объединенный
институт
ядерных
исследований
дубна

E6-82-38

B.A.Alikov, I.Kholbaev, H.I.Lizurej, E.G.Tsoy, J.Wawryszczuk

LEVEL STRUCTURE OF THE 89-NEUTRON NUCLEUS ^{153}Gd

1. Levels and Gamma-Transitions in ^{153}Gd Excited in the Decay of ^{153}Tb

Submitted to "Nuclear Physics A"

1982

1. Introduction

Among the numerous papers devoted to experimental studies of the properties of the ^{153}Gd nucleus, the works of Tuurnala et al.[1] and Alexandrov et al.[2] occupy a significant position. As a result of precise γ-ray and conversion electron spectrum measurements in ref.[2], over 300 γ-transitions were detected and assigned to the ^{153}Gd nucleus. For many of them the relative intensities and multipolarities were determined. In ref.[1], in addition to single spectra, two-dimensional γ-γ and e^--γ coincidences were studied. The authors of both papers construct the schemes of ^{153}Gd excited states: in ref.[1] a full decay scheme of ^{153}Tb is given; and in ref. [2], a table of γ-transition and their positions in the scheme only. Both schemes agree fairly well in the region of low and high excitations. In the energy range of 500-800 keV, a number of levels was introduced by Alexandrov et al.the presence of which was not ascertained either in γ-γ or e^--γ coincidence measurements of Tuurnala et al.[1].

Recent investigations [3] of the ^{153}Gd states indicate the erroneous identification, in both papers under discussion, of the above-mentioned states and some other low-energy states.

So far, no final solution has been found for the problem of the main characteristics of even reliably established states, namely:

i) the spins have been determined unambiguously only for strongly populated levels[4-6];

ii) lifetime data are inaccurate and contradictory[7-9];

iii) the magnetic moment has been determined (ref.[10]) for the 129,2 keV state only.

Among theoretical studies of the properties of the ^{153}Gd nucleus, researches[3,6,11-13] performed within the framework of the particle-rotor model appear to be most successful. However, these works are at variance in the interpretation of the ground state. Some of them[12,3] consider it to be a single-particle deformed state with the $3/2^-$ [521] predominant component whereas others[14,6] interpret it as the $3/2^-$ [532] state.

This suggests that it is necessary to re-examine critically not only the experimental data on the decay of ^{153}Tb, but also their interpretation. An attempt of such a re-examination was undertaken by the authors.

The first part of our results is presented below. On the basis of the presently available data and the results of our new measurements of e^{-}-γ coincidences, γ-γ angular correlations, delayed e^{-}-γ and e^{-}-e^{-} coincidences, and perturbed γ-γ angular correlations, for the 102-110 and 83-129 keV cascades, the following is proposed:

i) a more ample scheme of ^{153}Gd excited states;
ii) spin values for the majority of the identified levels in ^{153}Gd;
iii) half-life values for the levels at 41.5, 93.4, 109.8, 129.2, 183.5, 212.0 and 216.1 keV;
iv) the values of magnetic moments for the 129.2 and 109.8 keV states;
v) absolute values of the reduced probabilities of some γ-transitions.

In the second part of our work, to appear at a later data, energy levels, spins, magnetic moments, and γ-transition probabilities are compared with those calculated using the nonadiabatic particle-plus-rotor model with the deformed Saxon-Woods potential/15/. The equilibrium deformation parameters ε and ε_4, calculated by the Strutinsky shell correction method/16,17/ are employed. In the conclusion, the applicability of this model to the description of transitional nuclei with N=89 is discussed.

2. Experimental Technique and Results

2.1. Source preparation

The radioactive isotope ^{153}Tb $T_{1/2}$=2.3 d was produced in spallation reactions on a Ta target exposed to a 660 MeV proton beam from the JINR Synchrocyclotron. After irradiation, the elemental separation of the target was done chromatographically, and then the element Tb was mass separated using an electromagnetic mass-separator. To measure the conversion electron spectra, the ^{153}Tb ions accelerated to an energy of 25 keV were implanted into an Al foil 5÷15 um thick. Liquid sources for γ-γ angular correlations were obtained by solving the active Al foil in an aqueous solution of HCl. For the measurements of perturbed angular correlations, the ^{153}Tb ions were accelerated additionally to an energy of 70 keV in the collector chamber of the mass separator and implanted to 12 um Fe foils.

2.2. e^{-}-γ coincidences

Measurements of γ-spectra in the decay of ^{153}Tb were carried out in coincidence with the most intense conversion electron lines: L41.5, L51.8, K109.8, K129+L88 and K195+L152 keV, belonging to transitions which de-excite the low-lying states in ^{153}Gd. Gamma-rays were

detected by a 40 cm^3 Ge(Li) detector of energy resolution ΔE_γ=2.9 keV at E_γ = 1.17 MeV. The registration of conversion electrons was carried out with an "ORANGE"-type magnetic β-spectrometer/18/. The resolution of the spectrometer was equal to 1.1% at 20% transmission. The selection of coincidences was made using the fast-slow principle with a time resolution $2\tau_0 \approx 40$ ns.

Examples of the coincidence spectra and a single γ-spectrum of ^{153}Tb are presented in figs. 1a and 1b. In the analysis of each spectrum, the energy scale and the efficiency of the coincidence circuit were corrected using the intensity and energy of the most intense γ-transitions in ^{153}Gd taken from ref./2/. A complete list of the γ-transitions detected in coincidence with the particular conversion electron groups indicated above is given in table 1. The transitions that constitute direct double cascades were established by comparing the relative intensities (areas) of the corresponding photopeaks in the coincidence spectra and in the single spectrum.

The statistical accuracy of the present measurements considerably exceeds the accuracy of the available data on the e^{-}-γ coincidences/1/ in the decay of ^{153}Tb. In the energy range of 60 to 1200 keV, we succeeded in identifying the majority of coincident γ-transitions, whose intensity exceeded 0.7÷1.5 units (the intensity of the 212.0 keV transition was assumed as 1000 units). The measurements of coincidences with the 41.5 keV transition were carried out for the first time.

2.3. Half-lives

The lifetimes of the ^{153}Gd excited states at 41.5, 109.8 and 129.2 keV were measured in papers/7-9/. Reliable and well consistent results were obtained only for the 41.5 keV state/7,8/. The value of $T_{1/2}$=0.35(8) ns, attributed to the 109.8 keV state seems to be insufficiently reliable since it is close to the limit of the time resolution of the spectrometer used by the authors of paper/9/. In the same paper, $T_{1/2}$=1.2 ns is proposed for the 129.2 keV state, and this value is almost twice as small as the values obtained in earlier works/7,8/.

The results of our investigations of the half-lives of all the three mentioned levels and additional levels at 93.4, 183.5, 212.0, 216.1 and 303.5 keV are presented below. The measurements were carried out using the method of delayed e^{-}-γ and e^{-}-e^{-} coincidences and conventional time spectrometers/19/, composed of Gerholm β-spectrometers and a scintillation detector with a plastic scintillator NEIII and photomultipleir XP 1021. The delayed coincidence curves were analysed with a computer using a "positronfit" code/20/, which took into account the time resolution of the spectrometer.

