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LOW-LYING STATES OF ^{94}Nb

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Following the ^{93}Nb (n, γ)^{94}Nb reaction the conversion electron and gamma ray spectra have been measured. A preliminary level scheme of $^{94}_{41}$Nb$_{53}$ has been established including 39 levels up to energy of about 1 MeV. An attempt has been made to interpret part of the states in terms of proton-neutron multiplets.

1. *Introduction*

The odd-odd nucleus $^{94}_{41}$Nb$_{53}$ is placed near magic numbers of protons $z = 40$ and neutrons $n = 50$. It was expected that the low-lying states of ^{94}Nb could be interpreted as an interaction of one proton, one or three neutrons in the field of the spherical (or only weakly deformed) vibrating core. The proton-neutron multiplet structure is based on the quasiproton $\tilde{g}^{+1}_{9/2}$, $\tilde{p}^{-1}_{1/2}$, $\tilde{p}^{-1}_{3/2}$, $\tilde{f}^{-1}_{5/2}$ and on the neutron cluster $(d_{5/2})^3$ 5/2$^+$, $s_{1/2}\,(d_{5/2})^2$ 1/2, $g_{7/2}\,(d_{5/2})^2$ 7/2 configurations. The first configuration for classification of the low-lying states is $[\pi g_{9/2}, \nu\,(d_{5/2})^3{}_{5/2}]$ 2$^+$, 3$^+$, 4$^+$, 5$^+$, 6$^+$, 7$^+$. The next positive parity multiplets could be made as

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$[\pi g_{9/2}, \nu (d_{5/2})^3{}_{3/2}]$ 3^+, 4^+, 5^+, 6^+; $[\pi g_{9/2}, \nu (d_{5/2})^3{}_{9/2}]$ 0^+, 1^+, 2^+, 3^+, 4^+, 5^+, 6^+, 7^+, 8^+, 9^+ etc. and $[\pi p_{1/2}, \nu (d_{5/2})^3{}_{3/2}]$ 1^-, 2^-; $[\pi p_{1/2}, \nu (d_{5/2})^3{}_{5/2}]$ 2^-, 3^- etc. as negative parity multiplets.

The previous experiments on the ^{93}Nb (n, γ)^{94}Nb$^{1,2)}$ and ^{93}Nb (d, p)^{94}Nb$^{3)}$ reactions were summarized in Ref. 4. The measurements on the ^{94}Zr (p, n γ)^{94}Nb reaction$^{5,6)}$ have been also made. In spite of the extensive number of measurements on ^{94}Nb some discrepances in the level schemes from different reactions were found.

For ^{94,96}Nb nuclei calculations have been done both in the shell model using an effective two body interaction between proton and neutron$^{7)}$ and using one phonon (quadrupole, dipole) exchange$^{8)}$ giving rise to a simple parabolic splitting of the multiplets. Deviations from the parabolic splitting have been found in general for those multiplets containing partners with spin value higher than $j = 3/2$.These deviations show a staggering pattern indicating contributions from higher multipoles.

In the present work the nucleus ^{94}Nb produced in the (n, γ) reaction, has been investigated by several techniques at the High-Flux Reactor of the Institute Laue-Langevin (ILL) in Grenoble and at the DIDO reactor of the Kernforschungsanlage Jülich.

The aim of this work was to construct the level scheme, to determine the spin and parity assignments and to interpret part of the states in terms of proton-neutron multiples.

A preliminary report on this work has been published in the Proceedings of the Fifth International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics 1984, Knoxville, Tennessee, Edited by S. Raman, AIP Conference Proceedings No. 125, p. 382.

2. *The experimental methods and results*

2.1. *The investigation of gamma transitions in ^{94}Nb*

2.1.1 The secondary gamma-ray spectra from the ^{93}Nb (n, γ) reaction have been measured at the bent crystal spectrometers GAMS1 in the energy range $40 < E_\gamma < 500$ keV and GAMS2, 3 in the region $150 < E_\gamma < 1500$ keV. The sample of 50 mg of niobium metal was irradiated in the thermal flux of 5.5×10^{14} n/cm^2. The energy calibration was performed using the energy of 255.92 keV transition obtained by Gruber et al.$^{1)}$. The error of this energy is not included in the errors of the obtained energies of gamma transitions given in Table 1. Intensities of gamma rays were derived using the absolute intensity of the 99.40 keV transition as 20.3(4).

