^{156}Gd'un Yapısındaki 1511 keV'luk seviyenin Kuantum Sayısı Hakkında

On The K-Quantum Number Of The 1511 keV Level In The Structure Of ^{156}Gd.

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^{156}Gd'un gamma bandında bulunan 1511 keV'luk enerji seviyesi, büyük M1 multipolüne sahip $4^+\gamma - 2^+_{gr}$, küçük fakat oldukça kesin M 3 multipolüne sahip $4^+\gamma - 6^+_{gr}$ ve $4^+\gamma - 2^+_{gr}$ geçişleri ile ilk hale dönmektedir. Bu ise 1511 keV seviyesinin sade $K\pi = 4^+$ statesi olamayacağı hakkındaki görüşlere yer verir. Esasen ölçülmüş olan multipole intensiteleri ile hesaplanan Alaga dallanması gösterir ki $K\pi = 2^+$ karışımı lüzumludur.

The 1511 keV level in the gamma band of ^{156}Gd ise deexcited by a $4^+\gamma - 4^+_{gr}$ transition which has a large M1 multipole, $4^+\gamma - 6^+_{gr}$ transition and a $4^+\gamma - 2^+_{gr}$ transition which have small but quite definite M 3 admixture. This leads to the argument that the 1511 keV level can not be a pure $K\pi = 4^+$ state. Infact the measured multipole intensities and the calculated Alaga braching rules indicate that $K\pi = 2^+$ mixing is essential.

On studying multipole mixing ratios of transition in ^{156}Gd [1] it was pointed out that the transitions from the 1511 keV $K\pi = 4^+$ level are interesting because they show a large M1 admixture in the 1222 keV, $4^+\gamma - 4^+_{gr}$ transition, and a quite definite, although small, M3 admixture in the 926 keV $9^+\gamma - 6^+_{gr}$ transition. Attempts to explain the anisotropy of the 1222 keV transition by allowing an M3 rather than M1 admixture cause the directional distribution and $\gamma - \gamma$ correlation measurements to be in marked disagreement. Consequently, it has been thought that the large M1 admixture should be correct. Furthermore, despite the smallness of the M3 admixture in the 926 keV transitiao the

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experimental results rule out the possibility that this transition is pure E2 radiation.

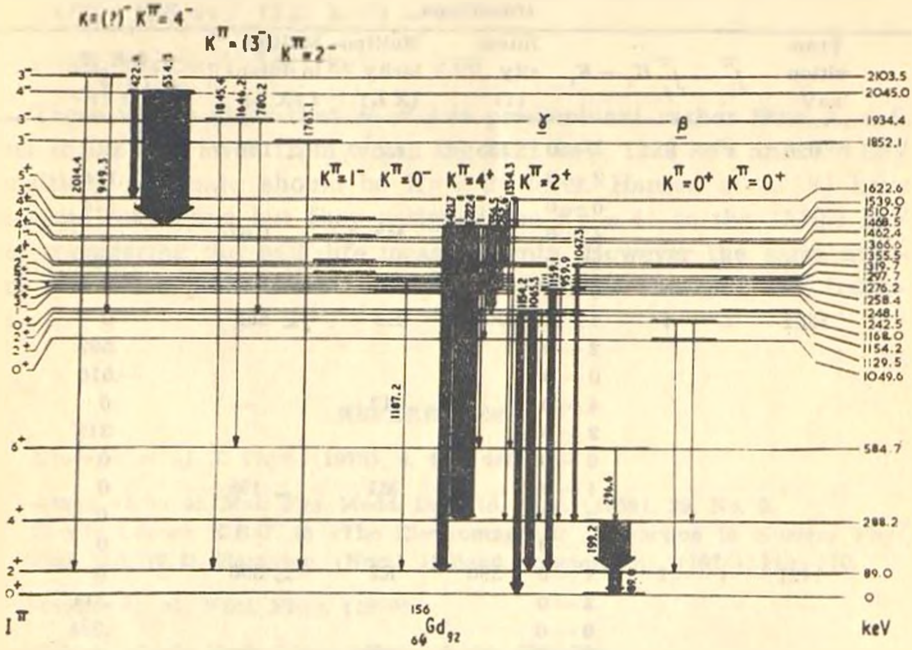

Fig. 1
A symplified version of the level structure of ^{156}Gd populated following the β^{+} and *EC* decay of ^{156}Tb ($T_{1}/_{2}$ = 5.4 *d*). Based on the work of Mc Millan et. al. [5].