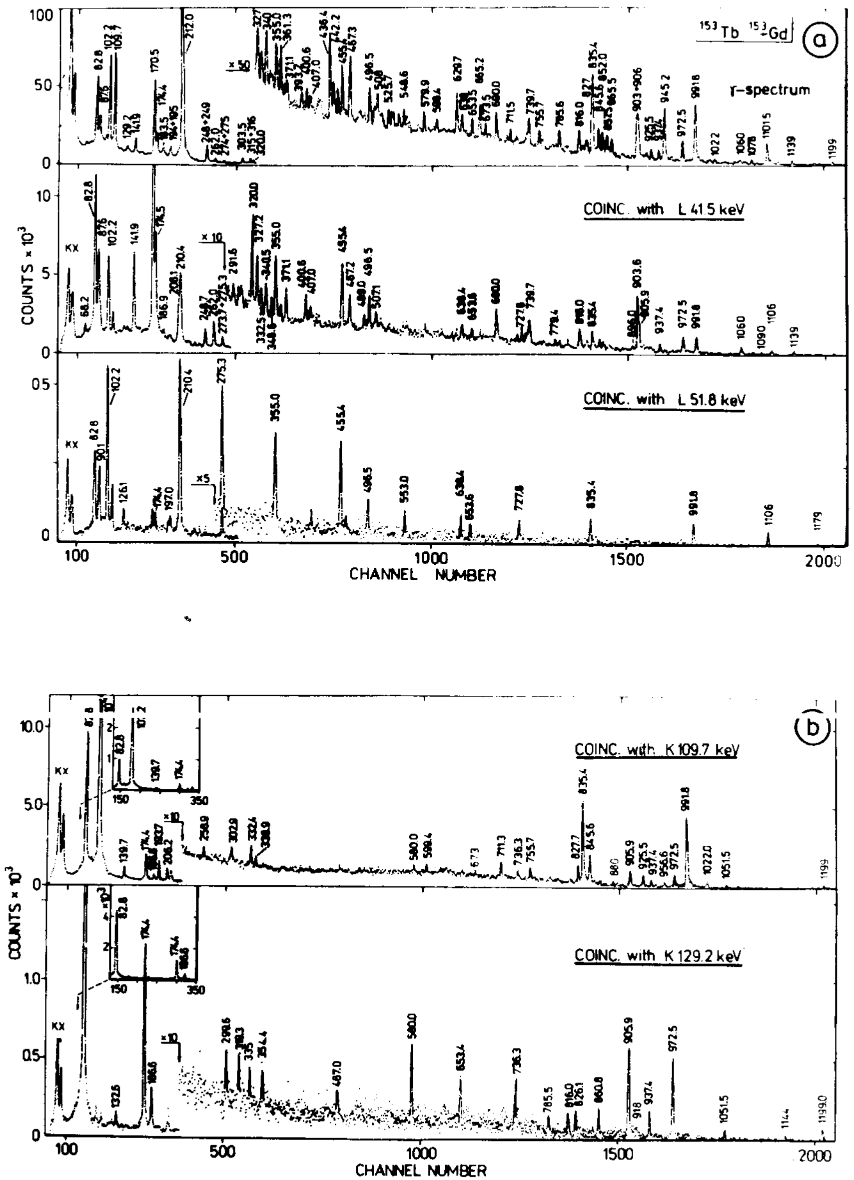

Fig. 1a,b. Single γ-ray spectrum of ^{153}Tb and examples of the $e^- - \gamma$ coincidence spectra for the L41.5, K93.3+L51.8(a), K109.7 and K129.2+L87.6(b) - electron gates.

TSBLF 1.

Observed $e^- - \gamma$ coincidences in the decay of ^{153}Tb

Gate (ICE-line)	Energy of coincident γ -rays in keV [a)]
L41.5	68.2, (82.8), 87.6, (102.2), (126.1), (132.5), 141.9, (152.5), 170.5, 174.6, (178.2), (186.9),(193.8), 208.1, (210.4), (233), (239), 248.7, 262.0,(268), 274+275, (283.5), (292), (299.6), (303), (314.5), 320.0, 327.2, (332.5), (340.4), 348.6, (355.0), (362.7), 371.1, 400.6, 407, (410), (417), (421), (455.4), 467.2, 488.9, (496.5), 507.0, (514),(553), (580), (622), (630), (638.2), (653.5), (665.2), (678), 690.0, (721.5), (728), 733, (736), (740), (755), (762), (779.4), (785.6), (799), 816.0, (827), (835.4), (845.6), (852), (861), 896, 903.6, (906), (925.5), 937.4, (965), (972.5), 973.5, (991.8), (1002), (1052), 1060, 1076.5, 1090, (1106), (1111),1139, (1180), (1199), (1218).
L51.8 +k93.4	(82.8), 90.1, (102.2), 122.8, (126.1), (132.5), (174.5), (193.8), 197.0, 210.4, (233), (239), 275.1, 349, 355.0, 398, (410), 455.4, (496.6), (553), 638.8, (653), 727.8, 755, (835.4), (845.5), (991.8), 1106, 1179, (1200).
K109.8	(82.8), 102.2, 139.8, (174.4), (186.8), 193.7, 206.2, (239), 259, 302.9, 332.4, 339, (392), 420.8, (467), (580), 599.4, 622, (653), 672, 711.3, (736.3), 755.8, (816), 827.6, 835.4, 845.6, (861), 880.6, 905.9, 925.5, (937.4), 956.6, (972.5), 991.8, 1022, (1051), 1071, (1199), 1218.
K129.2 +L 87.6 +L 88.3	82.8, 132.5, 174.4, 186.1+186.9, 259, 299.6, 319.2, (335), 354.4, (393), (467), (496), (505), (526), 579.9, (630), 653.6, (718), 736.3, (785.5), 816.0, 826.1, 860.9, 905.9, 918, 937.4, 972.5, 1051.5, 1144, 1199.
K195.2	(109.8), 151.8, 195.2, 248, 258.4, 267, 278.5, 340.5, 346.5, 419, 502.8, 557.3, 646.8, 665, 745, 890.

a) γ-rays which do not form direct cascades with the gated electrons are given in brackets.

The conditions of particular measurements, selected radiations, the $T_{1/2}$ values of the levels under study and the final averaged results are listed in table 2. The conversion electron spectrum and some delayed coincidence curves are presented in fig.2.

TABLE 2

Selection of gates and results of the half-live measurements for low-lying levels in ^{153}Gd

Gate (keV) start	stop	Level (keV)	$T_{1/2}$ (ns)	$T_{1/2}$ (ns) average
$\gamma(\geq 120)$	L41.5+KLL	41.5	4.02 ± 0.10	4.05-0.09
$\gamma(\geq 250)$	L51.8+K93.4+ MN41.5	93.4 41.5	0.45 ± 0.08 4.18 ± 0.18	0.45 ± 0.08
$\gamma(\geq 250)$	K129+L87.6+ L88.3	129.2 183.5	2.29 ± 0.22 0.76 ± 0.12	2.39 ± 0.14 0.76 ± 0.12
L82.8	K129+L87.6+ L88.3	129.2	2.48 ± 0.29	
$\gamma(\geq 80)$	K109.8	109.8 129.2	0.32 2.6 ± 0.4	0.243 ± 0.014 [a)]
$\gamma(\geq 600)$	L109.8	109.8 129.2	0.248 ± 0.024 2.3 ± 0.5	0.244 ± 0.042
K102.3	K109.8	109.8	0.239 ± 0.018	
K102.3	L109.8	109.8	0.228 ± 0.038	
$\gamma(\geq 120)$	K174	216.1 (303.5)	0.21 0.21	0.21 0.21
KX	K212	212.0	0.18	0.18 [a)]

a) From the center of gravity shift. The promt curve was determined with the help of a ^{60}Co source.

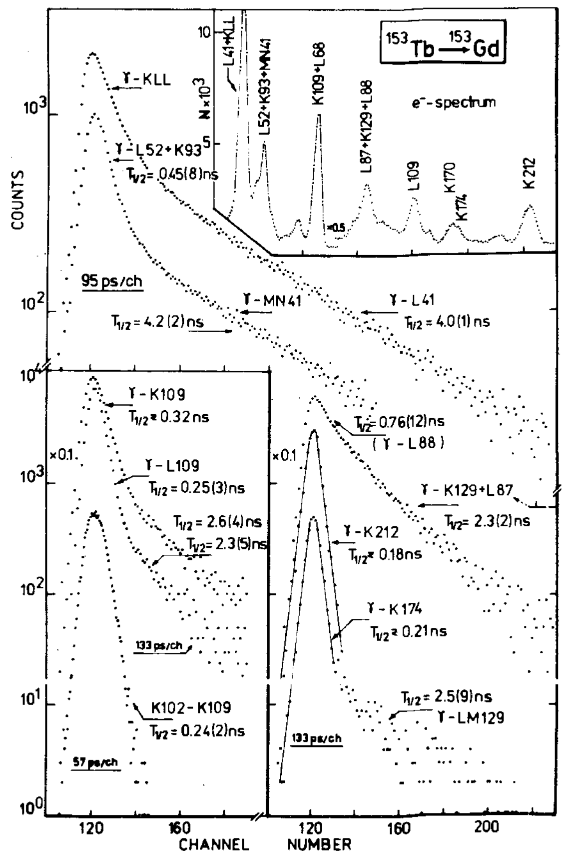

Fig. 2. e⁻-γ and e⁻-e⁻ delayed coincidence spectra for selected e⁻-lines, and part of single conversion-electron spectrum of ^{153}Tb obtained with β-spectrometer of the Gerholm-type.