2.1.2 At DIDO reactor in KFA-Jülich two single gamma spectra from ^{93}Nb (n, γ) reaction have been measured with 1.4 cm^3 Ge and 60 cm^3 Ge (Li) detectors in the region of gamma energies 0—550 keV and 0—1350 keV, respectively. The metal foil 12×12 mm^2 and 0.05 mm thick has been used as a target. The background without the ^{93}Nb metal, only with the holder, has been also measured. Energy calibration has been made with ^{133}Ba and ^{152}Eu lines and with the data of ^{94}Nb obtained in the GAMS experiment. The resolution was 0.4 keV at 99.41 keV line for 1.4 cm^3 Ge measurement.

TABLE 1.

E_γ/keV dE_γ[a]	I_γ (/100N) dI_γ (%)[b]	E_i/keV	E_f/keV	α_K^{exp} $d\alpha$ (%)	Multipolarity
17.98(7)	5.10(17)	58.70	40.90		
40.90(5)	0.045(10)	40.90	0	789(11)	M3
				$L_2/L_1 = 0.18$	
				$L_3/L_1 = 1.12$	
45.89(5)	0.015(3)	970.18	924.50		
46.55(5)	0.034(3)	1023.34	976.75		
47.63(5)	0.027(3)				
48.03(5)	0.026(3)				
49.79(50)	0.009(2)				
54.4247(35)[d]	0.379(65)				
54.706(13)	0.606(4)	113.40	58.70	1.78(10)	M1 + 9%E2
56.4856(70)	0.555(25)				
57.244(10)[d]	0.337(164)				
57.5435(54)	0.900(37)				
57.89(5)	0.243(16)				
59.21(7)	0.190(12)				
61.15(5)[c]	0.102(9)				
64.99(4)	0.160(12)				
65.29(4)	0.173(12)				
67.5334(45)	0.146(11)				
71.42(10)	0.053(7)	1230.10	1158.70		
71.842(5)	0.200(11)				
78.6683(8)	2.42(8)	78.67	0	0.370(10)	M1
99.4074(9)	20.3(4)	140.01	40.90	0.108(8)	M1
				$L_1 = 0.016(13)$	
103.41(10)	0.071(8)				
104.20(10)	0.063(7)	1262.83	1158.70		
108.108(9)	0.116(13)				
110.8510(4)	0.147(8)				
113.4007(8)	10.65(24)	113.40	0	0.148(7)	M1
118.72(8)	0.060(5)	1179.14	1060.35		
125.183(16)	0.034(4)	1060.35	935.16		
127.67(15)	0.022(5)	1060.35	932.66		
		1023.33	895.65		
134.540(10)	0.187(8)	1030.19	895.65		
135.344(30)	0.303(82)	1158.70	1023.33		
138.614(8)	0.917(178)				
140.099(34)	0.283(198)	932.66	792.57		
142.65(12)	0.029(4)	935.16	792.57		
145.90(4)	0.143(6)	1231.98	1086.15		
146.87(15)	0.033(8)	932.66	785.89		
148.69(11)	0.008(3)	450.21	301.57		
149.837(12)	0.136(35)				
150.707(24)	0.123(6)	816.82	666.10		
153.64(11)	0.020(8)	1086.15	932.66		
156.13(8)	0.034(4)				
161.261(2)	1.31(8)	301.57	140.31		
190.42(7)	0.064(5)	1086.15	895.65		
194.14(30)	0.011 (6)	1011.16	816.82		
229.90(15)	0.044(8)	895.65	666.10		
253.113(5)[c]	9.25(6)	311.82	58.70	0.033(12)	E2
254.85(14)[d]	0.527(255)				
255.929(2)	12.4(4)	396.23	140.31	0.020(18)	M1 + 14%E2
263.21(7)	0.063(7)	1158.70	895.65		
267.85(7)	0.136(25)	1060.35	792.75		

