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J.Lipták, G.Beyer, K.J.Gromov,
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J. Lipták[1], G.Beyer[2], K.J.Gromov,
V.I.Fominikh, A.F.Novgorodov, K.Krištiaková[3],
W.Habenicht[4]

THE EXCITED STATES OF ^{85}Sr

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[1] From the Faculty of Mathematics and Physics, Charles University, Praque, CSSR.

[2] From the Institute of Nuclear Physics, Department of Nuclear Chemistry Rossendorf-Dresden, GDR.

[3] From the Institute of Physics, Slovac Academy of Sciences, Bratislava, CSSR.

[4] Permanent address:Faculty of Physics Technical University Dresden, GDR.

1. INTRODUCTION

The several works[1-5] have shown the existence of two isomeric states in the ^{85}Y nucleus with half-lives of 2.68 ± 0.05 h and 4.8 ± 0.2 h, respectively.

The decay scheme of ^{85}Y, proposed by Horen and Kelly[4], has been based on $\gamma-\gamma$ and $\beta^{+}-\gamma$ coincidence studies using a scintillation detectors. They determined the decay energy of these isomers as Q(2.68 h)= = (3320 ± 50) *keV* and Q(4.8h) = (3270 ± 50) *keV*.

The level structure of the daughter nucleus ^{85}Sr, has been studied by means of the nuclear reaction (d,t)[6], (^{3}He,α)[7] and (d,p)[6,8] too. The excited states of ^{85}Sr have been examined theoretically in refs.[9-12].

However, the comparison of the experimental data[3,4] about the ^{85}Sr levels with theoretical calculation based on $(g_{9/2})^{-3}$ and $(p_{1/2})^{-2}(g_{9/2})^{-1}$ neutron configurations was incompleted because of the lack of the experimental data.

It was therefore thought worthwhile to examine the structure of ^{85}Sr levels in more detail. Further, one would like to compare the data from decay studies with those from nuclear reactions in order to determine the levels of the $(g_{9/2})^{-3}$ neutron configuration.

2. EXPERIMENTAL PROCEDURE

2.1. Source Preparation

Two kinds of radioactive sources were used for γ-ray spectroscopy.

The first source consisted of the ^{85}Y isotope and of a ^{85m}Sr isomer contamination. The second one contained ^{85m}Sr activity only.

The isotopes ^{85}Y and ^{85m}Sr were produced by a spallation of Mo or Zr targets (0.1 *mm* thick) by 660 *MeV* protons in the external beam of the synchrocyclotron at JINR, Dubna. Both sources of the needed activity were prepared by the electromagnetic mass-separation technique using a surface ionization ion source /13/ connected with the method of a hot solid target /14/.

2.2. Gamma-Ray Measurement

The singles of γ-rays were examined by using 41 and 47 cm^3 Ge(Li) coaxial detectors. The resolution of these detectors was 2.5 *keV* at 1332 *keV*. The γ-ray spectrum of typical run is shown in *fig. 1*. The energies of the more intense transitions were determined from spectra taken with ^{85}Y sources mixed with γ-emitters containing transitions of well-known energies (^{226}Ra). The energies of the stronger lines so determined were then used as secondary calibration standards.

The relative intensities of strong γ-rays which belong to the decay of $^{85m,g}Y$ and ^{85}Sr were determined in several measurements lasted up to 20 hours after irradiation.

The ratio of the intensities I_γ (231.7 *keV*, ^{85}Sr)/ $/I_\gamma$(151.3 *keV*, ^{85}Rb) was determined for both sources of radioactivity, i.e., ^{85m}Sr and $^{85m}Sr + {}^{85m,g}Y$. The agreement of both values of the ratio was excellent (in the range of 3%).

The relative intensity of β^+-decay of ^{85g}Y and ^{85m}Y was determined by the measurements of I_γ (511 *keV*). The duration of these measurements was 20 hours too.

The $\gamma-\gamma$ coincidences were observed using Ge(Li) detectors with an active volume of 30-40 cm^3. The cooling ($\sim$-100°C) of the first stage of both the preamplifiers ensured a good resolution of 2.5-3.1 *keV* and 2.1-2.7 *keV*, respectively, at an energy range 122-1332 *keV*.

The Ge(Li) detectors were housed in horizontal cryostats. The absolute efficiency of the detectors was