The $T_{1/2}$ values obtained for the 41.5 keV and 129.2 keV states are in good agreement with the results of papers /7,8/. In the case of the 109.8 keV level, thorough measurements were done using the e⁻-γ and e⁻-e⁻ coincidence methods. The final half-life $T_{1/2}=0.243 \pm 0.014$ ns turned out to be smaller than that in ref./9/.

The spectrum of delayed γ-K129+L87+K88 keV coincidences, in addition to the main component corresponding to the half-life of the 129.2 keV ($T_{1/2}$=2.39 ns) level, contains a weak component with $T_{1/2}$ = =0.76 (12) ns. Its intensity increases inconsiderably with the decreasing energy of the γ-rays selected. This component should be attributed to the coincidences between γ-rays and L88 keV electrons. Since, as will be shown below, the 88.3 keV transition depopulates the 183.5 keV level, the observed half-life should characterise this particular level.

To determine the half-life of the 93.4 keV level the time distributions of the coincidences between γ-rays ($E_\gamma \geq 200$ keV) and L51.8+K93.4 keV electrons were measured. In the electron spectra obtained using β-spectrometers, the L51.8 and K93.4 keV lines were overlapped by more intensive MN41.5 keV lines. This resulted in the manifestation

$\omega_L\tau = +0.065^{+0.013}_{-0.007}$, $g = +0.18^{+0.06}_{-0.04}$ for 109.8 keV state,
and
$\omega_L\tau = +0.8^{+0.5}_{-0.2}$, $g = +0.23^{+0.17}_{-0.07}$ for 129.2 keV state.

A more accurate value of the g-factor of the 129.2 keV state $g=0.25\pm0.05$ was obtained by Badica et al.[10] using the IPAC method in an external magnetic field. The g-factor of the 109.8 keV state was determined by us for the first time. The preliminary results of these measurements and the method of calculating g-factors are given in report[22].

3. Discussion of Experimental Results

3.1. Decay scheme

A new, more complete decay scheme of ^{153}Tb has been constructed (fig. 3a,b,c) on the basis of the above presented e^--γ coincidence measurements and the γ-γ coincidence data obtained in our earlier investigations[5] of the γ-γ angular correlations in ^{153}Gd.

It should be noted that the most valuable information required for establishing this scheme was provided by the as yet unmeasured coincidences with the 41.5 keV transition. Out of a total of 50 levels introduced to the scheme, 30 levels could be identified by analysing this coincidence spectrum. The γ-transition energies indicated in the proposed scheme, as well as the relative intensities and multipolarities, are mainly those taken from refs.[1]. The intensities of the components of combined transitions were found from the coincidence spectra. In determining the log ft value Q_{EC}=1.58 MeV (ref.[23]) was assumed.

In comparison with the decay scheme of ^{153}Tb given in ref.[2]

(i) we introduced new levels with energies of 95.2, 216.1, 290.2, 412.8, 636.4, 720.7, 731.5, 847.6, 990.1, 1015.1, 118,5, and 1199.2 keV;

(ii) the 195.1, 346.7, 727.6, 1024.7, 1043.6 and 1408.4 keV levels were excluded;

(iii) a new location of a number of γ-transitions was proposed.

The direct coincidence of the 174.4 keV γ-rays with the L-conversion electrons of the 41.5 keV transition indicate the existence of the 216.1 keV level. In refs.[1,2] the 174.4 keV transition was suggested to be located between the 303.5 and 129.2 keV states only. In our measurements the intensity of the 174.4 keV γ-lines in the γ-K129+L87 and K109.8 keV coincidence spectra was found to be smaller than that in the single γ-spectrum by a factor of two. For example, the intensity ratio of the 174 keV to 186 keV γ-lines in the

single γ-spectrum is equal to 8.9 ± 0.5, it is only 4.4 ± 0.2 in the γ-K129+L87 and γ-K109.8 coincidence spectra whereas it increases to 14 ± 2 in the coincidences with L41.5 keV electrons. To explain these facts it was necessary to assume that the 174.4 keV transition is in fact a double one, whose components depopulate the 303.5 keV level ($I_\gamma = 26\pm4$) and the newly introduced level 216.1 keV ($I_\gamma = 24\pm5$). Their multipolarities estimated on the basis of the α_K-conversion coefficient for the complex transitions at 174.4 keV (ref.[2]) correspond to E1 and M1+(E2), respectively.

In the coincidence spectrum with the 174.4 keV γ-ray there are the 87.6, 129.2 and 109.7 keV γ-lines, which confirm the existence of the 174.4 keV transition between the 303.5 and 129.2 keV states. Other γ-lines, in particular the 332.7, 420.6, 721.4, 739.5 and 799.0 keV ones with relative intensities ranging from 2 to 10 units were observed. They also appeared without attenuation in coincidence with the L41.5 keV electrons, whereas in the γ-γ 303.5 keV coincidence spectrum no γ-line with intensity $I_\gamma > 1.5$ unit was observed. This indicates that γ-transitions with energies $E_\gamma > 129.2$ keV, observed in direct coincidences with complex transition at 174.4 keV (and with the 41.5 keV transition), should go to the 216.1 keV level (since they constitute direct cascades with the 174.4 keV transition which couples the 216.1 and 41.5 keV levels). In ref.[1] these transitions were directed to the 303.5 keV level. Bearing all this in mind, it is necessary to assume the existence of a new level with an energy of 1015.1 keV on the basis of the 799-174.4 keV cascade and exclude the 1024.7 and 1043.6 keV levels introduced in ref.[1], to explain the coincidences of the 721.4 and 739.8 keV transitions with that at 174.4 keV. In addition, we attribute to the depopulation of the 1015.1 keV level the 1015.1, 765.1, 698.6 and 566.2 keV γ-transitions that so far have not been placed in the decay scheme of ^{153}Tb.

The levels at 95.2 keV ($I^\pi = 9/2^+$, $T_{1/2} \approx 3.5$ µs) and 290.2 keV were observed in nuclear reaction experiments[3,13,25]. The presence of 197.0 and 248.7 keV γ-rays in coincidence with the 51.8 and 41.5 keV L-electrons, γ 151.8 with K195 keV coincidence and the coincidences of the K151.8 keV electrons with the 195.2, 197 and 248 keV γ-rays provide evidence for the excitation of these levels in the decay of ^{153}Tb ($I^\pi = 5/2^+$). These coincidences indicate also that the 195.2 keV transition couples the 290.2 keV state with that at 95.2 keV. Introducing the 290.2 and 95.2 keV levels into the decay scheme of ^{153}Tb we had to eliminate from it the 195.2 and 346.7 keV levels, introduced in ref.[1] according to the coincidence of 195.2 KeV with 151.8 KeV γ-rays, as well as the 88.3 keV level proposed in ref.[2] (the 88.3 keV transition is located between the 183.5 and 95.2 keV states).

The 412.8 keV level is introduced on the basis of the direct coincidences between 371.1 keV γ-rays and L41.5 keV electrons. Additional evidence for the existence of this level is provided by weak coincidences between 302.9 and K109.8 keV lines as well as 229.5 and 183 keV γ-lines. In ref./1/ the 371.1 keV transition is placed between the 821.1 and 448.6 keV states erroneously.