E_γ/keV $dE_\gamma$$^{a)}$	I_γ (/100 N) dI_γ (%)$^{b)}$	E_i/keV	E_f/keV	α_K^{exp} $d\,\alpha$ (%)	Multipolarity
270.46(7)	0.496(17)	1247.25	976.74		
293.205(4)	4.48(16)	334.10	40.89	0.019(33)	(M1),E2
303.43(11)	0.142(10)	935.16	631.51		
309.914(8)	4.64(3)	450.21	140.31		
316.510(31)	0.10(8)	957.45	640.99		
319.62(13)	0.204(8)	631.51	311.82		
329.174(13)	0.826(28)	970.18	640.99		
		640.99	311.82		
330.98(7)	0.033(9)				
332.33(15)	0.063(6)	1230.10	924.50		
337.529(8)	4.09(15)	396.23	58.70		
338.733(71)	0.230(12)	970.18	631.51		
355.362(50)	0.473(25)	396.23	40.90		
360.447(57)	0.161(33)				
366.10(25)	0.029(8)	1158.70	792.57		
367.11(25)	0.042(8)	1262.83	895.65		
374.03(8)	0.036(8)				
377.32(8)	0.101(9)	1272.82	895.66		
		1169.83	792.57		
381.84(25)	0.121(9)	1023.33	640.99		
396.38(50)	0.052(9)	792.57	396.23		
399.10(50)	0.053(9)	1030.19	631.51		
409.26(15)	0.091(12)	450.21	40.89		
413.02(18)	0.092(9)	1230.10	816.82		
437.73(25)	0.067(8)	1230.10	792.57		
443.55(25)	0.072(11)				
451.04(15)	0.202(10)				
454.34(50)	0.184(10)	1247.25	792.57		
		1086.14	631.51		
455.963(38)	0.605(9)	1272.81	816.82		
458.464(11)	1.64(5)	792.57	334.10		
482.637(64)	0.145(11)	816.82	334.10		
484.356(26)	0.444(51)	785.89	301.57		
491.41(17)	0.063(11)				
499.426(8)	4.42(7)	895.65	396.23		
518.117(14)	4.07(15)	631.51	113.40		
525.766(48)	0.563(44)	666.10	140.31		
527.574(24)	0.85(5)	640.99	113.40		
530.75(25)	0.134(10)				
535.24(25)	0.052(11)				
538.34(25)	0.048(10)	1179.14	640.99		
		1169.83	631.51		
547.76(10)	0.299(16)	1179.14	631.51		
552.76(16)	0.084(14)	666.10	113.40		
		631.51	78.67		
561.931(52)	0.227(9)				
562.341(14)	2.00(2)	640.99	78.67		
572.79(50)	0.121(12)	1023.33	450.21		
		631.51	40.90		
583.79(12)	0.094(10)	895.65	311.82		
590.595(51)	0.630(40)	631.51	40.90		
598.84(50)	0.144(10)	1230.10	631.51		
		932.66	334.10		
600.48(50)	0.217(13)				
612.28(50)	0.072(12)	924.50	311.82		
622.26(100)	0.062(10)	924.50	301.57		
624.11(100)	0.075(11)				

E_γ/keV dE_γ a)	I_γ (/100 N) dI_γ (%) b)	E_i/keV	E_f/keV	α_K^{exr} $d\alpha$ (%)	Multipolarity
627.636(65)	0.126(11)				
635.986(35)	0.445(2)	1086.15	450.21		
		970.18	334.10		
638.742(69)	0.255(58)				
641.054(61)	0.345(11)	640.99	0		
642.585(44)	0.444(25)	976.74	334.10		
645.19(25)	0.153(11)	785.89	140.31		
656.47(50)	0.067(10)				
658.20(50)	0.096(11)	970.18	311.12		
663.11(15)	0.187(14)				
672.50(50)	0.173(12)	785.92	113.40		
683.03(22)	0.348(28)				
685.56(15)	0.161(12)				
689.907(24)	1.23(6)	1086.15	396.23		
693.763(42)	0.614(2)				
696.17(25)	0.101(11)	1030.19	334.10		
705.86(25)	0.123(16)				
711.56(18)	0.147(11)	1023.33	311.82		
718.37(50)	0.057(11)	1030.19	311.82		
721.20(23)	0.202(12)				
734.15(40)	0.093(10)	792.57	58.70		
735.15(35)	0.200(11)				
748.40(25)	0.216(13)	1060.35	311.82		
751.783(69)	0.932(6)	792.51	40.89		
755.281(71)	0.847(54)	895.65	140.31		
761.85(30)	0.127(18)				
771.17(10)	0.052(13)				
775.993(54)	1.095(71)	816.82	40.89		
782.57(25)	0.432(40)	1179.14	396.23		
		895.65	113.40		
791.83(50)	0.111(12)				
801.74(30)	0.115(13)				
812.46(13)	0.592(51)	1262.83	450.21		
820.73(15)	0.158(11)				
822.54(50)	0.128(10)	1272.82	450.21		
835.717(29)	2.58(13)	1231.98	396.23		
844.37(25)	0.083(13)				
849.17(15)	0.111(14)				
851.34(35)	0.142(12)	1247.25	396.23		
854.35(35)	0.155(13)	932.67	78.67		
857.31(21)	0.178(12)				
876.41(11)	0.501(42)	935.16	78.67		
878.852(95)	1.36(8)	957.45	78.67		
879.75(14)	0.510(40)				
883.75(59)	1.34(8)	924.50	40.89		
888.67(38)	0.084(19)				
890.705(419)	0.130(18)				
894.237(50)	1.32(8)	935.16	40.98		
896.998(65)	0.985(51)				
901.23(25)	0.104(19)				
911.560(82)	1.23(8)	970.18	58.70		
932.87(50)	0.130(20)	932.66	0		
935.90(50)	0.286(28)				
944.55(15)	0.515(42)	1023.33	78.67		
946.835(32)	3.28(17)				
950.94(35)	0.172(15)	1262.83	311.82		
957.336(44)	1.79(10)	957.45	0		