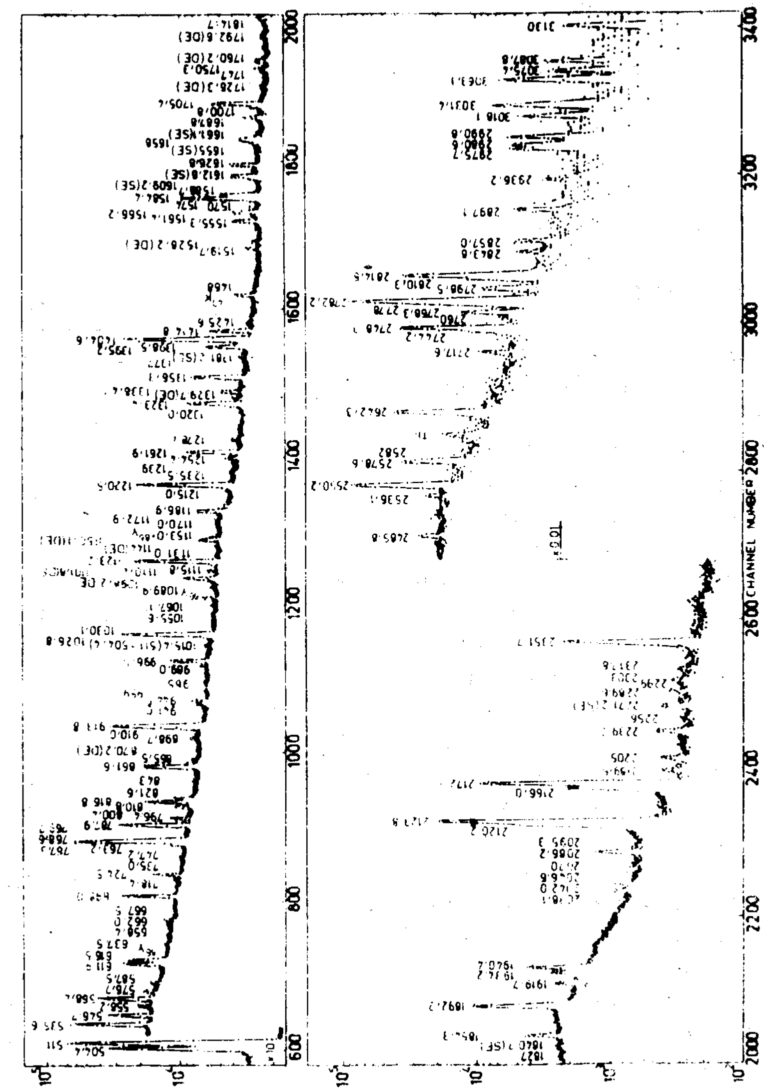

Fig. 1. The single spectrum of γ-rays from $\beta^+-\epsilon$-decay of $^{85m,g}Y$. The lead absorber of 5 mm thick was placed between the radioactivity source and Ge(Li) detector.

3.5×10^{-4} and 4.8×10^{-4}, respectively, for the energy 1332 *keV*. The time resolution of the system was ~50 *nsec* at the range E_{γ} = 70-2000 *keV*.

The coincidence events were stored in the memory of the MINSK-2 computer. The gates of coincidence spectra were chosen numerically by this computer.

3. RESULTS

3.1. Energy and Intensity of γ-Rays

The energies and intensities of the various γ-rays emitted in the β^{+}-decay of ^{85m}Y and ^{85g}Y are given in *Table 1*. The intensities of γ-transition are calculated on the basis of single and coincidence measurements.

From the total of 145 γ-transitions assigned to the decay of ^{85}Y 111 γ-transitions have been observed as new ones. In the study of β^{+}-decay of ^{85m}Y and ^{85m}Sr 10 γ-rays were observed.

In the case of $\gamma-\gamma$ coincidences the gates were at the E_{γ}= 231.7; 240 (a background window); 546.7; 600(B.G.); 611.9; 616.5; 698.0; 754 (B.G.); 767.3; 768.6; 769.7; 1204 (B.G.) and 1220.5 *keV*.

The $\gamma-\gamma$ coincidence spectra after subtraction of background spectra are shown in *figs. 2* and *3*.

All the results of $\gamma-\gamma$ coincidence measurements and the subsequent analysis are listed in *table 2*. The energy and intensity of γ-transitions of 151.3, 767.3, 768.6, 769.7, 914.5 and 2785 *keV* identified as following the ^{85g}Y decay were determined from the $\gamma-\gamma$ coincidence studies only. These transitions were either relatively weak or unresolved at the single γ-ray spectrum.

The intensities of the γ-transitions (see *table 1*) are normalized on sum of the intensities of unresolved γ-transitions in the area of 768 *keV*. The absolute intensity of this group is 5.47% per decay. This value agrees very well with the value obtained from $\gamma-\gamma$ coincidences.

Because of the nonexistence of isomeric transition in

Table 1

Energies and relative intensities of the γ-transitions from the $^{85m,g}Y \rightarrow {}^{85}Sr$ decay

($T_{1/2}$ = 4.8 h)

This work		Horen and Kelly [3]
Energy (keV)	Relative intensity	Relative intensity
1	2	3
129.6±0.5	1.3 ± 0.1	-
151.0±1.0 a)	0.37± 0.15 a)	-
179.8±0.5	1.64± 0.08	-
193.4±0.4	6.4 ± 0.3	-
231.7±0.1	422 ±25	710
238.9±0.4	0.29± 0.06 b)	-
438.4±0.5	3.1 ± 0.2	-
468.4±0.4	2.2 ± 0.2	-
504.4±0.2	27.9 ± 1.3 b)	-
535.6±0.2	64.0 ± 2.5	82
546.7±0.2	22.0 ± 1.0	23.4
558.2±0.3	4.9 ± 0.3	-
568.4±0.2	31.0 ± 1.3	34.8
576.7±0.3	4.2 ± 0.3	-
587.5±0.4	2.2 ± 0.2	-
611.9±0.2	20.0 ± 1.0	} 39.7
616.5±0.2	16.0 ± 1.0	}
637.5±0.4	1.8 ± 0.3	-
658.4±0.6	1.1 ± 0.2	-
662.0±0.6	1.5 ± 0.3	-

Table 1 (continued)

1	2	3
667.5±0.4	2.7 ± 0.3	-
698.0±0.2	24.0 ± 1.0	24
718.4±0.3	1.5 ± 0.2	-
724.5±0.2	8.2 ± 0.4	7
735.0±1.0	0.37± 0.20	-
747.2±0.4	0.66± 0.13	-
763.2±0.5	3.2 ± 0.4	}
767.3±0.7 [a]	67.3 ± 7.0 [a]	} 100
768.6±0.8 [a]	24.0 ± 2.6 [a]	}
769.7±1.0 [a]	5.5 ± 1.1 [a]	}
787.9± 0.2	29.0 ± 1.1	29
796.4±0.3	4.4 ± 0.3	-
800.4±0.9	0.73± 0.24	-
810.8±0.2	3.5 ± 0.3	}
816.8±0.2	14.4 ± 0.8	} 22.7
821.6±0.2	4.0 ± 0.3	}
843.0±0.8	0.3 ± 0.1	-
861.6±0.2	18.0 ± 0.8	} 29
865.5±0.3	2.2 ± 0.2	}
898.7±0.3	1.6 ± 0.1	-
910.0±0.3	3.7 ± 0.3	-
914.5±1.0 [a]	2.4 ± 0.7 [a]	-
941.0±0.3	1.60± 0.16	-
944.5±0.3	3.10± 0.23	-
959.0±0.6	0.37± 0.12	-
965.0±1.0	0.18± 0.09	-
989.0±0.3	1.1 ± 0.1	-

