HIGH-ENERGY GAMMA TRANSITIONS IN Ga^{72} *DECAY*

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USING a γ hodoscope, we investigated at the Scientific Research Institute of Physics of Leningrad State University, the Ga^{72} γ spectrum in the energy range above 2000 keV. The measurements were carried out with two Ga^{72} specimens, with activity ~ 3 and 5 Ci.

In the course of our investigations we identified the previously known [1-3] 2205, 2500, (2490 + 2508), 2846, 2976 and 3340 keV γ lines, and observed γ rays with energy ~ 3100 keV. A detailed study of the γ spectrum in the 3000—4000 keV range made it possible to detect γ rays with energy 3680 ± 40 keV. The half-life which was found in accordance with the change in intensity of the 3680 keV γ line is (13 ± 3) hours, which indicates that this line belongs to the Ga^{72} γ spectrum ($T_{1/2} = 14$ hours). Gamma rays of this energy were observed for the first time in Ga^{72} decay.

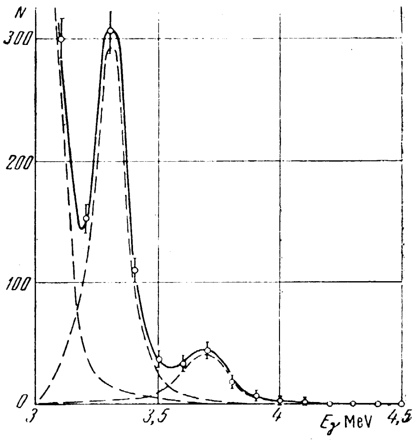
The figure shows the form of the Ga^{72} γ spectrum (after subtraction of the background) obtained with a magnetic field intensity of 1322 Oe (range of E_γ which could be recorded by the instrument is 3050—5360 keV); the dashed curve shows the resolution of the spectrum.

The ratio of the intensities of the 3338 and 3680 γ transitions, which was found by comparing the areas of the corresponding lines, is $1 : (0.061 \pm 0.004)$. In addition, the ratios of the intensities of the 2976, 3338 and 3680 keV transitions to the intensities of the 2205, 2500 and 2846 keV transitions were determined. The data from [3] were used for determining the intensities expressed as the number of photons per disintegration.

The investigations show that in Ga^{72} decay there are no transitions with higher energies whose intensity would be greater than 2×10^{-7} photons per disintegration.

In the table, the results of our investigations are compared with those obtained by other authors.

We also investigated the Ga^{72} γ-ray spectrum in the 3000--4000 keV range, by means of a scintillation γ-spectrometer. From this, we obtained confirmation of the existence of low-intensity 3700 keV γ rays.



Experimental Ga^{72} γ-ray spectrum in the 3000-4000 keV energy range. At H = 1322 Oe, the recording probability was optimum for 4300 keV energy; under these conditions, the 2976, 3338 and 3680 keV lines were attenuated 172, 5.1 and 1.8 times respectively. On the left—sharp drop in the 2976 keV line; N—number of nuclei; continuous-line curve—sum of the spectrum components; o—experimental points of the histogram.

Since the first Ge^{72} level has an energy of 690 keV, and the decay energy is 4000 ± 10 keV, the γ rays with energy 3680 keV point directly to the existence of an excited state of the Ge^{72} nucleus with this energy.

The presence of 3680 keV γ rays means that in Ga^{72} decay there occurs a β^- transition with end-point energy ≤ 320 keV and intensity not less than $5 \times 10^{-4}\%$ disintegrations. The quoted half-life of this β transition is $ft \leq 2.4 \times 10^9$ ($\log ft \leq 9.4$). It seems most probable that this β transition leads directly to an excited state of the Ge^{72} nucleus with

E, keV	γ-transition intensities (10^{-4} photons/disintegration)			
	[1]	[2]	[3]	Our data
2976	—	—	7±2	9.8±2.0
3050	13	—	~2	} 0.7
3100	—	4	<1	
3340	3	2	—	0.75±0.22
3680	—	—	—	0.05±0.02

energy 3680 keV. In this case, this state cannot have the 1^- quantum characteristics which have been imputed to the excited state of the Ge^{72} nucleus with energy 3740 keV which was found in As^{72} decay [4]. With 1^- characteristics, the β-transition would belong to the $3^- \rightarrow 1^-$ type and would be twice-forbidden (log ft $\geq$ 12).