E_γ/keV dE_γ $^{a)}$	I_γ (/100 N) dI_γ (%) $^{b)}$	E_i/keV	E_f/keV	α_K^{exp} $d\alpha$ (%)	Multipolarity
964.79(15)	0.118(20)	1023.33	113.40		
977.07(50)	0.123(33)	976.74	0		
982.39(10)	0.098(30)	1023.33	40.89		
984.73(50)	0.210(31)				
1001.75(15)	0.247(38)	1060.35	58.70		
1007.79(42)	0.464(57)				
1019.58(35)	0.187(16)	1060.35	40.89		
1023.48(22)	0.088(14)	1023.33	0		
1026.704(282)	0.054(15)				
1049.13(50)	0.079(15)				
1052.91(50)	0.453(51)				
1056.39(15)	0.112(37)	1169.83	113.40		
1061.45(11)	0.178(42)				
1067.36(17)	0.082(12)				
1071.61(50)	0.097(28)				
1087.95(25)	0.163(34)				
1100.11(15)	0.577(57)	1158.70	58.70		
1107.42(25)	0.578(57)	1247.25	140.35		
1111.13(17)	0.083(14)	1169.83	58.70		
1118.00(25)	0.83(7)	1158.70	40.89		
1119.08(40)	2.31(53)	1231.98	113.40		
1120.36(50)	0.643(57)	1179.14	58.70		
1122.65(25)	0.453(40)	1262.83	140.31		
1129.02(25)	1.11(8)	1169.83	40.89		
1132.83(100)	0.142(13)				
1151.49(50)	0.402(62)	1230.10	78.67		
1159.98(50)	0.473(51)	1272.81	113.40		
1180.24(50)	0.162(16)				
1185.08(30)	0.314(15)				
1188.26(35)	0.405(31)	1247.25	58.70		
1192.16(50)	0.883(70)				
1206.52(24)	1.53(10)	1247.25	40.89		
1209.97(50)	0.251(16)				
1214.57(50)	0.317(42)	1272.81	58.70		
1216.52(50)	0.220(34)	1256.95	40.89		
1220.07(50)	0.348(42)				
1222.98(12)	0.728(70)	1281.63	0		
1228.21(11)	0.671(62)				
1230.08(15)	0.334(40)	1230.10	0		
1234.27(50)	0.337(42)				
1239.38(25)	0.609(71)				
1257.03(14)	0.382(51)	1256.95	0		
1258.85(17)	0.395(78)				
1264.69(15)	0.161(15)				
1273.44(50)	0.388(48)				
1279.705(464)	0.165(16)				
1281.66(50)	0.115(55)	1281.63	0		
1291.30(50)	0.725(48)				
1300.46(50)	0.108(16)				
1304.80(50)	0.068(15)				
1308.14(35)	0.453(37)				
1319.00(100)	0.070(21)				
1327.46(50)	0.231(17)				
1334.55(50)	0.388(33)				
1344.75(50)	0.056(13)				
1347.06(50)	0.055(10)				
1349.44(50)	0.072(17)				

The final list with values for energies and intensities of gamma transitions is presented in Table 1. The errors given in parentheses represent one standard deviation.