Table 1 (continued)

1	2	3
996.5±0.2	10.0 ± 0.5	-
1026.8±0.3	2.0 ± 0.2	} 44
1030.1±0.2	37.4 ± 1.5	}
1055.6±0.6	0.55± 0.15	-
1067.1±0.6	0.73± 0.18	-
1089.9±0.4	1.1 ± 0.2	-
1110.4±0.4	2.0 ± 0.2	-
1115.8±0.7	0.55± 0.13	-
1123.2±0.2	33.0 ± 1.4	37.6
1131.0±0.4	0.64± 0.12	-
(1153)	-	-
1170.0±0.6	0.73± 0.18	-
1172.9±0.6	0.92± 0.19	-
1186.9±0.2	5.1 ± 0.3	-
1215.0±0.8	0.82± 0.16	-
1220.5±0.2	36.6 ± 1.6	37
1235.5±0.6	0.73± 0.14	-
1239.4±0.8	0.3 ± 0.1	-
1254.4±0.3	1.8 ± 0.2	-
1261.9±0.2	12.0 ± 0.5	14
(1320)	-	-
1323.4±0.2	12.7 ± 0.6	20.6
1338.4±0.2	3.1 ± 0.2	-
1356.3±0.2	12.3 ± 0.6	5.7
1377.0±0.5	0.55± 0.13	-

Table 1 (continued)

1	2	3
1395.2±0.2	8.2 ± 0.5	
1398.5±0.9	1.8 ± 0.4	79
1404.6±0.2	57.0 ± 2.3	
1414.8±0.2	7.5 ± 0.4	
1425.6±0.4	0.73± 0.14	-
(1468)	0.2 ± 0.2	-
1519.7±0.3	0.65± 0.13	-
1555.3±0.3	4.0 ± 0.2	3.9
1561.4±0.4	0.73± 0.11	-
1566.2±0.3	4.2 ± 0.2	-
1570 ±1	0.26± 0.18	-
1574 ±1	0.18± 0.15	-
1584.4±0.2	22.0 ± 1.2	27
1588.7±0.3	6.2 ± 0.4	
1626.8±0.2	5.0 ± 0.3	-
1658.0±0.7	2.4 ± 0.4	-
1687.8±0.3	2.7 ± 0.2	-
1700.8±0.3	1.5 ± 0.2	-
1705.4±0.2	11.0 ± 0.6	-
1747.0±0.6	0.73± 0.14	-
1750.3±0.4	1.5 ± 0.2	-
1814.7±0.4	1.3 ± 0.2	-
1827.0±0.5	0.73± 0.13	-
1854.3±0.2	7.5 ± 0.4	
1892.2±0.2	33.0 ± 2.2	25
1919.7±0.3	2.6 ± 0.2	

Table 1 (continued)

1	2	3
1934.2±0.2	4.0 ± 0.3	15.5
1940.4±0.2	10.6 ± 0.6	
2038.1±0.3	1.1 ± 0.1	-
2042.0±1.1	0.3 ± 0.1	-
2046.6±0.3	1.2 ± 0.1	-
2070.0±0.8	0.3 ± 0.1	-
2086.2±0.2	2.7 ± 0.2	-
2095.3±0.7	0.31± 0.08	-
2120.2±0.3	14.6 ± 1.1	85
2123.8±0.2	92.0 ± 4.8	
2166.0±0.2	8.1 ± 0.5	41
2172.1±0.2	42.0 ± 2.2	
2189.5±0.4	0.47± 0.07	-
2205.0±0.4	0.55± 0.06	-
2239.2±0.3	0.91± 0.08	-
2256 ±1	0.14± 0.07	-
2289.6±0.4	0.47± 0.07	-
2317.8±0.5	0.18± 0.03	-
2351.7±0.2	10.4 ± 0.7	10.6
2485.8±0.4	0.47± 0.05	-
2536.1±0.5	0.31± 0.04	-
2550.2±0.2	4.2 ± 0.3	4
2578.6±0.4	1.4 ± 0.2	-
2582.0±0.5	0.5 ± 0.1	-
2642.3±0.3	2.4 ± 0.2	-
2717.6±0.6	0.22±0.04	-

Table 1 (continued)

1	2	3
2744.2±0.8	0.35± 0.06	2.5
2748.3±0.3	2.0 ± 0.1	
2760.0±1.5	0.05± 0.02	-
2768.3±0.4	0.52± 0.05	-
2777.8±0.5	0.63± 0.08	7.8
2782.2±0.3	6.2 ± 0.3	
2785 ±2 a)	0.4 ± 0.3 a)	
2798.5±0.5	0.37± 0.04	-
2810.3±0.6	0.44± 0.08	2.5
2814.6±0.3	2.20± 0.16	
2843.8±0.7	0.09± 0.02	-
2857.0±0.6	0.18± 0.03	-
2897.1±0.5	0.18± 0.03	-
2936.2±0.8	0.09± 0.02	-
2975.7±0.4	0.29± 0.04	-
2980.6±0.4	0.29± 0.04	-
2990.8±0.4	0.29± 0.04	-
3018.1±0.5	0.26± 0.04	-
3031.4±0.4	0.49± 0.05	-
3063.1±0.4	0.46± 0.05	-
3075.4±0.6	0.14± 0.03	-
3087.8±0.6	0.16± 0.03	-
3130.0±1.2	0.13± 0.08	-

