CROSS SECTION FOR THE REACTION $C^{13}(\gamma, p)B^{12}$

V. P. DENISOV, A. V. KULIKOV, and L. A. KUL'CHITSKIĬ

A. F. Ioffe Physico-technical Institute, Academy of Sciences, U.S.S.R.

Submitted to JETP editor October 23, 1963

J. Exptl. Theoret. Phys. (U.S.S.R.) **46**, 1488-1490 (April, 1964)

THE yield of the reaction $C^{13}(\gamma, p)B^{12}$ has been studied by means of the β activity of the residual nucleus B^{12}, which was counted in the intervals between the pulses of a synchrotron γ-ray beam. A crystal of stilbene was used as target and detector. The discrimination threshold was set so that pulses from the C^{10} and C^{11} activities were not counted. In order to obtain integral and differential cross sections, the yield curve was analyzed by the method of Penfold and Leiss.

Figure 1 shows the differential cross section curve. This curve has a sharply developed structure. The energies of the observed peaks and their integrated cross sections are listed below. The absolute value of the integrated cross section from the reaction threshold up to 50 MeV is 72 ± 9 MeV-mb.

Energy of peaks, MeV:	18.5	20.0	23.5	26.0	29.0	32—50
$\int \sigma_i(E)\,dE$, MeV-mb:	1.1	4.4	22.8	7.0	8.4	28.0

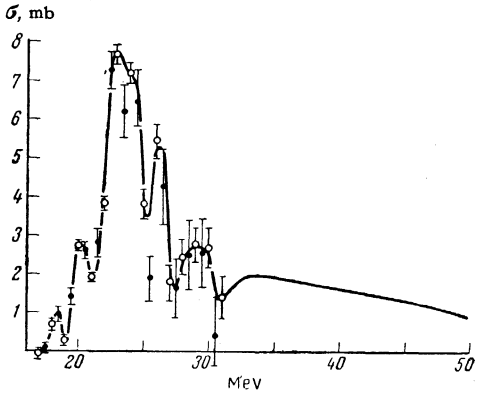

FIG. 1. Differential cross section for the reaction $C^{13}(\gamma,p)B^{12}$. The hollow circles indicate average values of three independent series of measurements; the solid circles refer to a separate series of measurements obtained at intermediate energy values.

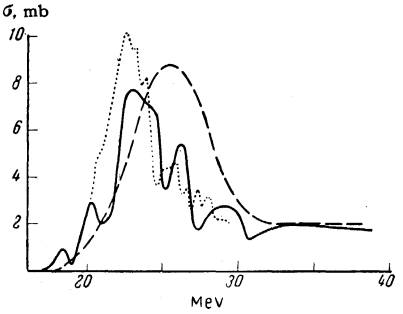

FIG. 2. Comparison of our experimental differential cross section curve for the reaction $C^{13}(\gamma,p)B^{12}$ (solid curve) with the curve obtained by Cook[1] (dashed curve), and with the curve obtained by Dodge and Barber[2] (dotted curve) for the cross section of the $C^{12}(\gamma,p)B^{11}$ reaction.

The shape of the differential cross section curve differs strongly from the curve obtained earlier by Cook[1] for the same cross section, as can be seen from Fig. 2. However, there is a considerable similarity to the differential cross section curve for the $C^{12}(\gamma, p)B^{11}$ reaction obtained by Dodge and Barber[2] from the proton spectrum in the electrodisintegration of the C^{12} nucleus.

The main part of the (γ, p) cross section in C^{13}, as in C^{12}, is concentrated in a single large peak (or in several unresolved peaks) with a width of about 3 MeV, whose center is located at 23.5 MeV for C^{13} and 22.5 MeV for C^{12}. The well resolved small peaks at energies of 18.5 and 20.0 MeV are absent in the cross section curve obtained from the proton spectrum of the $C^{12}(\gamma, p)B^{11}$ reaction. However, in the cross section for the total absorption of γ rays by the C^{12} nucleus, Bugrov et al[3] have observed peaks of approximately the same intensity at energies of 17.6 and 19.1 MeV. By comparing the position of the main peaks obtained experimentally for C^{12} and C^{13}, we can observe that in C^{13} there is a shift of the analogous peaks by approximately 1 MeV towards higher energies.