2.2. The investigation of the internal conversion electron spectrum from the ^{93}Nb (n, γ) reaction with the iron-core electron spectrometer BILL at ILL in Grenoble$^{9)}$ has been performed. The target at about 80 μg/cm^2 thick was made by evaporation of niobium oxide onto an 200 μg/cm^2 Al foil. The rather small (1.2 × × 10^{-24} cm^2) cross section for the reaction was the reason that only the strongest electron conversion lines could be measured. The electrons were registered with the multiwire (32 wires) proportional counter. The GAMS data were used for the energy calibration. Absolute conversion electron intensities were obtained using the intensity of the electron conversion lines for M3 40.90 keV gamma transition and the theoretical conversion coefficients of Hager and Seltzer$^{10)}$. The experimental values of the internal conversion coefficients and corresponding multipolarities are given in Table 1.

3. *The level scheme*

The level scheme of ^{94}Nb was constructed on the basis of the new experimental results and previously published level schemes$^{4,5)}$. The γ-γ coincidence data given in Refs. 3 and 5 were used to confirm the levels obtained by Ritz combinations. The spin and parity assignments were made using the internal conversion, thermal and resonance neutron capture$^{12)}$ and (d, p) reaction data$^{2)}$.

The list of the levels, parity and spin assignments is given in Table 2. The level scheme of ^{94}Nb is presented in Figs. 1 and 2.

The levels at 0 (6^+), 40.9 (3^+), 58.7 (4^+), 78.7 (7^+), 113.4 (5^+) and 140.3 keV (2^-) are of the same energies and spin and parity assignments as previously published$^{4)}$.

The levels at 301.6, 450.2, 666.1, 785.0, 924.5 keV energies were made on the basis of γ-γ coincidence results given by Fedorets et al.$^{5)}$. The 161 keV transition depopulating 301 keV level has been found in coincidences with the 6437 keV primary transition$^{1)}$ what is in the contradiction with the present placement. By the Ritz combinations the 161 keV transition could be placed only between the 301 and 140 keV levels.

The levels at 311.8, 334.1, 396.2, 631.5, 641.0, 792.6, 816.8, 895.65, 935.2, 957.4, 970.2, 976.7, 1011.2, 1060.3, 1086.1, 1158.7, 1169.8, 1179.1, 1232.1, 1247.25, 1256.95, 1262.8, 1272.8 and 1281.6 keV were found in the Ref. 4. All these levels were determined on the basis of the (d, p)$^{2)}$ and primary thermal and resonance neutron capture results$^{12)}$.

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a) The errors in brackets are those of the last digitis .
b) The errors given in brackets are those of the last digits.
c) Doubtful line.
d) The line measured only with GAMS.
e) ^{94}Nb + Ge, the Ge component intensity is equal to 1.8(3).

Low energy transitions and conversion electron data in ^{94}Nb.

TABLE 2.

Level energy keV (eV)	J^{π}	Level energy keV (eV)	J^{π}
0	6^+	935.158(33)	$3^{(+)}, 4^{(+)}, 5^{(+)}$
40.894(12)	3^+	957.449(41)	5^+
58.702(10)	4^+	970.176(23)	$4^{)+(}, (3^+, 5^+)$
78.668(10)	7^+	976.743(370)	$4^+, 5^+$
113.401(10)	5^+	1011.160(12)	$4^+, 5^+$
140.302(12)	2^-	1023.33(36)	5^+
301.562(12)	2^-	1030.194(17)	$3, 4, 5^+$
311.816(10)	$4^+, 5^+$	1060.348(34)	$4^+, 5^+$
334.102(13)	$2^+, 3^+$	1086.142(22)	$4^{(-)}, 5^-$
396.231(12)	3^-	1158.703(38)	$3^{(+)}, 4^{(+)}, 5^+$
450.213(14)	$3^{(-)}$	1169.827(29)	$4^+, 5^+$
631.513(13)	$4^+, 5^+$	1179.139(61)	$3^+, 4^+, 5^+$
640.994(11)	$5^+, 6^+$	1230.101(67)	5^+
666.101(44)	$2^-, (3^-)$	1231.983(36)	$4, (3^+, 5^-)$
785.886(24)	$3^+, (4^-)$	1247.253(72)	$3^+, (3^-, 4^-)$
792.566(16)	$4^+, (3^+)$	1256.950(10)	$4^+, 5^+$
816.824(3L)	$3^+, (4^+)$	1262.832(74)	4^-
895.654(17)	$4^-, (3^-)$	1272.811(46)	$4^+, (5^-)$
924.498(54)	$3^-, (4^-)$	1281.63(11)	$4^+, 5^+$
932.661(34)	5^+		

Energy levels and J^{π} assignments.

The new level at 932.7 keV was also found on the basis of (d, p) and primary thermal and resonance neutron capture results.