Table 1 (continued)

($T_{1/2}$ = 2.68 h)		
1	2	3
151.3±0.2	20.0 ± 0.8	18
216.0±0.6	0.32± 0.03	-
231.7±0.1	140.0 ±10.0	132
238.9±0.4	0.56± 0.10	0.43
409.4±0.4	1.4 ± 0.1	1.14
504.4±0.2	100	100
698.0±0.2	0.3 b)	-
913.8±0.2	15.0 ± 0.8	11
1278.4±0.8	0.40± 0.04	0.3
1320 ±1	0.61± 0.15	0.42

a) values determined on basis of γ-γ coincidence measurements.

b) calculated from the scheme of levels of ^{85}Sr.

Table 2

Results of γ-ray coincidence measurements associated with the decay of 4.8 h ^{85}Y.

Energy (keV)	Intensity exp.	Intensity calc.	Energy (keV)	Intensity exp.	Intensity calc.
1	2	3	1	2	3
Gate 231.7 keV					
438.4	0.09	0.10	1123.2	1.6	1.8
511	14	12.5	1172.9	0.1	0.05
535.6	3.5 a)	3.5 a)	1254.4	0.1	0.05
558.2	0.11	0.17	1323.4	0.68	0.69
568.4	0.85	0.86	1356.3	0.35	0.38
576.7	0.07	0.07	1395.2	0.38	0.45
587.5	0.08	0.06	1404.6	1.35	1.48
616.5	0.43	0.46	1425.6	0.06	0.04
637.5	0.09	0.05	1584.4	0.47	0.57
724.5	0.33	0.28	1687.8	0.15	0.15
768.6	0.85	0.82	1750.3	0.07	0.08
787.9	0.75	0.76	1814.4	0.05	0.07
796.4	0.2	0.12	1854.4	0.33	0.41
810.8	0.24	0.12	1892.2	2.2	1.8
816.8	0.53	0.49	1934.2	0.26	0.22
821.6	0.1	0.1	1940.4	0.74	0.58
861.6	0.57	0.75	2120.2	0.80	0.80
989.0	0.1	0.06	2239.2	0.04	0.05
996.5	0.36	0.34	2485.8	0.024	0.026
1030.1	2.0	2.1	2536.1	0.022	0.017

Table 2 (continued)

1	2	3	1	2	3
2550.2	0.21	0.23	2744.2	0.10 (2744.2 + 2748.3)	0.02
2578.6	0.09 (2578.6 + 2582)	0.08	2748.3		0.11
2582		0.027	2785	0.02	-
-	-	-	2798.5	0.02	0.02
Gate 546.7 keV					
151	0.02	-	914.5	0.13	-
568.4	0.19 a)	0.18 a)	1338.4	0.18 a)	0.17 a)
616.5	0.1	0.1	1566.2	0.21 a)	0.23 a)
667.5	0.08	0.15	2189.5	0.05	0.03
769.7	0.35	0.3	2205.0	0.02	0.03
898.7	0.1	0.09	-	-	-
Gate 611.9 keV					
438.4	0.05	0.06	810.8	0.06	0.07
504.4	1.1 a)	1.1 a)	816.8	0.27	0.29
558.2	0.05	0.05	996.5	0.14	0.20
768.6	0.46	0.48	-	-	-
Gate 616.5 keV					
231.7	0.4	0.46	787.9	0.44	0.49
535.6	0.24 a)	0.24 a)	1323.4	0.2	0.21
546.7	0.1	0.1	1555.3	0.05	0.067
767.3	0.37 (767.3 + 769.7)	0.25	-	-	-
769.7		0.10	-	-	-
Gate 698.0 keV					
468.4	0.09	0.094	1705.4	0.5	0.46
1186.9	0.21 a)	0.22 a)	2038.1	0.04	0.047
1414.8	0.33 a)	0.32 a)	-	-	-

Table 2 (continued)

1	2	3	1	2	3
Gate 787.9 keV					
231.7	0.73	0.78	616.5	0.41	0.49
535.6	0.69 a)	0.78 a)	767.3	0.9	0.82
568.4	0.97 a)	0.93 a)	796.4	0.15	0.13
Gate 1220.5 keV					
511	1.3	1.25	944.5	0.16 a)	0.17 a)
865.5	0.13 a)	0.12 a)			

Energy (keV)	Intensity exp.	calculated with 767.3	768.6	769.7	summary
1	2	3	4	5	6
Gate (767.3 + 768.6 + 769.7) keV					
231.7	0.74 a)	-	0.82	-	0.82 a)
504.4	0.44 a)	-	0.48	-	0.48 a)
535.6	0.03	-	0.025	-	0.025
546.7	0.3	-	-	0.3	0.3
568.4	0.56	0.48	-	0.23	0.71
576.7	0.08	0.04	-	-	0.04
587.5	0.12	0.063	0.052	-	0.11
611.9	0.37	-	0.48	-	0.48
616.5	0.3	0.25	-	0.1	0.35
767.3 }	0.08	-	0.027	-	} 0.054
768.6 }		0.027	-	-	
787.9	0.84 a)	0.82	-	-	0.82 a)
796.4	0.11	0.068	-	0.025	0.09

Table 2 (continued)

1	2	3	4	5	6
821.6	0.16	0.11	-	-	0.11
1123.2	0.8 a)	-	0.78	-	0.78 a)
1356.3	0.4	0.3	-	-	0.3
1398.5	0.06	0.053	-	-	0.053
1404.6	1.5 a)	1.6	-	-	1.6 a)
1584.4	0.6	0.62	-	-	0.62

a) Intensities normalized here.