The levels at 636.4 and 731.5 keV have been identified for the first time by the authors of the paper/2/, according to the sums of γ-ray energies in the decay of ^{153}Tb. Our coincidence measurements confirm the presence of both levels and show that the 346.3 keV γ-transition depopulates the level at 636.4 keV (the 346.3 keV γ-ray coincides with the K195 keV line) but not the 346.7 and 541.3 keV levels that were suggested in papers/1,2/. The 346.7 and 541.3 keV levels are non-existent according to our data.

The analysis of the coincidence spectra for the K195, γ174 and γ249 keV lines indicated the existence in ^{153}Gd of direct cascades 504.6-174.4, 471.2-249.5, 278.5-151.8, 557.3-192.2 and 598.1-249.5 keV, according to which it was necessary to introduce new levels with energies of 720.7 keV (for the first three cascades) and 847.6 keV, in the case of the above location of the transitions at 151.8, 195.2 and 174.4 keV.

The 990.1 keV level is introduced to explain the observed 860.9-K129+L87 and 880.6 - K109.8 keV coincidences. In ref./2/ the 860.9 and 880.6 keV transitions are not located in the decay scheme. The authors of paper/1/ have not displayed the 880.6 keV transition, while the transition at 860.9 keV is located, according to the energy balance, between the 1043.6 and 183.5 keV states erroneously.

The coincidence of the 1076.6 with the L41 keV and 869.0 with 249.5 keV lines indicate the existence of the 1118.5 keV level. The energy balance also allows the possibility of depopulating this level by the 1118.5, 682.1 and 570.2 keV transitions.

The presence of the 1106 keV line in the spectra of the γ-L51+K93 keV and γ-L41.5 keV coincidences gives us the ground for introducing a new 1199.3 keV level. Weak transitions at 750.2, 776.8 and 1157.2 keV, so far unlocated in the decay scheme of ^{153}Tb, can also be attributed to the decay of this level. In ref./1/, on the basis of the 1106 keV transition directed to the 303.5 keV level and the 1106 keV transition, the 1408.4 keV level is introduced. Our data and the conclusion of the authors of refs./34,24/ that the 1408.1 keV line in the γ-ray spectrum of ^{153}Tb obtained in ref./1/ does not belong to the nucleus ^{153}Gd eliminate this state.

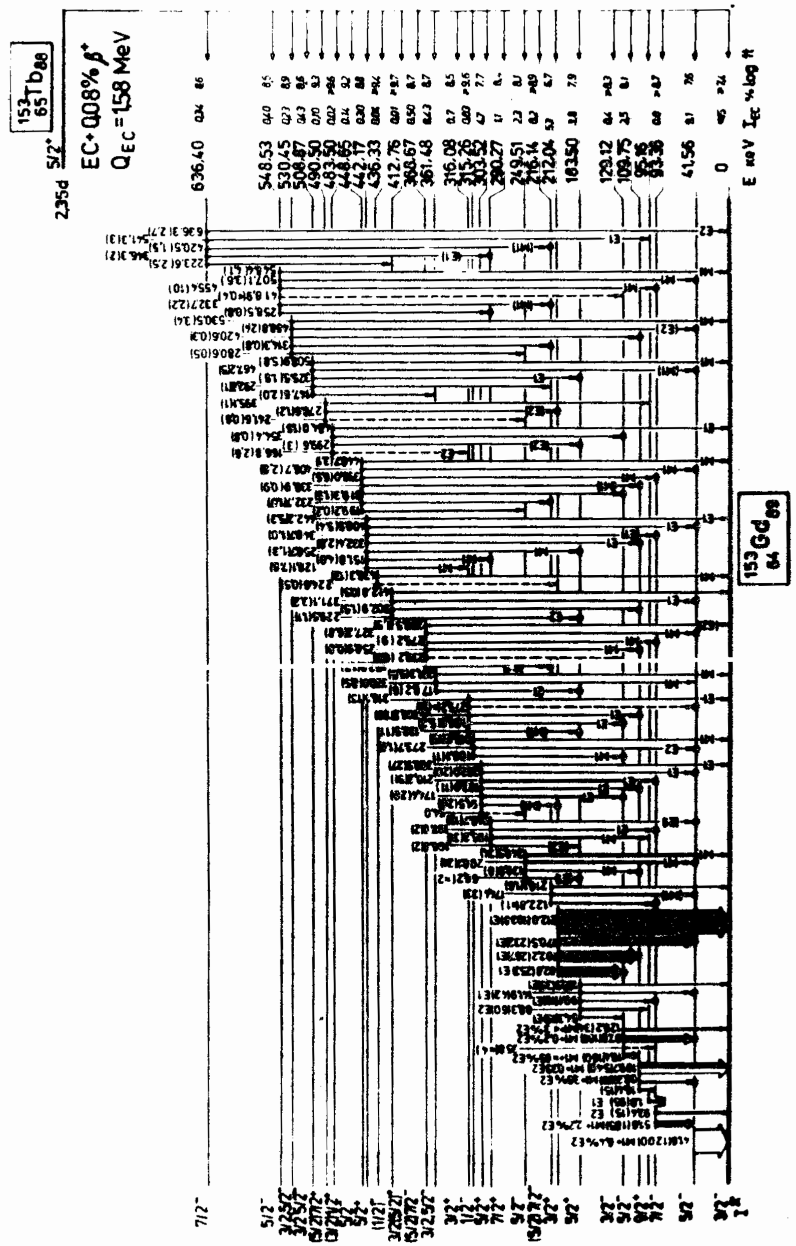

Fig.3a

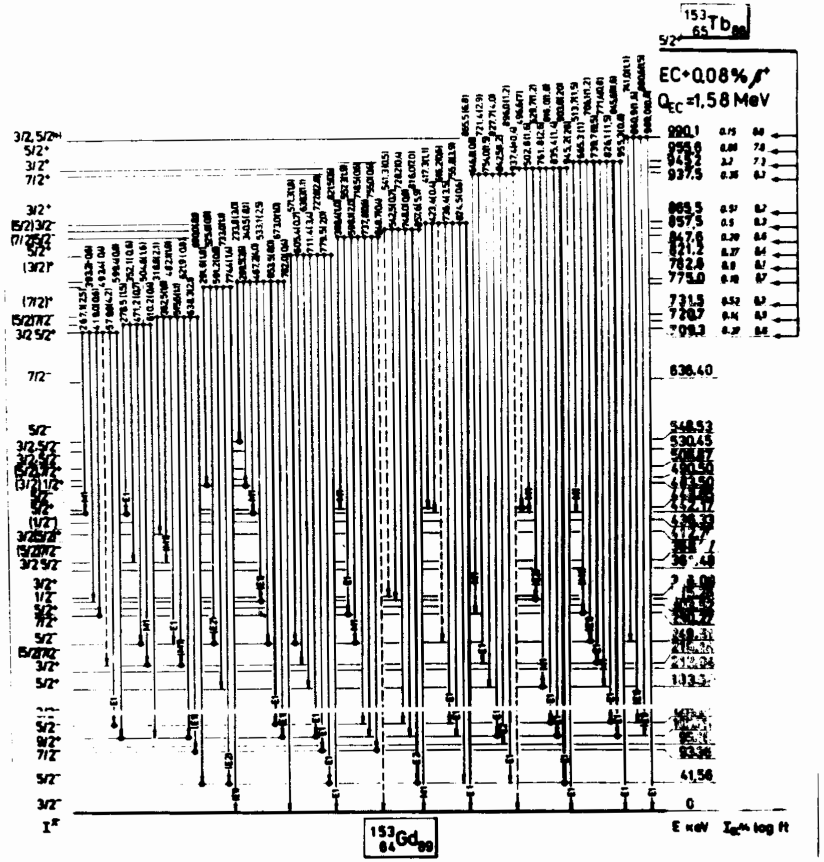

Fig. 3b

Having established the erroneous location in ref./1,2/ of the 197.0, 727.8 and 598.1 keV transitions (based on the γ-K93+L52 and γ-γ 249 keV coincidence spectra) we have to exclude the 727.8 keV level from the list of the excited states of ^{153}Gd.