The new levels at 1023.3, 1030.2 and 1230.1 keV were found only by the Ritz combinations.

Looking at the properties of the neighbouring odd *A* nuclei one can notice that in both $^{93}_{40}Zr_{53}$ and $^{93}_{41}Nb_{52}$ the situation is rather involved. Beside the predominantly one quasiparticle states we have also low-lying brocken pairs and collective states. This makes difficulties in interpreting the low-lying states in ^{94}Nb in terms of proton-neutron multiplets.

As already stated the states at 334 (2^+), 113 (5^+), 79 (7^+), 59 (4^+), 41 (3^+) and 0 (6^+) keV are serious candidates for the $(\pi\, \tilde{g}_{9/2}^{+1}, \nu\, \tilde{d}_{5/2}^{-1})$ $2^+, 3^+, 4^+, 5^+, 6^+, 7^+$ multiplet. They are connected by strong M1 transitions, have comparable spectroscopic factors in (d, p) reaction and angular distribution consistent with $l_n = 2$ transfer angular momentum. Only in 113 (5^+) state a small $l_n = 0$ component is required to fit the angular distribution. However, the transfered neutron with $l_n = 2$ has a spectroscopic factor an average of $S \approx 0.64$ consistent with a quasiparticle characteristics of the transfered neutron, indicating the importance of the additional cluster configurations.

In Fig. 3 the experimental points of the multiplet are given in full circles and connected by a heavy drawn line. The calculated spectra are given as a parabola for one phonon exchange with $2/b_2^2$ as a scale factor fitted to the 2^+ and 6^+ states. The P_2 term and a smaller part of the linear $X/2$ term originate from the quadrupole while the part of the $X/2$ term is the dipole contribution. These points are indicated by crosses and connected by a dashed line. Keeping the last term the same as

