⁰⁹, which were used in calculating the reaction cross sections. In the third and fourth columns of the table are given the maximum energies of the investigated β -radiations, as accepted in the literature and as calculated from our absorption measurements from the empirical relation $E = 2.12 \cdot 10^{-2} d_{1/2} + 0.17$ (2).

(Figure: Fig. 2. Results of graphical analysis of Fig. 1)

Fig. 2. Results of graphical analysis of Fig. 1

Table 1

Radiation	Half-absorption thickness $d^{1/2}$, mg/cm ²	E_{\max} , MeV, calc.	E_{\max} , MeV, lit.	Correction for absorption in the counter window
Ag ¹⁰⁶	96	2.21	1.96	0.70
Ag ¹¹¹	40	1.02	1.04	0.44
Ag ¹¹²	195	4.30	4.20	0.84
Ag ¹¹³	97	2.23	2.20	0.70
Pd ¹⁰⁹	42	1.06	0.96	0.45

As follows from the table, the values we measured for the maximum energies of the 24 min, 3.2 h, 5.3 h, and 7.3 day radiations agree well with the literature values for the β -radiations of Ag¹⁰⁶, Ag¹¹², Ag¹¹³, and Ag¹¹¹.

In Table 2 the initial activities of Ag¹⁰⁶, Ag¹¹¹, Ag¹¹², and Ag¹¹³, obtained in two independent experiments, are compared; in Table 3, the activities of Ag¹¹¹ and Pd¹⁰⁹, obtained in three parallel irradiations.

Table 2

Initial activities, allowing for decay during irradiation	Relative activities						
	Ag ¹¹¹	Ag ¹¹²	Ag ¹¹³	Ag ¹⁰⁶	Ag ¹¹¹	Ag ¹¹²	Ag ¹¹³
37600	150	19500	3680	251.0	1.0	130.0	24.6
85000	376	49800	9350	226.0	1.0	133.0	24.9

The reaction cross sections were calculated from the data of Tables 1, 2, and 3, from the known half-lives of Ag¹⁰⁶, Ag¹¹¹, Ag¹¹², Ag¹¹³, and from the percentage contents of Cd¹⁰⁶, Cd¹¹¹, Cd¹¹², Cd¹¹³ in the natural mixture of cadmium isotopes.

According to the literature data ⁽³⁾, Ag¹⁰⁶ has two isomers with $T = 24$ min and 8.2 days. The isomer with $T = 8.2$ days decays exclusively by electron capture; the isomer with $T = 24$ min, according to the literature data ⁽⁴⁾

Table 3

Initial activities with allowance for decay during irradiation	Initial activities with allowance for decay during irradiation	Ratio of initial activities $\alpha = \frac{I_{\text{Ag}^{111}}}{I_{\text{Pd}^{109}}}$
Pd ¹⁰⁹	Ag ¹¹¹	
368	150	0.407
450	221	0.490
420	180	0.428

Table 4

Reaction	Cross sections, mbarn
Cd ¹⁰⁶ (<i>n, p</i>) Ag ¹⁰⁶ (24 min)	(76 ± 24)
Cd ¹¹¹ (<i>n, p</i>) Ag ¹¹¹	(15.0 ± 3.8)
Cd ¹¹² (<i>n, p</i>) Ag ¹¹²	(9.8 ± 2.9)
Cd ¹¹³ (<i>n, p</i>) Ag ¹¹³	(7.2 ± 2.2)

decays by positron emission in 69%, and by electron capture in 31%. Our data make it possible to calculate the cross section only for the isomer with $T = 24$ min.

The results of the cross-section calculation are presented in Table 4.

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Institute of Chemical Physics
Academy of Sciences of the USSR

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CITED LITERATURE

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