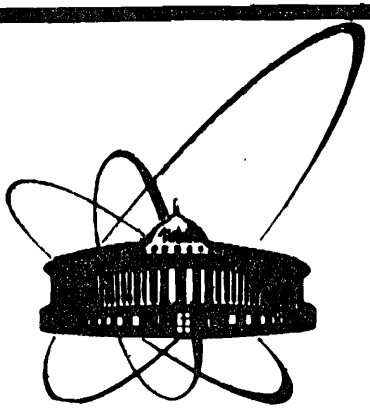

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ON THE INFLUENCE OF THE FINAL STATES STRUCTURE ON THE INTENSITY OF TWO-QUANTA CASCADES

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Two-quanta cascades found in the study of γ-decay of the compound state λ with Ge(Li) detectors by summation of the amplitudes of coinciding pulses populate the f-final levels of different structure. The total intensity $I_{\gamma\gamma}$ of the cascades being summed over intermediate levels can be considered as not fluctuating, because of a very large number of the cascades. The former determined, in the first place, by the ratio of partial widths to total radiation widths of decaying levels. Therefore, as follows from the statistical theory, the total intensity $I_{\gamma\gamma}$ must depend only on interrelation of spins and parities of the levels connected by the cascades and on the excitation energy of the final level.

The intensity of the cascades can be calculated, provided some model gives the total number of γ-transitions and their partial widths.

The difference between experimental $I^{E}_{\gamma\gamma}$ and calculated $I^{Th}_{\gamma\gamma}$ intensities may have an identical sign and change smoothly with the excitation energy of the final level. Then the models used in the calculation should be considered insufficient for the adequate description of γ-decay. But, if the ratio $I^{E}_{\gamma\gamma} / I^{Th}_{\gamma\gamma}$ changes irregularly for different final levels, then such difference should be attributed to the influence of the final level structure on partial widths of γ-transitions.

A search for the connection between the intensity of the cascades and the structure of their final levels in the $(n,2\gamma)$ reaction considered here has several advantages in comparison with the study of the analogous effect by hard primary γ-transitions:

a) the region of investigation is extended to about neutron binding energy;
b) secondary γ-transitions are in general a result of decay of the level with a simpler than compund state structure.

What is important, the dependence of the cascades on the structure of their final levels should regularly reveal itself in similar nuclei (even number of neutrons and protons, deformation, atomic weight, etc.) due to a large degree of averaging of $I^{E}_{\gamma\gamma}$:

Table

Compound nucleus $\mathcal{P}(J^\pi)$	Total energy of cascade (keV)	Final Level E_f	I^π	$K[Nn_z\Lambda]$	$I^E_{\gamma\gamma}$	$I^{Th}_{\gamma\gamma}$	$R_{\gamma\gamma}$
	5307	515	$1/2^-$		17,2(40)	8,5	2,0
^{175}Yb	5266	556	$3/2^-$	1/2 [510]	18,1(47)	7,9	2,3
$1/2^+$	5220	602	$5/2^-$		9,0(16)	3,8	2,4
	5183	639	$5/2^-$	5/2[512]	2,3(16)	3,5	0,7
	5010	811	$3/2^-$	3/2 [512]	11,5(59)	4,9	2,3
	4951	871	$5/2^-$		2,3(13)	2,2	1,0
	4902	920	$1/2^-$	1/2 [521]	6,3(37)	4,0	1,6
	4831	992	$3/2^-$		3,4(13)	3,5	1,0
	5725	375	$1/2^-$		15,5(16)	6,3	2,5
	5678	421	$3/2^-$	1/2 [510]	16,5(21)	6,0	2,7
^{179}Hf	5622	476	$5/2^-$		7,6(16)	3,6	2,1
$1/2^+$	5581	518	$5/2^-$	5/2[512]	4,0(8)	3,3	1,2
	5484	614	$1/2^-$		9,5(16)	4,8	2,0
	5419	679	$3/2^-$	1/2 [521]	3,8(8)	4,1	0,9
	5398	701	$5/2^-$		2,6(5)	2,1	1,2
	5379	721	$3/2^-$	3/2 [512]	3,1(7)	3,9	0,8
	5312	788	$5/2^-$		2,7(8)	1,8	1,5
	7691	80	2^+	0^+_1	4,6(4)	3,8	1,2
^{168}Er	7507	264	4^+	0^+_1	7,7(8)	6,9	1,1
3^+(32%)	7222	549	6^+	0^+_1	3,1(2)	1,4	2,2
4^+(67%)	6950	821	2^+	2^+_1	2,8(4)	1,6	1,8
	6875	896	3^+	2^+_1	5,4(9)	2,8	1,9
	6776	995	4^+	2^+_1	3,1(12)	2,9	1,1
	7626	0	0^+	0^+_1	0,5(2)	0,4	1,2
^{178}Hf	7533	93	2^+	0^+_1	7,5(5)	4,0	1,9
3^-(40%)	7320	306	4^+	0^+_1	6,5(4)	5,1	1,3
4^-(60%)	6452	1174	2^+	2^+_1	0,5(2)	1,0	0,5
	6366	1261	2^-	2^-			
	6358	1267	3^+	2^+_1	1,8(5)	3,2	0,6
	6350	1276	2^+	2^+_2			