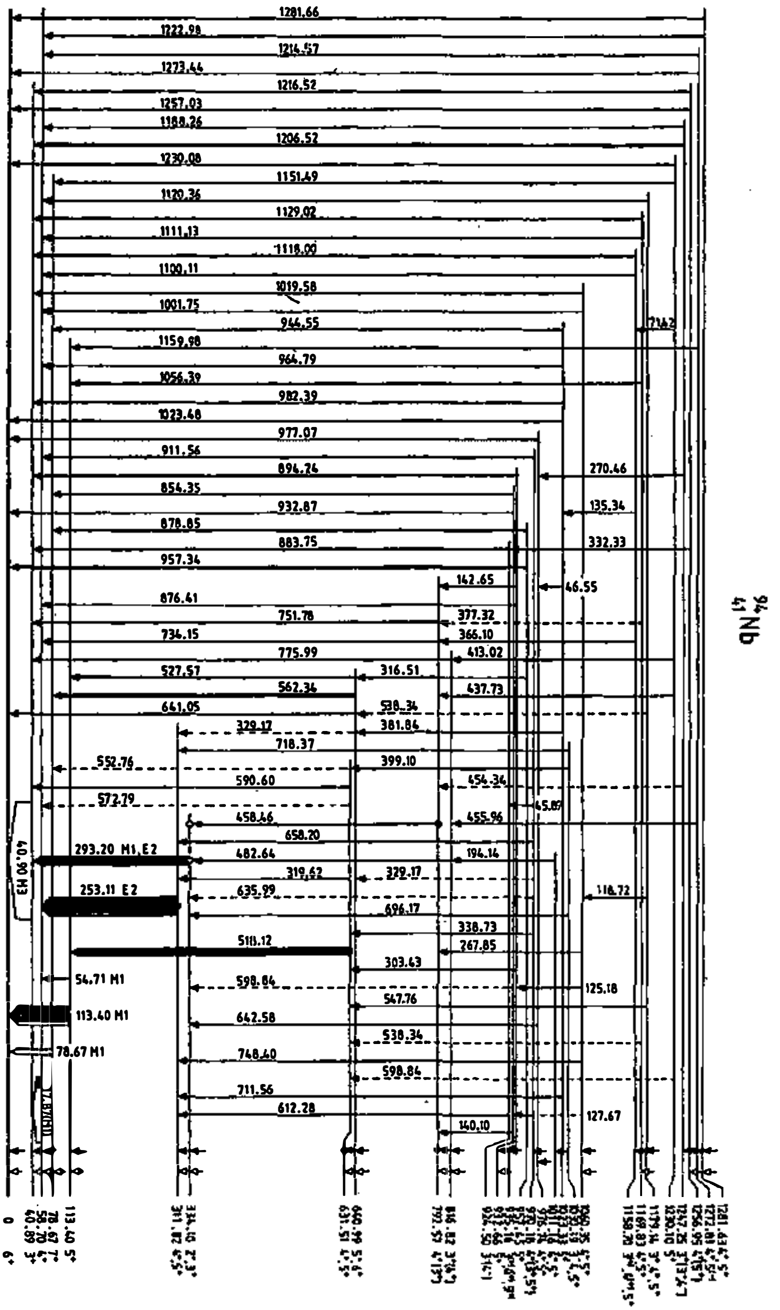

Fig. 1. The ^{94}Nb level scheme from the (n, γ) reaction incluiding all levels of positive parity. The full and open portions of the transitions are proportional to the γ and e$^-$ intensity, respectively. The open arrows to the states indicate that the states are excited in (d, p) reaction, full arrows mark primary transitions in n_{th} and n_{res} capture[2]. Open and full circles indicate γ—γ coincidences from Refs. 2 and 4, respectively.

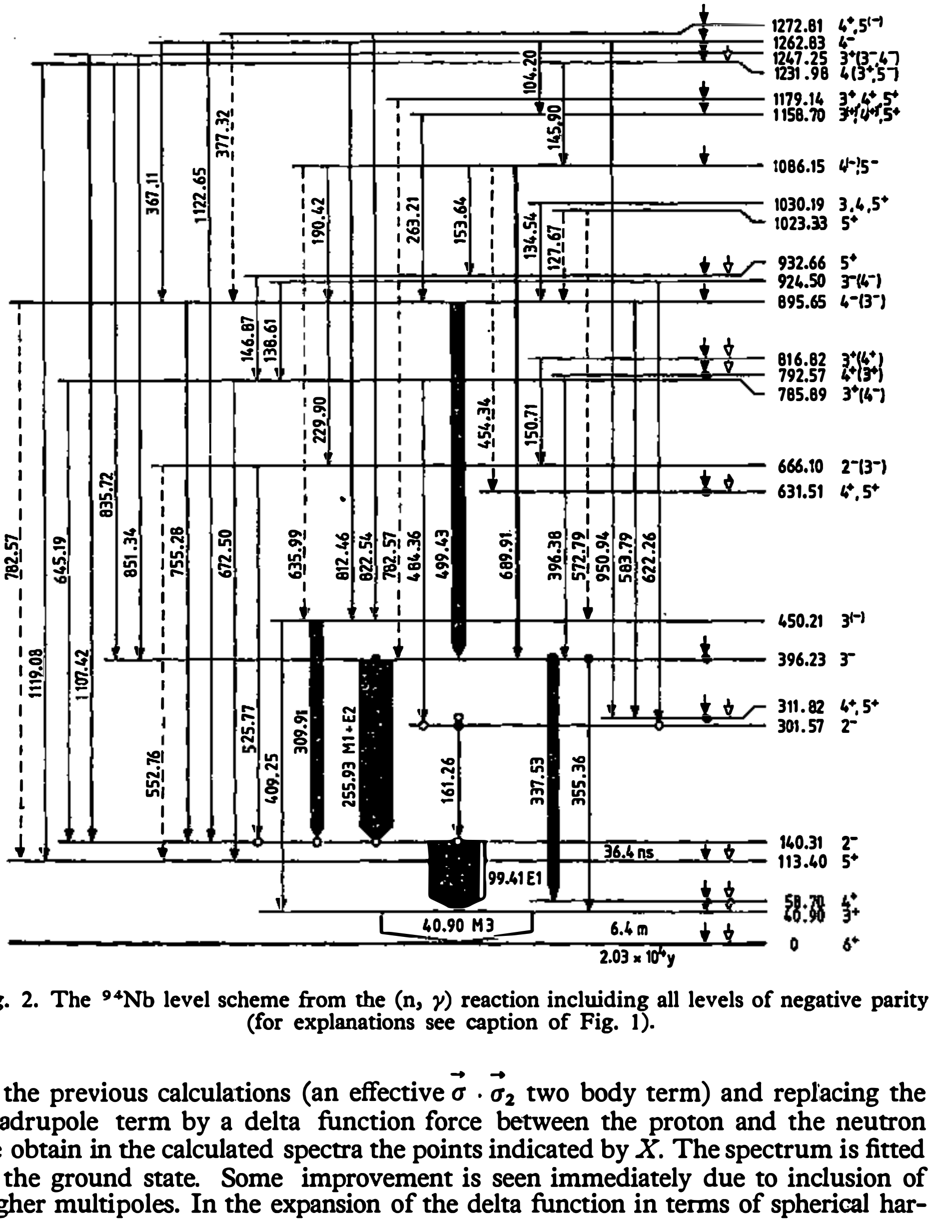

Fig. 2. The ^{94}Nb level scheme from the (n, γ) reaction incluiding all levels of negative parity (for explanations see caption of Fig. 1).