Comparison with theoretical results obtained by Easlea[4] shows that the energy values of the main transitions agree quite satisfactorily with the energies of the peaks obtained by us. For example we can mention the good agreement of the transitions at 18.0, 20.2, and 25.7 MeV with the

measured peaks at energies of 18.5, 20.0, and 26.0 MeV, corresponding to the levels $T = 1/2$, $I = 1/2^+$; $T = 1/2$, $I = 3/2^+$; and $T = 3/2$, $I = 1/2^+$, respectively. However, the most intense transitions in the energy region 21–25 MeV occur to the excited nuclear states $T = 3/2$, $I = 3/2^+$ at energies 24.3 and 24.5 MeV, and for $T = 3/2$, $I = 1/2^+$, at 24.8 MeV, whereas the main peak obtained in our experiments is located at an energy of 23.5 MeV.

[1] B. C. Cook, Phys. Rev. **106**, 300 (1957).

[2] W. R. Dodge and W. C. Barber, Phys. Rev. **127**, 1746 (1962).

[3] Bugrov, Danil'en, Dolbilkin, Lazareva, and Nikolaev, Izv. AN SSSR ser. fiz. **27**, 866 (1963), Columbia Tech. Transl. **27**, 856 (1963).

[4] B. R. Easlea, Phys. Letters **1**, 163 (1962).

Translated by C. S. Robinson
216

RADIATION OF Pd^{100}

N. M. ANTON'EVA, M. K. NIKITIN, and V. B. SMIRNOV

Physics Institute, Leningrad State University

Submitted to JETP editor October 26, 1963

J. Exptl. Theoret. Phys. (U.S.S.R.) **46**, 1490-1492 (April, 1964)

AN investigation of the radiation of the radioactive isotope Pd^{100} was made with the aid of a "ketron" type magnetic spectrometer, a scintillation gamma spectrometer (single and double), and a total-absorption gamma spectrometer. The Pd source was prepared by chemical separation from a silver target bombarded with 660-MeV protons.

Figure 1 shows the soft region of the Pd-fraction conversion-electron spectrum. A group of lines with an intensity that decreases with a half-life of 3.7 ± 0.3 days, is observed. The gamma transition energy and the relative intensities of the conversion lines are given in the table. The values obtained for K – L, L – M, and K – M show convincingly that the transitions occur in the Rh nucleus.

According to the literature data, Pd^{100} has a half-life of 4.0 days.[1] To interpret the observed activity, the accumulation and decay curve was plotted for the 2380 keV gamma line belonging to the Pd^{100}–Rh^{100} daughter isotope (Fig. 2). An analysis of the curve gave respective values of 20 hours and 3.7 days for the half-life. It is there-

Transition energies, energy differences K – L and K – M, and relative intensities of the conversion lines and γ transitions, and the results of the $\gamma\gamma$ coincidences

№	$h\nu$, keV	Observed lines	K–L, keV	K–M, keV	$K/K_{84\,keV}$	K/L	$J/_\gamma J_{\gamma 84\,keV}$	γ transitions coinciding with given $h\nu$, keV
			L–M					
1	32.4±0.2	K,L, M	=2.84±0.05	—	—	—	1.5±0.5	—
2	41,9±0.5	K	—	—	—	—	1.5±0.6	—
3	51.7±0.5	K	—	—	—	—	—	—
4	74.4±0.4	K,L, M	20.0±0.2	22.8±0.2	52±8	8.4±0,8	45	84
5	83.8±0.4	K,L, M	19.9±0.2	22.8±0,2	100	9.0±0.9	100	32, 42, 74
6	126.5±0.5	K, L	19.6±0,2	—	1,6±0.3	—	10	32
7	158,1±0.5	K, L	—	—	—	—	1,3	None

Relative intensities $J_\gamma/J_{\gamma 84\,keV}$ are given with an error not more than 20%.