The authors of paper/2/ proposed to introduce into the decay scheme of ^{153}Tb weakly populated excited states of ^{153}Gd with energies 420.6, 615.6, 618.0, 698.8, 1070.5 and 1107.7 keV, and later (ref./24/) the 593.8, 925.5, 1240.6, 1313.7 and 1392.0 keV states, in addition to the 88.3, 541.3, 636.0 and 731.5 keV states mentioned above, according to the energy sums of the γ-transitions. Analysing our results of the γ-γ and e⁻-γ coincidence measurements and those presented in ref./1/ we do not find unambiguous evidence which could confirm the existence of these levels, except for the levels at

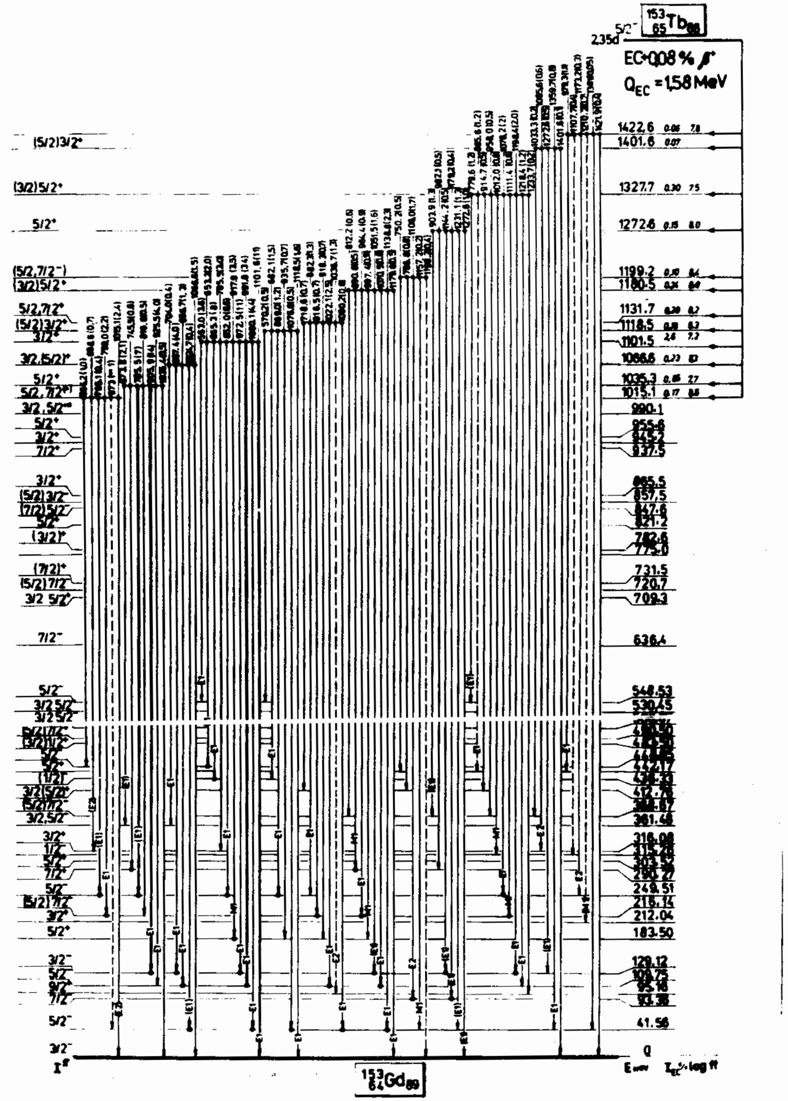

Fig. 3a,b,c. Proposed level scheme of ^{153}Gd from the decay ^{153}Tb: (a)-up to 640 keV, (b)-from 640 to 1000 keV and (c)-from 1000 to 1430 keV. Dots at the end of transition arrows indicate observed coincidences. Energy, total intensity in parentheses and multipolarity of transitions were established by data of papers /1,2,35/ and results of the present investigations. All the spins and parity assignments are based merely on our data (see table 4).

731.5 and 636.4 keV. We suggest to locate the majority of the most intense transitions (e.g.,420.6, 327.2, 541.3, 346.3, 291.6, 299.6, 488.8, 368.5, 1070.5, 982.1, 1111.4, 1199.1 keV and others) which in ref./2/ determined the existence of the discussed levels, between other states which have reliably been established, fig. 3a,b,c.

In nuclear reactions, many high-spin states of ^{153}Gd, which have not been observed in the decay of ^{153}Tb, get excited/25,13/, among them the isomeric state $11/2^-$ ($T_{1/2} \approx 76\ \mu s$) with an energy of 171 keV and the state $13/2^+$ at 134.7 keV.

3.2. Spins and parities of excited states

The results of our measurements of the anisotropy of the γ 109.8 keV cascades, presented in table 3, permit spin assignments for the states at 821.2, 865.5, 937.5, 945.2, 955.4, 1035.3, 1101.5, and 1131.7 keV. According to the known multipolarities of the γ-transitions (refs./1,2/) that depopulate these states, and the spin and parity data for the lowest-lying states/5/ it is necessary to assume the identical positive parity for all of them and the possible values of spins 3/2 or 5/2, while for the states at 937.5 and 1131.7 keV, also a spin value of 7/2 is allowed. The first γ-transitions in the cascades under study should be of E1 multipolarity, the spins and parities of the 109.8 and 249.5 keV levels are $5/2^-$, and that of the 129.2 keV level is $3/2^-$ (ref./5/). This conclusion follows also from the experimental values of the α_K -conversion coefficients measured for some of these transitions in refs./1,2,21/.

The expected values of the A_{22} coefficients of the function of the γ-γ angular correlation of double cascades $I^+(E1)\ 5/2^-(109.8)3/2$ depending on spin, are the following

$(A_2\ (109.8) = 0.45 \pm 0.02$ – according to ref./5/):

$$+0.169 \pm 0.007, \quad \text{if } I = 3/2$$
$$-0.193 \pm 0.008, \quad \text{if } I = 5/2$$
$$\text{and} \quad +0.061 \pm 0.003, \quad \text{if } I = 7/2$$

Comparing these values with experimental ones (table 3) it is seen that the levels at 821.2, 955.4 and 1035.3 keV should be assigned spin I = 5/2, the 865.5, 975.2 and 1101.5 keV levels – I = 3/2 and the 1131.7 keV level – I = 7/2. In fact, the coefficient $A_2 = +0.090 \pm 0.057$ of the 785.8-109.8 keV cascade allows for the 865.5 keV level spin 7/2, which we exclude bearing in mind the intense E1 transition at 865.5 keV coupled to this level.

Similarly, spin 7/2 is assigned to the 937.5 keV level. On the basis of the obtained value of the A_{22} coefficient for the 827.7-109.7