Table 3

The values of log ft and the ratios of reduced transition probabilities of γ-transitions to g.s. and the first excited state in ^{85}Sr.

Energy of level (keV)	R (E2)	I^{π}	log ft	Energy of level(keV)	R (E2)	log ft
231.7	-	$7/2^+$	7.0	1220.5	12	6.7
767.3	0.18	$5/2^+$	-	1588.7	1.5	7.2
1261.9	0.11	$(11/2^+)$	6.8	1657.6	1.5	7.3
1626.9	0.28	$(9/2^+)$	7.1	-	-	-

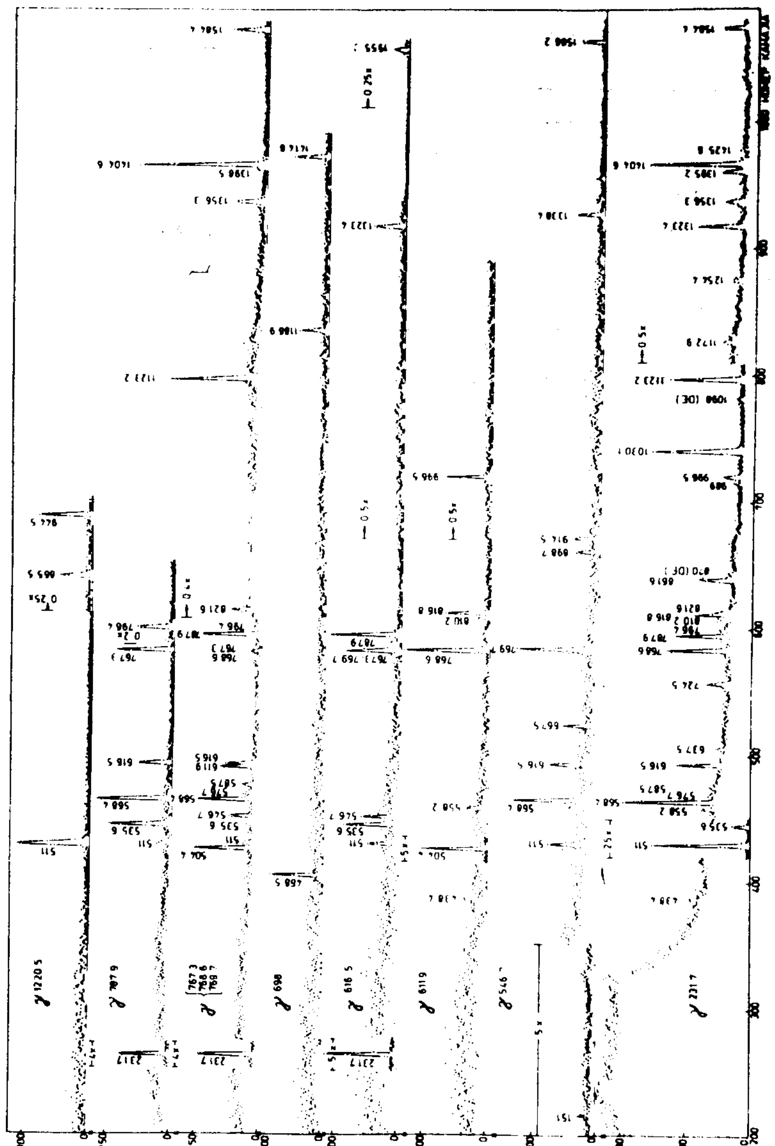

Fig. 2. The coincidence spectra from the ^{85g}Y *decay studies.*

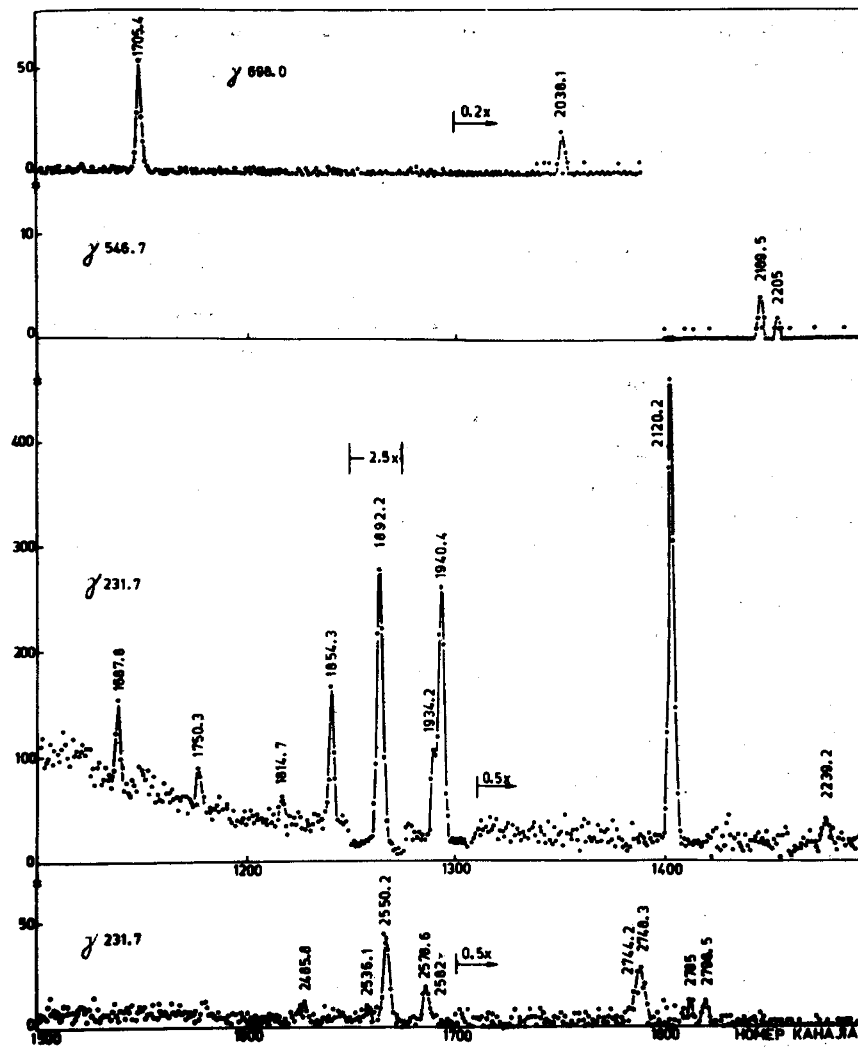

Fig. 3. The coincidence spectra from the ^{85g}Y *decay studies.*

^{85}Y it is possible to discuss the decay scheme of ^{85g}Y and ^{85m}Y separately.

3.2. *Decay Scheme of* ^{85m}Y *(* $T_{1/2}$ *= 2.68 h)*

The allowed $\beta^{+}-\epsilon$ -decays of $^{85m}Y(1/2^{-})$ lead to the levels of the ^{85}Sr nucleus with the spin and the parity $I^{\pi} = 1/2^{-}$ or $3/2^{-}$. The results of the work show the existence of 3 such levels at the energies of 238.9 $(1/2^{-})$, 743.3 $(3/2^{-})$ and 1152.7 *keV* $(1/2^{-}$ or $3/2^{-})$.

The β^{+} -decay to these levels has the values of log ft equal to 6.2, 5.4 and 5.8, respectively. The absence of coincidence data in the decay of ^{85m}Y restricted the evidence for new levels to an intensity balance and an energy sum. So, the levels 1517.0, 1558.9 and 936.9 *keV* $(5/2^{-})$ have been postulated on the basis of the transitions of the energy of 1278.4, 1320.0 and 216 *keV*, respectively. The first two levels are mentioned by D.J.Horen /5/, too.