in the previous calculations (an effective $\vec{\sigma} \cdot \vec{\sigma}_2$ two body term) and replacing the quadrupole term by a delta function force between the proton and the neutron we obtain in the calculated spectra the points indicated by X. The spectrum is fitted to the ground state. Some improvement is seen immediately due to inclusion of higher multipoles. In the expansion of the delta function in terms of spherical harmonics for $j_p = 9/2$ and $j_n = 5/2$ configurations only the $l = 0{,}2$ and 4 terms contribute. Since the $l = 0$ contribute only an unimportant constant, the only correction to the quadrupole term in delta function comes from the hexadecapole contribution. The quadrupole and the hexadecapole terms appear in the expansion of the delta function with a given weight limiting the possible pattern of the spectra in this model. Sticking to the model the deviations should be atributed to the influence of the additional configurations.

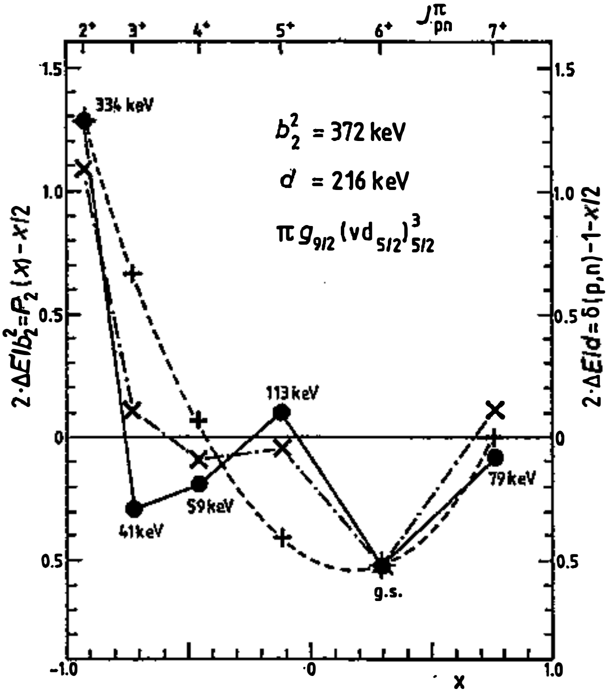

Fig. 3. The g. s. multiplet in ^{94}Nb (● experimental energies, + lowest order quasiparticle-vibrational model, x short range residual interaction)

$$x = \frac{\mathcal{J}_{pn}(\mathcal{J}_{pn}+1)-j_p(j_p+1)-j_n(j_n+1)}{2(j_p(j_p+1)j_n(j_n+1))^{1/2}}.$$

With these remarks in mind it is easy to obtain a simple rule saying that for multiplets containing $j = 3/2$, $5/2$, $7/2$ etc. configurations we have parabolic level splitting and deviation from the parabola of hexadecapole and higher multipole type. This makes it possible to attempt to classify the proton-neutron multiplets along the line suggested by J. P. Schiffer et al.$^{7)}$.

Unfortunately there is not sufficient data on higher excited states to resolve the other multiplets. The states at 792, 641, 631 and 311 keV are candidates for a $(\pi g_{9/2}, \nu 3/2)$ 3, 4, 5, 6 multiplet with an approximate parabolic level splitting.

As the last remark we would like to point out the strong E2 transition connecting the 312 and 59 keV states indicating that collective states are appreciably mixed into the low lying states in ^{94}Nb.

A further investigation of the missing weak lines certainly would help to establish some of the low spin states and thereby also improve the level sheme of ^{94}Nb.

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NISKO POBUĐENA STANJA U ^{94}Nb

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Ispitivana je šema nisko pobuđenih stanja jezgra ^{94}Nb na osnovu eksperimentalnih podataka dobijenih posle ^{93}Nb(n, γ) reakcije. Mereni su spektri konverzionih elektrona i sekundarnih gama prelaza. Nađeno je 39 pobuđenih stanja do energije od 1 MeV. Utvrđena su stanja osnovnog protonsko-neutronskog multipleta.