TABLE 4

Spin and parity of the levels observed in ^{153}Gd from the decay of ^{153}Tb

Level energy (keV)	Our date	Tuurnala et.al./4/	Warner et.al./6/	Reaction data /25,3/	Adopted values
1	2	3	4	5	6
0	$3/2^-$ b)	$3/2^-$	$3/2^-$	$3/2^-$	$3/2^-$
41.56	$5/2^-$ c)	$5/2^-$	$5/2^-$	$5/2^-$	$5/2^-$
93.36	$7/2^-$	$7/2^-$	$7/2^-$	$7/2^-$	$7/2^-$
95.16	$(9/2^+)$			$9/2^+$	$9/2^+$
109.75	$5/2^-$ c)	$3/2,5/2^-$	$5/2^-$	$5/2^-$	$5/2^-$
129.18	$3/2^-$ c)	$3/2,5/2^-$	$3/2^-$	$3/2^-$	$3/2^-$
183.50	$5/2^+$	$5/2^+$	$5/2^+$	$5/2^+$	$5/2^+$
212.04	$3/2^+$ c)	$3/2^+$	$3/2^+$	$3/2^+$	$3/2^+$
216.14 a)	5/2,7/2				$7/2^-$ d)
249.51	$5/2^-$	$3/2,5/2^-$	$5/2^-$	$5/2^-$	$5/2^-$
290.27	$7/2^+$			$7/2^+$	$7/2^+$
303.52	$5/2^+$ c)	$5/2^+$	$5/2^+$	$(5/2^+)$	$5/2^+$
315.26	$1/2^-$	$3/2^-$	$1/2,3/2^-$		$1/2^-$
316.08	$3/2^+$ c)	$3/2,5/2^+$	$5/2^+$ d)		$3/2^+$
361.48	$3/2,5/2^-$	$3/2^-$	$3/2^-$	$(3/2^-)$	$3/2^-$
368.67	$(5/2),7/2^-$	$5/2,7/2^-$	$5/2,7/2^-$		$(5/2),7/2^-$
412.76 a)	$(5/2)3/2^+$			$(3/2^-)$	$3/2^-$
436.33	$(1/2)^-$	$1/2,3/2^-$	$(3/2),1/2^-$		$(1/2)^-$
442.17	$5/2^+$ c)	$5/2^+$	$5/2^+$	$5/2^+$	$5/2^+$
448.65	$5/2^-$		$5/2^-$		$5/2^-$
483.5	$(3/2),1/2^+$	+		$1/2^+$	$1/2^+$
490.5	$(5/2),7/2^+$				$(5/2),7/2^+$
508.87	$3/2,5/2^-$	(-)		$3/2^-$	$3/2,5/2^-$
530.45	$3/2,5/2^-$	-		$3/2^-$	$3/2^-$
548.53	$5/2^-$	$5/2^-$	$5/2^-$	$5/2^-$	$5/2^-$
636.4	$7/2^-$				$7/2^-$
709.3	$3/2,5/2^+$	(+)			$3/2,5/2^+$
720.7 a)	$(5/2),7/2^-$				$(5/2),7/2^-$
731.5	$(5/2),7/2^+$				$7/2^+$
775.0	-				-
782.6	$(3/2)^+$	$5/2^+$			$(3/2)^+$
821.2	$5/2^+$ c)	(-)			$5/2^+$
847.6 a)	$5/2,7/2^-$				$5/2,7/2^-$
857.6	$1/2,3/2^-$		$3/2^-$	$(1/2^-)$	$3/2^-$

Table 4./continued/

1	2	3	4	5	6
865.5	$3/2^{+}$ c)		$3/2^{+}$		$3/2^{+}$
937.5	$7/2^{+}$ c)				$7/2^{+}$
945.2	$3/2^{+}$ c)	$3/2^{+}$	$3/2^{+}$	$(3/2^{-})$	$3/2^{+}$
955.6	$5/2^{+}$ c)	+	$5/2^{+}$		$5/2^{+}$
990.1 a)	$3/2,5/2^{+}$				$3/2,5/2^{+}$
1015.1 a)	$5/2,7/2^{(+)}$				$5/2,7/2^{(+)}$
1035.3	$5/2^{+}$ c)	+	$5/2^{+}$		$5/2^{+}$
1066.6	$(5/2)3/2^{+}$				$(5/2)3/2^{+}$
1101.5	$3/2^{+}$ c)	$3/2,5/2^{+}$	$3/2^{+}$		$3/2^{+}$
1118.5 a)	$5/2,3/2^{+}$				$(5/2)3/2^{+}$
1131.7	$7/2^{+}$ c)				$7/2^{+}$
1180.5	$(3/2)5/2^{+}$				$(3/2)5/2^{+}$
1199.2 a)	$7/2,5/2^{-}$				$7/2,5/2^{-}$
1272.5	$5/2^{+}$				$5/2^{+}$
1327.9	$(3/2)5/2^{+}$		$5/2^{+}$		$5/2^{+}$
1401.6	$(5/2)3/2^{+}$				$(5/2)3/2^{+}$
1422.6	3/2,5/2				3/2,5/2

a) Observed new levels.

b) Basis for all other assignments

c) Obtained from γ-γ -angular correlation measurements (see text)

d) See text.

keV cascade, two values of I = 3/2 and 7/2 should be allowed. Taking into account the character of the depopulation (the presence of the 646.8(M1) and 721.4 keV(E1) transitions to levels with I = 7/2), the value of I = 3/2 is eliminated.

The obtained spin values of the 1035.3 and 1101.5 keV states are also confirmed by the correlation of the triple 905.9-(19)-109.8 k 785.6-(139)-109.8 and 972.5-(19) - 109.8 keV cascades,if the 139.7 keV and 19.4 keV transitions are assigned multipolarities of type E1 and E2 +$\lesssim$60% MI, respectively.

In our previous paper/5/, by using the γ-γ angular correlation method, we made spin assignments for low-energy 41.5(5/2), 109.8($5/2^{-}$), 129.2($3/2^{-}$), 212($3/2^{+}$), 249.5($5/2^{-}$), 303.5($5/2^{+}$) and 316.1($3/2^{+}$)

states, which subsequently were confirmed, except for the spin of the 316.1 keV level, by Warner et al./6/, who investigated the anisotropy of the γ-radiation due to the oriented ^{153}Tb nuclei. The 316.1 keV level is assigned spin 5/2 according to the $A_2(\gamma)$ coefficient of only one 541.3 keV γ-transition, uncertainly placed in the decay scheme. Our result I = 3/2 has been obtained from analysing the γ-γ angular correlations of the two distinctly separated cascades: 206.2(E1)-109.8 keV (A_{22}=+0.163$\pm$0.059) and 186.9(E1) - 129.2 keV (A_{22}=+0.17 $\pm$ 0.09). This disagreement is eliminated if we place the 541.3 keV transition between the 636.4 and 95.2 keV states, as proposed in the present paper. The value of the coefficient A_2(541.3)=0.11$\pm$0.07 given in ref./6/ would then correspond to the spin value of the 636.4 keV level, I = 7/2 (the spin of the 95.2 keV level is I = $9/2^{+}$), which agrees with the values obtained from the analysis of the multipolarities of the γ-transitions.

The value of the coefficient A_2 = 0.10$\pm$0.07 of the 739.7 keV (E1) transition, located in our decay scheme of the excited states of ^{153}Gd between the levels at 955.6 keV ($5/2^{+}$) and 216.1 keV, has been obtained in ref./6/ and indicates that the spin of the 216.1 keV state is 7/2.

In the assignment of spins and parities for the rest of states, including those introduced by us, we considered the multipolarities of the γ-transitions, the way of populating and deexciting the levels, and also the log ft values. The spin and parity values for all the states of ^{153}Gd, established in the present paper, the data of Tuurnala et al./1/ and Warner et al./6/ and those on nuclear reactions/25,3/ are compared in table 4. The final values which follow from this comparison are listed in the last column of table 4.

3.3. Reduced γ-transition probabilities

From the established values of the half-lives of the investigated states, the absolute values of the reduced of ^{153}Gd at 41.5,93.4, 95.2, 109.8, 129.2, 183.5, 212.0 and 216 keV have been calculated (table 5). The required values of the δ^2-mixing coefficients of the M1+E2 transitions have been found from the $L_I/L_{II}/L_{III}$ subshell ratios/2,26-28/. The energies and intensities of the γ-transitions are taken from refs./2,35/.

