

## Isomeric flag of Nb-102, Tc-102, Rh-108, Sb-128, Sb-132

(N. Otsuka, 2021-04-26, Memo CP-D/1009(Rev.))

**Note added to this Working Paper:**

Adoption of the ground and metastable state assignment in ENSDF and NUBASE is proposed for  $^{102}\text{Nb}$ ,  $^{102}\text{Tc}$ ,  $^{108}\text{Rh}$ ,  $^{128}\text{Sb}$  and  $^{132}\text{Sb}$ .

Andrea Mattera (NNDC) informed that the independent isomeric yield ratios of  $^{132}\text{Sb}$  from low-energy neutron-induced fission in EXFOR 20589, 20878, 22017, 22161, 33011, 33016-33018 and 33029 are consistent except for EXFOR 20878.007-008 and 012 compiled from G. Paffarth and H.O. Denschlag, R,MAINZ-75,90,1976. This report gives the isomeric ratio of the independent fission yields IFY(2.8 min, 4<sup>+</sup>)/IFY(4.2 min, 8<sup>-</sup>) in Table 12. They do not mention which one is the ground state, and the ratios have been compiled in EXFOR as the -M/G ratios.

Memo CP-D/0888 reports this assignment (M/G) is opposite to the assignment in the Nuclear Wallet Cards.

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132SB L 0.0 (4)+ 2.79 M 7 E
132SB2 L %B==100
132SBX L XREF=A
132SB cL J$M1+E2 |g from (3)+. Configuration=|pg{-7/2}~#|nd{-3/2}{+-1}.
132SB2cL J|p=3+ is not completely ruled out
132SB cL T$ weighted average of 2.70 min {I15} (1972Na10), 2.80 min {I10}
132SB2cL (1974Ke08), 2.80 min {I7} (1975Ba36), 2.79 min {I10} (1975NuZX).
132SB3cL Other: 2.1 min {I3} (1973Er18). Others: 1974Fo06,
132SBxcL 1974Gr29, 1973Mc09, 1973Ke25, 1972Ke20, 1966St25, 1956Pa20
132SB L 0+X (8-) 4.10 M 5 AM
132SBX L XREF=A(?)B$
132SB2 L %B==100
132SB cL E$x=150-250 keV (1989St06). Other: 200 {I30} (2017Au03)

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However, the level energy of the 2.8 min state is “0+X” in ENSDF. This falls into Type=L (“The ground state is not well established”) defined in CP-D/0888, and the assignment M/G has been unchanged after this memo.

I would like to propose adoption of the assignment in ENDF and NUBASE for  $^{132}\text{Sb}$  (i.e., -G for the 2.8 min state and -M for the 4.1 min state) for better consistency with the other datasets, and replace M/G with G/M in 20878.007-008 and 012 in general considering the situation reported by Mattera. Balraj Singh (McMaster Univ.) reminded me (1) presence of the comment line which mentions by an experimental evidence of  $E_x(8^-)=150-250$  keV [C.A.Stone et al., Phys.Rev.C39(1989)1963] and (2) adoption of its mean ( $200\pm 30$  keV) in Nubase2016. These could justify the assignment in ENDF and NUBASE.

Among 103 DECAY-DATA records providing the half-life of the  $^{132}\text{Sb}$  ground or metastable states in EXFOR Master 2020-12-19, isomeric flagging in the following subentries are opposite from the others:

20589.002, 20589.003, 20878.007, 20878.008, 20878.012, 20878.013, 30691.002,  
32666.001, 30751.002, 30751.004, G0500.001

and their corrections are proposed (see **Appendix**).

In this opportunity, I extracted all nuclides having Type=L cases in Memo CP-D/0888, and found the following 20 nuclides:

<sup>88</sup>Nb, <sup>102</sup>Nb, <sup>102</sup>Tc, <sup>108</sup>Rh, <sup>110</sup>Rh, <sup>120</sup>In, <sup>120</sup>Sb, <sup>128</sup>Sb, <sup>132</sup>Sb, <sup>146</sup>La, <sup>152</sup>Pm, <sup>154</sup>Pm, <sup>154</sup>Tb, <sup>156</sup>Ho, <sup>178</sup>Ta, <sup>182</sup>Re, <sup>236</sup>Np, <sup>250</sup>Es, <sup>261</sup>Rf, <sup>265</sup>Sg