The 238.9 *keV* level is an isomeric state of ^{85}Sr with $T_{1/2}$ = 70 *min* /15/. This level decays by ϵ -capture to the ^{85}Rb level and through the isomeric transitions to the first excited or the ground state of ^{85}Sr. The decay scheme is shown in the right side of *fig.4*.

3.3. *Decay Scheme of* ^{85g}Y *(* $T_{1/2}$ *= 4.8 h)*

The basic criterion of construction of the ^{85g}Y decay scheme was $\gamma-\gamma$ coincidence results, having regard to the intensities and the energies of relevant γ -transitions.

The proposed decay scheme is shown in the left side of *fig. 4*. Here 28 levels of the 41 excited ones observed in the ^{85g}Y decay studies are introduced for the first time. But several of these levels have been observed in (d,t), (^{3}He,α) and (d,p) nuclear reactions /6-8/.

The comparison of our results with the decay scheme proposed by Horen and Kelly /3/ shows that the levels

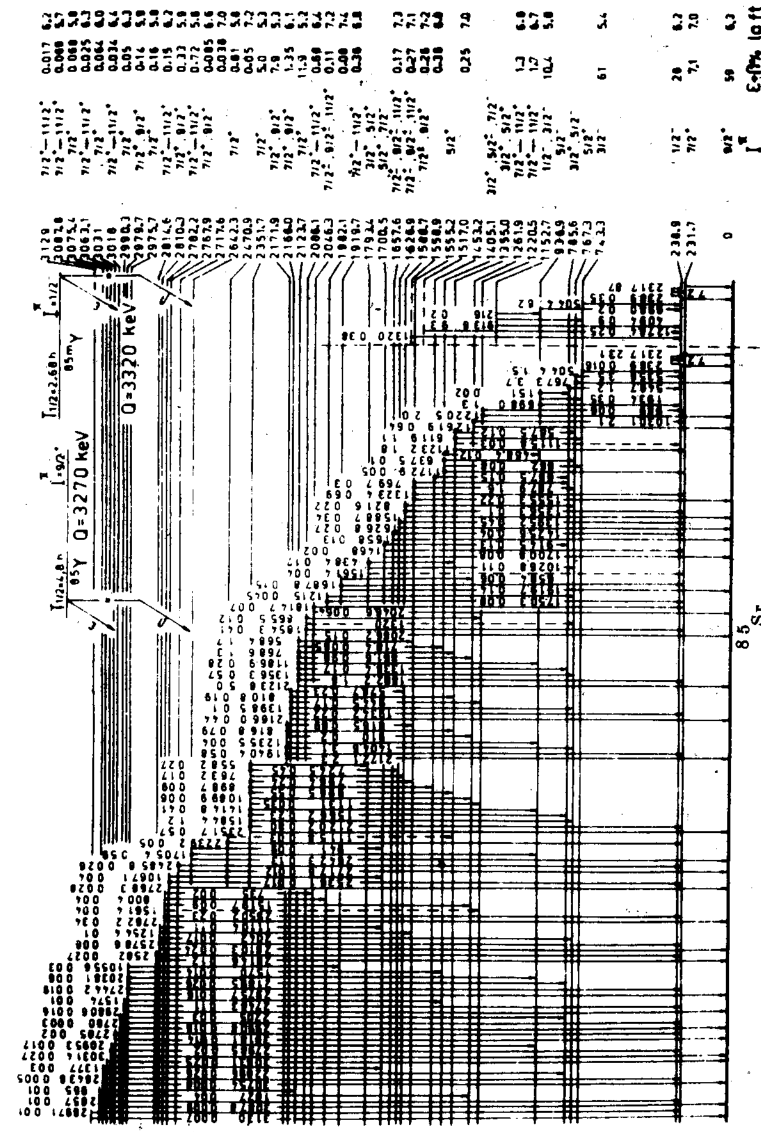

Fig. 4. Decay scheme of two isomers ^{85}Y.

at the energy of 802 and 2329 *keV* cannot be introduced. The transitions of 568.4 and 546.7 *keV* are not in the coincidence therefore they have to be placed elsewhere than they are in ref. /3/.