Infact if one calculates the Alaga branching rule [2] for the 1222 keV and 926 keV transitions assuming M3 multipole

$$A(M\,3)=\frac{|<J_i=4\ \ L=3\ \ K_i=2\ K_f-K_i=-\,|J_f=4\ \ K_f=0>|^2\ 1222\ \text{keV}}{|<J_i=4\ \ L=3\ \ K_i=2\ K_f-K_i=-\,|J_f=6\ \ K_f=0>|^2\ 926\ \text{keV}\ 6}=0.46$$

which means the probability that the 926 keV transition can have M3 multipole is more than twice as much as that of 1222 keV ; and this is consistent with the *small* M3 mixing found in the 926 keV transition and no M3 mixing found in 1222 keV transition.

The Alaga branching ratio for 1222 keV and 1421 keV transitions assuming M3 multipole

$$A(M3)=\frac{|<J_i=4\ K_i=2\ K_f-K_i=-2\,|\,J_f=4\ K_f=0>|^2\ 1222\ \text{keV}}{|<J_i=4\ L=3\ K_i=2\ K_f-K_i=-2\,|\,J_f=2\ K_f=0>|^2\ 1421\ \text{keV}}=0.91$$

TABLE 1
The Clebsh - Gordon Coefficients of 926 keV, 1222 keV, and 1421 keV transitions.

Transition keV	$J_i^\pi - J_f^\pi$	$K_i - K_f$	Intensity (I)	Multipolarity (XL)	Multipole Intensity $I(XL)$	$\langle J_i L K_i K_f - K_i \mid J_f K_f \rangle$
926	$4^- - 6^-$	4 — 0	135	E2	~ 134	0
		2 — 0				.174
		0 — 0				.674
		4 — 0		M3	~ 0.67	
		2 — 0				.460
		0 — 0				0
1222	$4^- - 4^+$	4 — 0	1000	E2	~ 802	0
		2 — 0				.592
		0 — 0				—.510
		4 — 0		M3	—	0
		2 — 0				.312
		0 — 0				0
		4 — 0		M1	~ 198	0
		2 — 0				0
		0 — 0				0
1421	$4^+ - 2^-$	4 — 0	390	E2	~ 390	0
		2 — 0				.344
		0 — 0				.534
		4 — 0		M3	~ .078	0
		2 — 0				.326
		0 — 0				0

* Taken from Kenealy et al. [4]

is also consistent with no M3 multipole found in 1222 keV transition and *very small* M3 multipole found in the 1421 keV transition. It can be seen from Table - 1. that the Clebsh - Gordon coefficients for these three transitions are zero when $K_i = 4$ and $K_f = 0$ for M3 multipolarity. The Alaga branching ratios above were calculated for $K_i = 2$; therefore, the observed M3 multipolarity in the 926 keV and the 1421 keV transitions require that the initial state must have $K_i = 2$.

Using the values in Table - 1. the following branching ratios are found for $E2$ multipolarity :

A ($E2$. 926 keV 1222 keV, $K_i = 2$) = 0.09
A ($E2$, 926 keV/1222 keV, $K_i = 0$) = 1.74
A ($E2$, 1222 keV/1421 keV, $K_i = 2$) = 2.98
A ($E2$, 1222 keV 1421 keV, $K_i = 0$) = 0.91

The intensity ratios for $E2$ multipolarity are :

I ($E2$, 926 keV 1222 keV) $\approx$ 0.17

I ($E2$, 1222 keV 1421 keV) $\approx$ 2.06

These values show that $K_i = 2$ is predominant rather than $K_i = 0$. Thus 1510.7 keV level, from which the 1421 keV, 1222 keV and 926 keV transitions originate should be $K\pi = 2^+$ level. Hansen et al [3] have the same conclusion but they assigned the $K\pi = 4^+$ to the 1510.7 keV level considering the half life measurements. However the same argument can not explain the M1 component found in the 1222 keV transition.

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