For underlined four nuclides, the ENSDF “Adopted levels, gammas” dataset (1) gives the isomeric transition probability, or (2) quotes an excitation energy determined by a mass measurement. I would like to propose the following isomeric flagging adopted in ENSDF/Nubase2016 for these four nuclides:

Nuclide	-G	-M	# of affected EXFOR data sets
<sup>102</sup> Nb	4.3 sec	1.3 sec	2
<sup>102</sup> Tc	5.28 sec	4.35 min	0 (all corrected)
<sup>108</sup> Rh	16.8 sec	6.0 min	11
<sup>128</sup> Sb	9.05 h	10.41 min	0 (all corrected)
<sup>132</sup> Sb	2.79 min	4.10 min	10

ATOMKI, CNDC, JAEA and NNDC could consult this proposal with their ENSDF evaluators.

### Appendix

#### DECAY-DATA records summarized in Memo CP-D/0888 with Type=L

Corrected: The flag was corrected after distribution of Memo CP-D/0888.

Nuclide	Subentry	T <sub>1/2</sub> (EXFOR)	T <sub>1/2</sub> (Wallet)	Corrected	Proposal
41-NB-88-M	C1944.002	14.3MIN	7.78MIN	G	
<b>41-NB-102</b>	<b>21701.003</b>	<b>1.3SEC</b>	<b>4.3SEC</b>		<b>M</b>
<b>41-NB-102-M</b>	<b>E2036.005</b>	<b>4.3SEC</b>	<b>1.3SEC</b>		<b>G</b>
43-TC-102	11923.010	4.5MIN	5.28SEC	M	
45-RH-108-G	10772.006	6.MIN	16.8SEC	M	
<b>45-RH-108-G</b>	<b>22415.012</b>	<b>6.0MIN</b>	<b>16.8SEC</b>		<b>M</b>
<b>45-RH-108-G</b>	<b>22433.023</b>	<b>6.0MIN</b>	<b>16.8SEC</b>		<b>M</b>
<b>45-RH-108-G</b>	<b>E1701.003</b>	<b>6.MIN</b>	<b>16.8SEC</b>		<b>M</b>
<b>45-RH-108-G</b>	<b>E2036.005</b>	<b>5.9MIN</b>	<b>16.8SEC</b>		<b>M</b>
<b>45-RH-108-M</b>	<b>10145.015</b>	<b>16.8SEC</b>	<b>6.0MIN</b>		<b>G</b>
<b>45-RH-108-M</b>	<b>30336.032</b>	<b>18.SEC</b>	<b>6.0MIN</b>		<b>G</b>
<b>45-RH-108-M</b>	<b>E1701.003</b>	<b>16.8SEC</b>	<b>6.0MIN</b>		<b>G</b>
<b>45-RH-108-M</b>	<b>E2036.002</b>	<b>16.8SEC</b>	<b>6.0MIN</b>		<b>G</b>
<b>45-RH-108-M</b>	<b>E2036.003</b>	<b>16.8SEC</b>	<b>6.0MIN</b>		<b>G</b>
<b>45-RH-108-M</b>	<b>E2036.005</b>	<b>16.8SEC</b>	<b>6.0MIN</b>		<b>G</b>
<b>45-RH-108-M</b>	<b>E2036.006</b>	<b>16.8SEC</b>	<b>6.0MIN</b>		<b>G</b>
45-RH-110-G	E2036.002	3.3SEC	N/A		
49-IN-120	40798.005	51.0SEC	3.08SEC	M	
49-IN-120-G	11957.003	50.SEC	3.08SEC	M2	
49-IN-120-G	20540.012	45.4SEC	3.08SEC		
49-IN-120-G	20540.014	45.4SEC	3.08SEC		
49-IN-120-G	O0407.071	47.3SEC	3.08SEC	Deleted.	
51-SB-120	11645.022	5.8D	15.89MIN		
51-SB-120	C2001.007	6.0D	15.89MIN	M	
51-SB-120	D0495.095	6.D	15.89MIN	M	
51-SB-120-G	A0291.003	5.76D	15.89MIN		
51-SB-120-M	A0085.018	15.8MIN	5.76D		
51-SB-120-M	A0291.003	16.MIN	5.76D		
51-SB-120-M	C0556.004	15.9MIN	5.76D	G	
51-SB-128-M	20589.004	9.1HR	10.4MIN	G	
51-SB-132	21701.004	252.SEC	2.79MIN	M	
<b>51-SB-132</b>	<b>30691.002</b>	<b>4.21MIN</b>	<b>2.79MIN</b>		<b>M</b>
51-SB-132	32666.001	252.0SEC	2.79MIN	M	
<b>51-SB-132-G</b>	<b>20589.002</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>
<b>51-SB-132-G</b>	<b>20589.003</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>
<b>51-SB-132-G</b>	<b>20878.007</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>