The 2329 *keV* level was proposed on the basis of the coincidence of 1404.6 - 698.0 *keV* transitions, however the 698.0 *keV* transition coincides with the 1414.8 *keV* transition. All of the rest of the Horen's proposed levels are confirmed by our results but it is not true as far as the intensities of γ -transitions are concerned.

As for the levels introduced by Arlt et al. /4/ their existence mostly is not confirmed by our results.

As far as the 767.3 *keV* level is concerned, it has been proposed /3/ on the basis of the component of the β^+ spectrum with the energy (1450 ± 150) *keV*. However, our measurements show the balance of the intensities of the γ-transitions which are populated and de-excited 767.3 *keV* level. Further, the annihilation photopeak did not appear in the coincidence spectrum with the gate on the 768 *keV* energy. In addition to these arguments the 767 *keV* level was observed in the (d,p) reaction and the spin and the parity of the level was determined as $3/2^+$ or $5/2^+$ /6,8/. It means that the suggested β^+-transition would have to be the second-forbidden transition, at least.

From the Q value of 3270 *keV* /3/, half-life /3,5/, the theoretical calculation of the ϵ/β^+ ratio /16/ and the intensities of the γ -transitions log ft values can be determined. The combination of these log ft values with the data from nuclear reactions and the systematics of the excited states can give the unique spin and parity values.

It is remarkable that the allowed $\beta^+ - \epsilon$ -transition leading to the 231.7 $(7/2^+)$ state /3,9/ has the value of log ft equal to 7.0. But several allowed $\beta^+ - \epsilon$ -transitions of the nuclei from a neighbourhood of ^{85}Sr have a similar value of log ft 6.6. Basing on this knowledge we expect that the allowed β^+-transitions not only have log ft 6.6. but there are log ft ~ 7.

The 238.9 *keV* level $(1/2^-)$ is heavily populated by γ -transitions from the levels at 785.6 and 936.9 *keV*. From this it follows that the spin and the parity of these levels can be $1/2^\pm$, $3/2^\pm$ or $5/2^-$. On the other hand, these levels are populated from the higher levels which are connected with the $^{85}Y(9/2^+)$ ground state by allowed $\beta^+ - \epsilon$ -transitions. From this fact the conclusion can be drawn that spin and parity of 785.6 *keV* state is $3/2^+$ or $5/2^-$. In case of the 936.9 *keV* level the reaction data /6,7/ restricted the spin and the parity to $5/2^-$.

The 767.3 *keV* level was observed in the (d,t), (d,p) nuclear reactions and its quantum characteristics have been established as $3/2^+$ or $5/2^+$ /6,8/. However, this level decays to the 231.7 *keV* $(7/2^+)$ level as well as to the ground state $(9/2^+)$, therefore we have proposed the values of $5/2^+$ as spin and parity of the 767.3 *keV* level.

We favour the assignment of $I^\pi = 3/2^+$ for the 1355.0 *keV* level as well as the value of $5/2^+$ for the 1555.2 *keV* state. This choice is in accordance with the facts that the level at energy of 1355.0 *keV* is de-excited to 231.7 $(7/2^+)$, 743.3 $(3/2^-)$, 767.3 *keV* $(5/2^+)$ and the level of 1555.2 *keV* is depopulated by γ -transitions to levels at energies of $0(9/2^+)$, 231.7 $(7/2^+)$, 767.3 $(5/2^+)$ and 785.6 *keV* $(3/2^+, 5/2^-)$.

Prior to a next discussion it is useful to remark that these uplying levels which are first populated by allowed $\beta^+ - \epsilon$ -transitions and after this they are de-excited by the γ -transitions to the levels with $I^\pi = 3/2^+$ or $5/2^-$ must have the quantum characteristics $7/2^+$.

With respect to this the levels at energies of 2123.7, (2171.9), 2351.7, 2642.3, 2975.7, 2990.3, 3031 and 3075.4 *keV* belong to a family of the levels with $7/2^+$.

Now we can say the spins and the parities of most of the excited states of ^{85}Sr have been deduced on the basis of similar arguments. All the deduced quantum characteristics of the levels of ^{85}Sr are shown in *fig. 4*.

4. DISCUSSION

According to the shell model the $^{85}_{38}Sr_{47}$ nucleus has 3 holes in a $g_{9/2}$ neutron shell and therefore several excited states with the positive parity can arise owing to a configuration interaction among these holes.

Talmi and Unna have calculated these positive parity levels /9/. The attempts have been made to identify these hole states by Horen and Kelly /3/ and Arlt et al. /4/.

One member of the three hole multiplet is the $7/2^+$ state at energy of 231.7 *keV* /8,9/. This excited state is populated by the β^+-decay of ^{85g}Y with the value of log ft equal to 7.0. The energy of this level has been taken by Talmi and Unna /9/ into calculation of multiplet splitting.

It is known that this state has not been observed in the (d,p), (d,t) and (^3He,α) reactions /6–8/. In accordance with this we suppose that all other members of the multiplet do not appear in the nuclear reactions of the kind mentioned above. Besides, we have formulated the additional two criteria of the identification of levels with $I^{\pi} = 7/2^+ - 11/2^+$ as members of $(g_{9/2})^{-3}$, $\nu = 3$ multiplet.

The first criterion was the value of log ft (~7) of $\beta^+-\epsilon$ -transitions leading to the levels in question.