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YIELD OF PHOTOPROTONS FROM CALCIUM

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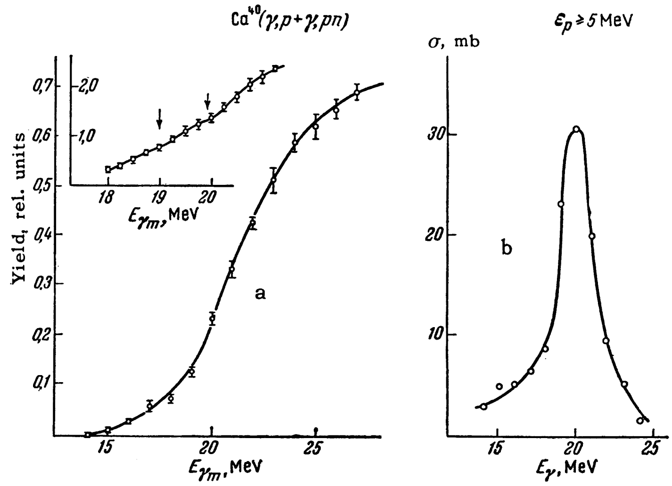
THE yield curve of the reaction $Ca^{40}(\gamma, p + \gamma, pn)$ has been measured up to the γ-ray energy $E_{\gamma m}$ = 27 MeV by counting protons in CsI(Tl).

The method differs from that described earlier by us [1] in the use of pulse shape discrimination of particles. Protons were counted with energies $\epsilon_p \geq 5$ MeV. The yield curve of photoprotons as a function of $E_{\gamma m}$, measured with 1 MeV intervals between points, is shown in Fig. a. More exact measurements in the region of the giant resonance indicate the existence of two peaks at energies E_γ = 19.0 and 19.9 MeV. The cross section for emission of photoprotons was calculated according to the method of Penfold and Leiss for the yield curve measured every 1 MeV (Fig. b). The peak in the cross section at E_γ = 19.9 MeV is 30.6 mb, and the half-width of the resonance curve amounts in all to 2.7 MeV. The integrated cross section for emission of photoprotons with $\epsilon_p \geq 5$ MeV turned out to be 124 ± 10 MeV-mb, and taking into account the unrecorded part of the photoproton spectrum, 280 MeV-mb. The ratio of the photoproton yield from calcium and from copper at $E_{\gamma m}$ = 27 MeV is 0.93 ± 0.09. The ratio of the photoproton yields at angles θ = 90 and 135°, and also at 90 and 45°, measured as a function of energy $E_{\gamma m}$, is constant within the experimental error.

The experimental position of the peaks in the photoproton cross section is extremely close to that found by Miller et al. [2] in a study of the reaction $Ca^{40}(\gamma, n + \gamma, np)$ and agrees fairly well with the data of Tanner et al. [3] obtained for the reaction $K^{39}(p, \gamma)Ca^{40}$. According to shell model calculations by Brown et al. [4] for a potential with exchange forces, the entire dipole sum is exhausted by the two transitions at 19.2 and 20.6 MeV.



a) Yield of photoprotons of energy $\epsilon_p > 5$ MeV from Ca^{40} as a function of $E_{\gamma m}$. Upper inset: the same quantity, measured every 0.25 MeV for $E_{\gamma m}$ from 18 to 21.5 MeV. The arrows indicate the location of inflection points in the curve. Root-mean-square errors are shown. b) Cross section for emission of photoprotons of energy $\epsilon_p > 5$ MeV from Ca^{40}.

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