Within this approach the intensities of the cascades were analysed in the ^{175}Yb, ^{179}Hf, ^{168}Er and ^{178}Hf nuclei studied for the present. They were compared with the intensities calculated with the earlier used models [1,2] under conditions that :

a) the partial widths of El-transitions are determined in the frame of the giant dipole resonance model, of Ml and E2 transitions -- within the Weisskopf model;
b) the level density was found within the Fermi-gas model that takes into account [3] the shell inhomogeneities in one particle spectrum with the help of the Strutinsky shell correction method;
c) below an excitation energy of 1.5 ÷ 2.0 MeV there was used in the calculation the experimentally obtained scheme of decay of the given nucleus.
d) the ratios of radiation strength functions of El, Ml and E2 transitions used in the calculation were found using the widths of hard primary γ-transitions of compound state decay [4] .

Experimental $I^E_{\gamma\gamma}$ and calculated $I^{Th}_{\gamma\gamma}$ intensities of some two-quanta cascades to the E_f level with parameters $I^\pi K^\pi$ are summarized in the table.

For the ^{168}Er and ^{178}Hf nuclei there is also given the probability $\mathcal{P}(J^\pi)$ of the J^π spin of the compound state excitation on thermal neutron capture.

The analysis of the data given in the Table brings one to the conclusion that:

a) though not predicted by the calculation there is observed in the experiment a regular enhancement of the cascades, to the rotational band levels of the one-quasiparticle state $1/2^-$ [510].
b) the ratio $R_{\gamma\gamma}$ of intensities of two-quanta cascades to two neighbouring levels with same $I^\pi = 5/2^-$, but different K^π (K=1/2 and 5/2) is 0.26± 0.3/0.2 for ^{175}Yb, and 0.53±0.15 for ^{179}Hf.
c) the average value of $R_{\gamma\gamma}$ for the cascades to the levels of the ground state rotational bands of ^{168}Er and ^{178}Hf are 1.15 (9) and 1.54 (7) and to the levels of the bands of one-phonon states (E_f > 800 keV) are 1.55 (21) and 0.55 (13), respectively.

This difference is out of the confidence level of the experiment. It should be attributed to a possible dependence of radiation widths of secondary γ-transitions on the final level structure.

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Бонева С.Т. и др. Е3-87-536

О влиянии структуры конечных состояний на интенсивность двухквантовых гамма-каскадов

Обнаружена зависимость интенсивности двухквантовых γ-каскадов от структуры их конечного уровня в компаунд-ядрах ^{175}Yb, ^{179}Hf и ^{168}Er, ^{178}Hf. Эксперимент выполнен с помощью метода суммирования амплитуд совпадающих импульсов двух Ge(Li)-детекторов. Зависимость интенсивности двухквантовых каскадов от структуры конечного уровня в ^{175}Yb и ^{179}Hf связывается с влиянием квантового числа K на парциальные ширины вторичных переходов каскадов, а в ^{168}Er и ^{178}Hf - со структурой конечных однофононных состояний каскадов.

Работа выполнена в Лаборатории нейтронной физики ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1987

Boneva S.T. et al. E3-87-536

On the Influence of the Final States Structure on the Intensity of Two-Quanta Cascades

The dependence of the intensity of two-quanta cascades on the structure of their final levels in the compound nuclei ^{175}Yb, ^{179}Hf and ^{168}Er, ^{178}Hf is observed.

The investigation has been performed at the Laboratory of Neutron Physics, JINR.

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