The second one was similar values of the ratio R of the reduced transition probability of the ground state γ-transition to the reduced transition probability of the γ-transition from the level in question to the first excited state in ^{85}Sr. Some results of the calculation of this ratio R are given in *Table 3* where the E2 multipolarity for all γ-transitions is supposed.

Considering all these criteria we have determined the next 5 levels as the members of the $(g_{9/2})^{-3}$ multiplet, i.e., 231.7 $(7/2^+)$, 767.3 $(5/2^+)$, 1261.9 $(11/2^+)$, 1405.1 $(3/2^+)$ and 1626.9 *keV* $(9/2^+)$.

The resulting comparison of the experimental data from our study of the ^{85}Y decay and nuclear reactions with the levels calculated on the basis of three holes clusters of configurations $(g_{9/2})^{-3}$ and $(p_{1/2})^{-2}(g_{9/2})^{-1}$ /9/ is shown in *fig. 5*.

It should be noted that several levels with similar value of log ft are distributed at about 1600 *keV*. We have

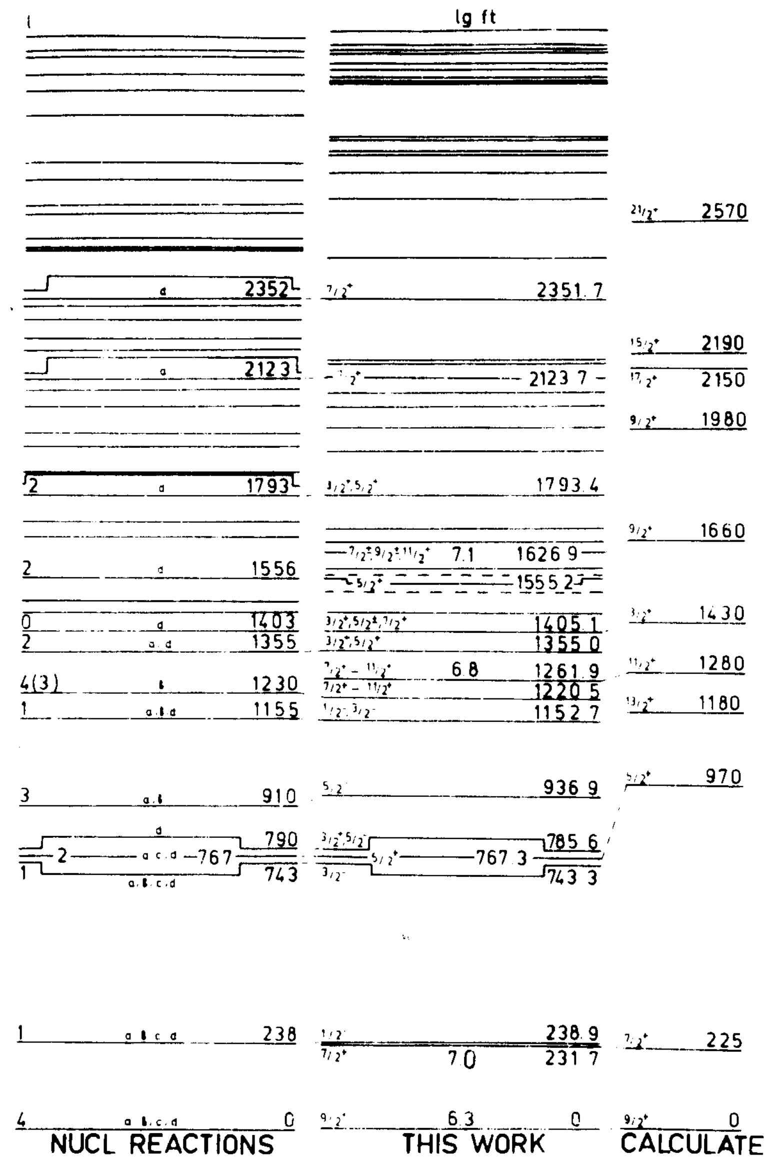

Fig. 5. The comparison of experimental levels of ^{85}Sr with the calculated levels of 3 - neutron hole cluster /9/. a) - (d,p), (d,t), ref. /6/ ; b) ; c) - (^3He, α), ref. /7/ ; d) - (d,p), ref. /8/

chosen the 1626.9 *keV* state as the member of the multiplet in conformity with the third criterion (see *table 3*).

There is one problem as to the 767.3 *keV* level attached to the $(g_{9/2})^{-3}$ multiplet. This level has been observed in (d,p) reaction [6,8] but in our opinion this fact can be explained by a configuration mixing.

Some levels populated by fast allowed ϵ-transitions (log ft ≈ 5.8) have been observed in the ^{85}Sr nucleus too. It is possible to relate those to transitions between the levels of spin-orbital doublet with $j_1 = \ell \pm 1/2$ and $j_2 = \ell \mp 1/2$. The transitions $p(g_{9/2}) \to n(g_{7/2})$, $p(p_{3/2}) \to n(p_{1/2})$ and $p(p_{1/2}) \to n(p_{3/2})$ can be ascribed to those mentioned above. In consequence of these transitions there are $n(g_{7/2})$, $p(g_{9/2})p(p_{3/2})^{-1}n(p_{1/2})$ and $p(g_{9/2})p(p_{1/2})n(p_{3/2})$ configurations with the spin in the range of $I^{\pi} = 5/2^{+} - 13/2^{+}$ but the $\beta^{+} - \epsilon$ - decays of ^{85}Y pick-up the states with $I^{\pi} = 7/2^{+}$, $9/2^{+}$, $11/2^{+}$ only.

However, many states can arise owing to configuration mixing and all of them can be populated by $\beta^{+} - \epsilon$ -transitions with a low value of log ft.

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