It is noteworthy that the values of the reduced probabilities of the M1-components of γ-transitions depopulating the $3/2^{-}$ state at 129.2 keV are abnormally small. Hindrance factors, compared with Weisskopf estimates, of the 129.2 and 19.4 keV transitions W_W (M1) $2\cdot10^{-4}$ W.u. are typical for the single particle M1-transitions K-

TABLE 5

Relative intensity, mixing ratio $\delta^2(\frac{E2}{M1})$, absolute reduced probabilities B(λ) and Weisskopf factor F(λ) of some γ-transitions in ^{153}Gd

Initial level E(keV) I^{π} [$T_{1/2}$(ns)]		Final level E(keV) I^{π}		E_γ(keV)[a)]	I_γ[a)]	$\delta^2 x10^{-2}$ / sign δ [b)]	α_t	λ	B(λ)[c)]	F_w(λ) (W.u.)
1		2		3	4	5	6	7	8	9
41.5	5/2⁻	0	3/2⁻	41.56		6.8±0.3	9.7	M1	1.19±0.04 $x10^{-2}$	6.6 $x10^{-3}$
[4.05±0.09]								E2	0.66±0.04	1.4 $x10^{+2}$
93.3	7/2⁻	41.5	5/2⁻	51.80	12.1±0.8	2.4±0.3	14.4	M1	3.7 ±0.7 $x10^{-2}$	2.1 $x10^{-2}$
[0.45±0.08]								E2	0.47±0.10	1.0 $x10^{+2}$
		0	3/2⁻	93.43	3.4±0.3		3.26	E2	0.30±0.06	0.6 $x10^{+2}$
109.7	5/2⁻	41.5	5/2⁻	68.20	11.8±0.6	3.5±0.6	6.49	M1	0.93±0.08 $x10^{-2}$	5.2 $x10^{-3}$
[0.243±0.014]						+		E2	0.10±0.02	0.2 $x10^{+2}$
		0	3/2⁻	109.75	208±11	0.33±0.03	1.58	M1	4.1±0.4 $x10^{-2}$	2.3 $x10^{-2}$
								E2	1.6±0.2 $x10^{-2}$	3.3
129.2	3/2⁻	109.7	5/2⁻	19.42		190^{+130}_{-60}	2620	M1	$1.2^{+0.4}_{-0.8}$ $x10^{-4}$	6.5 $x10^{-5}$
[2.39±0.14]								E2	0.83±0.09	1.7 $x10^{+2}$
		41.5	5/2⁻	87.63	42.5±2.3	$0.2^{+0.2}_{-0.1}$	3.03	M1	3.1±0.3 $x10^{-3}$	1.7 $x10^{-3}$
								E2	$1.2^{+1.4}_{-0.7}$ $x10^{-3}$	2.4 $x10^{-1}$
		0	3/2⁻	129.16	17.8±0.9	≤ 3	1.0	M1	3.7 ±0.3 $x10^{-4}$	2.1 $x10^{-4}$
						+		E2	≤ 1 $x10^{-4}$	≤ 2 $x10^{-1}$

TABLE 5 (continued)

1		2		3	4	6	7	8	9
183.5	5/2⁺	129.2	3/2⁻	54.28	3.0±0.5	1.47	E1	6.9±1.6 $x10^{-7}$	3.7 $x10^{-5}$
[0.76±0.12]		95.2	9/2⁺	88.30	12.8±0.8	4.03	E2	1.13±0.18	2.3 $x10^{-2}$
		93.3	7/2⁻	90.15	3.2±0.5	0.387	E1	4.1±0.7 $x10^{-7}$	2.2 $x10^{-5}$
		41.5	5/2⁻	141.95	34.9±1.9	0.114	E1	4.5±0.8 $x10^{-7}$	2.4 $x10^{-5}$
		0	3/2⁻	183.51	32.7±1.8	0.057	E1	2.0±0.3 $x10^{-7}$	1.0 $x10^{-5}$
212.0	3/2⁺	129.2	3/2⁻	82.86	157± 9	0.485	E1	≥ 0.4 $x10^{-7}$	≥ 2.0 $x10^{-4}$
[≤0.18]		109.7	5/2⁻	102.26	192±10	0.276	E1	≥ 0.2 $x10^{-7}$	≥ 1.3 $x10^{-4}$
		41.5	5/2⁻	170.50	2[illegible]9±12	0.070	E1	≥ 5.0 $x10^{-7}$	≥ 0.3 $x10^{-4}$
		0	3/2⁻	212.04	1000±50	0.039	E1	≥ 0.1 $x10^{-7}$	≥ 0.7 $x10^{-4}$
216.1	7/2⁻	41.5	5/2⁻	174.44	50.7±2.7	0.43	M1	≥ 2.3 $x10^{-2}$	≥ 1.3 $x10^{-2}$
[≤0.21]		0	3/2⁻	216.1	[illegible].6±0.5	0.173	E2	≥ 2.1 $x10^{-2}$	≥ 4.2
95.2	9/2⁺	93.3	7/2⁻	1.73		600	E1	3.9±0.5 $x10^{-7}$	2.1 $x10^{-5}$
[3.5±0.4 $x10^3$]									

a) Taken from ref./2/

b) From the $L_I/L_{II}/L_{III}$ ratios, presented in refs./2,26-28/ and γ-γ angular correlation date.

c) Taken from ref./13/

B(M1) are given in μ_N^2; B(E2) - in e^2b^2 and B(E1) - in e^2b.

-forbidden in well deformed nuclei, or for l-forbidden transitions in some spherical nuclei.

The weak E2-components of the 129.2 and 87.6 keV transitions are also slighty hindered $F_w(E2) \approx 0.2$ W.u., while the strong E2-components of the 19.4 keV transitions is strongly enhanced $F_w(E2) \approx 170$ W.u., suggesting that it is a collective transition.

Reduced probabilities of the M1 transitions deexciting remaining levels fit into the systematics of the probabilities of γ-transitions in deformed odd N nuclei.

3.4. The rotational band of the ^{153}Gd ground state

As early as in papers /29,30/, it was suggested to consider the low-lying states of ^{153}Gd at 41.5 keV ($5/2^-$) and 93.3 keV ($7/2^-$) as the levels of the ground state rotational band with Nilsson characteristics $3/2^-[521]$. The same interpretation of this band was supported by the authors of the later works devoted to the theoretical description of the properties of the ^{153}Gd in terms of the particle-rotor model with the Nilsson potential /11,12/ and then Saxon-Woods potential /3/ taking into account the Coriolis and $\Delta N=2$ interactions.

Guttormsen et al. /14/ and Warner et al. /6/ present another approach and a different interpretation of the ^{153}Gd ground state. In analogy to the $7/2^-$ ground state of isotopes with N=87 ($I^\pi = 7/2^-$) and the structure of the lowest lying states of $^{151}_{89}$Sm, the authors of this work take into account the fact that in all nuclei with N=89 the lowest-lying states with $I^\pi = 3/2^-$ belong to the spherical subshell $2f_{7/2}$ and, correspondingly, attribute the asymptotic characteristics $3/2^-[532]$ to these states.

The theoretical analysis of the structure of low-excited states of ^{155}Dy (ref. /31/), shows that the correct reproduction of the ground state rotational band is possible only in the case where its wave function contains the main component $3/2^-[521]$. The correctness of this interpretation of the ^{155}Dy ground state is confirmed by the negative value of its magnetic dipole moment $\mu = -034 \pm 0.03$ ref. /32/. The single-particle state with the $3/2^-[532]$ main component should be characterized by the positive value of the magnetic moment. In the case of ^{153}Gd, the ground state magnetic moment has not been measured. But if we take into account the positive value of the magnetic moment of the 129.2 keV state, which, in the case of assigning to the ground state of the characteristics of the $3/2^-[532]$ state, is considered as the $3/2^-[521]$ state, then the ground state of ^{153}Gd (as well as the ^{155}Dy ground state) should be considered with certainty as a deformed state with a $3/2^-[521]$ predominant component.

From the obtained values of B(E2) and B(M1) of the 41.5 keV transition, the values of the internal quadrupole moment Q_0 and the parameter $g_k - g_R$, which characterise the ground state band, have been calculated as follows:

$$Q_0 = 4.4 \pm 0.1 \text{ barn and } g_K - g_R = (-)\, 0.288 \pm 0.006$$

The sign of the parameter $g_K - g_R$ has been estimated in refs. /33,34/.

The authors express their gratitude to R.R.Usmanov and U.S.Salikhbaev for their help with the lifetime measurements and to N.A.Lebedev and I.I.Gromova for the preparation of the mass-separated sources. We are also indebted to Profs. K.Ya.Gromov and T.M.Muminov for many valiable discussions and their critical reading of the manuscript.

References

1. Tuurnala T., Siivola A., Jartti P. and Liljavirta T. Z.Phys., 1974, 266, p.103.
2. Vylov C., Gromova I.I., Gromov K.Ya., Kuznetsov V.V., Lebedev N.A., Potempa M., Fominykh M.I., Aleksandrov V.C., Khamidov A.Sh., Kholbaev I. and Iskhakov T. Izv.Acad.Nauk SSSR (ser.fiz.), 1975, 39, p. 506.
3. Katajanheimo R. and Hammaren E. Phys.Scripta, 1979, 19, p. 497.
4. Polok G., Rybicka M., Stachura Z. and Styczen J, Cracow INP Progress Rep. No. 1, 1972, p. 116.
5. Alikov B.A., Budzynski M., Badica T., Wawryszczuk J., Zuk W., Ion-Mihai R., Kuznetsov V.V., Lizurej H.I., Morozov V.A., Muminov T.M. and Kholbaev I. Acta Phys.Polonica , 1976, B7, p. 69.
6. Warner D.D., Hamilton W.D., Fox R.A., Finger M., Konicek J., Pavlov V.N., and Tsupko-Sitnikov, J.Phys. G, Nucl.Phys., 1978, 4, p. 1887.
7. Andrejtscheff W., Meiling W., and F.Stary, Nucl.Phys., 1969, A137, p. 474.
8. Wawryszczuk J., Novgorodov A.F., Morozov V.A., Muminov T.M., Razov V.I. and Sarzynski J.J. Preprint JINR P6-5526, Dubna 1970.
9. Afanasiev V.P., Gromova I.I., Lebedev N.A., Morozov V.A., Muminov T.M., Fuja, Khalikulov A.B., Khamraev F.Sh., Preprint JINR P6-6426, Dubna 1972.
10. Badica T., Bogdan D., Ciortea C., Dima S., Petrovici A. and Popescu I. Hyperfine Interactions, 1977, 3, p. 423.
11. Lovhoiden G. and Burke D.G. Can.J.Phys., 1973, 51, p. 2354.
12. Tuurnala T. Z.Phys., 1974, 268, p. 371.
13. Katajenheimo R. Phys.Scripta, 1979, 20, p. 125.
14. Guttormsen M., Osnes E., Rekstad J., Lovhoiden G. and Straume O. Nucl.Phys., 1978, A298, p. 122.

15. Baznat M.I., Pyatov N.I. and Cherney M.I. Particles and Nucleus, 1973, 4, p. 941.
16. Brack M., Damgaard J., Jensen A.S., Pauli H.C., Strutinsky V.M. and Wong G.Y. Rev.Mod.Phys., 1973, 44, p. 320.
17. May F.R., Paskevich V.V. and Frauendorf S. Preprint JINR,P4-10173, Dubna,1976.
18. Gonsior M., Gromov K.Ya., Kuznetsov V.V. and Lizurej H.I. Preprint JINR,D6-7094, Dubna 1973.
19. Alikov B.A., Lizurej H.I., Muminov K.M., Muminov T.M., Salikhbaev U.S., Usmanov R.R. and Wawryszczuk J,. Nukleonika, 1978, 23, p. 833.
20. Eldrup M. and Kirkegaard P. Comp.Phys. Communic., 1972, 3, p. 240.
21. Sen P., Burman C., Bakhru H. and Howe D. Z.Phys.,1975, A274,p. 343.
22. Wawryszczuk J., Gromova I.I., Zuk W., Ion-Mihai R., Krupa E., Lizurej H.I., Malikov M.M., Muminov T.M., Tanska-Krupa W. and Kholbaev I, Preprint JINR,P6-10703, Dubna,1977.
23. Cretcu T., Kuznetsov V.V., Lizurej H.I., Goroshankin V.M., Macarie H. Izv. Akad.Nauk SSSR (ser. fiz.) 1978, 42, p. 56; Preprint JINR, P6-10562, Dubna,1977.
24. Aleksandrov V.S., Vylov C., Gudov V.I. and Kuznetsov V.V. Proc. of the 28-th Conf. on Nucl.Spectroscopy and Nucl.Structure Alma Ata, 1978, p. 82 and 83.
25. Lederer C.M. and Shirley V.S. Table of Isotopes (Wiley- Interscience. New York. 1978) 7-th ed. p
26. Harmatz B., Handley T.H., Michelich J.W. Phys.Rev.,1962,128,p.1186.
27. Zuber K., Vylov C., Gromova I.I., Zuber J., Ortlepp X.-G., Lebedev N.A. Preprint JINR, P6-8669, Dubna, 1975.
28. Artamonova K.P., Gromova I.I., Zolotavin A.V. and Sergeev V.O. Proc. of the 26-th Conf. on Nucl.Spectroscopy and Nucl.Structure, Baku,1976, p. 106,Leningrad, Nauka, 1976.
29. Tjom P.O. and Elbek B. Mat.Fys.Medd.Dan.Vid. Selsk. 1967, 36,No.8.
30. Borggreen J. and Sletten G. Nucl.Phys., 1970, A143, p. 255.
31. Alikov B.A., Gromov K.Ya., Muminov T.M., Pyatov N.I. Salikhbaev U.S. and Tsoy E.G. Izv.Acad.Nauk SSSR (ser. fiz.) 1980, 44, p.103.
32. Rosen A. and Nyquist H. Phys.Scripta 1972, 6, p. 24.
33. Lovhoiden G., Waddington J.C., Hagemann K.A., Hjorth S.A. and Waddington J.C. Nucl.Phys., 1970, A144, p. 513.
34. Lovhoiden G., Hjorth S.A., Ryde H. and Harms Ringdahl L. Nucl.Phys., 1972, A181, p. 589.
35. Peghaire A., Aguer P., Torres J.Ph. Journal de Phys.Letters,1974, 35, p. 589.

Received by Publishing Department
on January 19 1982.

Аликов Б.А. и др. E6-82-38

Структура уровней ядра ^{153}Gd с N=89. I. Уровни и гамма-переходы в ^{153}Gd, возбуждаемые в распаде ^{153}Tb

Проведены исследования возбужденных состояний ^{153}Gd, заселяемых в распаде ^{153}Tb. Выполнены измерения: спектров совпадений e^{-}-γ с линиями конверсионных электронов L41, K93+L52, K110, K129+L87+L88 и K195+L152; угловых корреляций высокоэнергетических γ-переходов, следующих через уровень 109,7 кэВ; спектров задержанных e^{-}-γ и e^{-}-e^{-} совпадений с целью определения периодов полураспада состояний 41,5; 93,3; 109,7; 129,1; 183,5; 212,0 и 216,1 кэВ; параметров R/135°, ±B/ возмущенных интегральных угловых корреляций для каскадов 102-109 и 83-129 кэВ с использованием источника ^{153}Tb, имплантированного в железную фольгу. Предлагается схема распада ^{153}Gd, состоящая из 50 возбужденных состояний. Определены их спины, четности, logft и, для низколежащих уровней, периоды полураспада. Даны оценки g-факторов уровней 109,7 и 129,1 кэВ. На основе периодов полураспада рассчитаны абсолютные значения приведенных вероятностей γ-переходов. Обсуждается структура основного состояния ^{153}Gd.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1982

Alikov B.A. et al. E6-82-38

Level Structure of the 89-Neutron Nucleus ^{153}Gd.
I. Levels and Gamma-Transitions in ^{153}Gd Excited in the Decay of ^{153}Tb

Investigations of the properties of ^{153}Gd excited states populated at ^{153}Tb decay were continued. The following measurements were performed: coincidence spectra e^{-}-γ with L41, K93+L52, K110, K129+L87+L88 and K195+L152 keV conversion electron lines; angular correlations of high energy γ-cascades going through 109.7 keV level; delayed e^{-}-γ and e^{-}-e^{-} coincidence spectra to determine the half-lives of 41.5; 93.3; 109.7; 129.1; 183.5, 212.0 and 216.1 keV states; R (135°, ±B) parameters of IPAC for the 102-110 and 83-129 keV cascades using ^{153}Tb sources implanted into Fe foil. A decay scheme of ^{153}Tb containing 50 excited levels is proposed. Their spins, parities, logft and, for low-lying levels, also the mean half-lives have been determined. An estimation of g-factors of 109.7 and 129.1 keV levels has been given. On the basis of half-lives of investigated absolute values of reduced γ-transition, probabilities for these states have been calculated. The structure of the ground state of ^{153}Gd is discussed.

The investigation has been performed at the Laboratory of Nuclear Problems, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1982