<b>51-SB-132-G</b>	<b>20878.008</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>
<b>51-SB-132-G</b>	<b>20878.012</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>
<b>51-SB-132-G</b>	<b>20878.013</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>
51-SB-132-G	22161.002	252.SEC	2.79MIN	M	
<b>51-SB-132-G</b>	<b>30751.002</b>	<b>4.21MIN</b>	<b>2.79MIN</b>		<b>M</b>
<b>51-SB-132-G</b>	<b>30751.004</b>	<b>4.21MIN</b>	<b>2.79MIN</b>		<b>M</b>
<b>51-SB-132-G</b>	<b>G0500.001</b>	<b>4.2MIN</b>	<b>2.79MIN</b>		<b>M</b>
57-LA-146	30691.002	11.1SEC	6.27SEC		
61-PM-152-M1	12033.029	6.5MIN	13.8MIN		
61-PM-152-M2	31439.002	13.8MIN	7.52MIN		
61-PM-154-M	12705.002	162.SEC	1.73MIN		
65-TB-154-M1	A0680.002	9.HR	22.7HR		
65-TB-154-M1	A0680.004	9.HR	22.7HR		
65-TB-154-M1	D4241.004	9.994HR	22.7HR		
65-TB-154-M1	D6180.003	9.4HR	22.7HR		
65-TB-154-M1	E2074.006	9.HR	22.7HR		
65-TB-154-M2	A0680.002	23.HR	9.4HR		
65-TB-154-M2	A0680.003	23.HR	9.4HR		
65-TB-154-M2	D4241.005	22.7HR	9.4HR		
65-TB-154-M2	D6180.004	22.7HR	9.4HR		
65-TB-154-M2	E2074.006	22.6HR	9.4HR		
67-HO-156-M1	O0768.196	56.MIN	9.5SEC		G
73-TA-178-G	A0283.008	2.2HR	N/A		
73-TA-178-G	A0567.002	9.3MIN	N/A		
73-TA-178-G	A0635.003	9.31MIN	N/A		
73-TA-178-G	B0032.002	9.4MIN	N/A		
73-TA-178-G	D4227.005	2.25HR	N/A		
73-TA-178-M	33004.016	2.36HR	9.31MIN		
73-TA-178-M	A0598.006	2.5HR	9.31MIN		
73-TA-178-M	A0635.003	2.45HR	9.31MIN		
73-TA-178-M	A0676.002	2.45HR	9.31MIN		
73-TA-178-M	A0721.003	2.36HR	9.31MIN		
73-TA-178-M	A0904.142	2.36HR	9.31MIN		
73-TA-178-M	B0032.002	2.1HR	9.31MIN		
73-TA-178-M	C0402.003	2.2HR	9.31MIN		
73-TA-178-M	D4233.013	2.36HR	9.31MIN		
73-TA-178-M	D4254.003	2.36HR	9.31MIN		
73-TA-178-M	D6181.012	2.50HR	9.31MIN		
73-TA-178-M	E2074.006	2.45HR	9.31MIN		
73-TA-178-M	O0768.184	2.36HR	9.31MIN		
73-TA-178-M1	O0276.434	9.25MIN	N/A		
73-TA-178-M1	O0781.004	2.36HR	N/A		
73-TA-178-M1	O1018.004	2.36HR	N/A		
73-TA-178-M1	O1019.004	2.36HR	N/A		
73-TA-178-M1	O1020.004	2.36HR	N/A		
73-TA-178-M1	O1021.004	2.36HR	N/A		
75-RE-182-G	A0070.002	12.7HR	64.0HR	M	
75-RE-182-G	A0070.003	12.7HR	64.0HR	M	
75-RE-182-G	A0070.004	12.7HR	64.0HR	M	
75-RE-182-G	A0168.168	12.7HR	64.0HR		
75-RE-182-G	A0194.186	12.7HR	64.0HR	M	
75-RE-182-G	A0195.095	12.7HR	64.0HR	M	
75-RE-182-G	A0195.146	12.7HR	64.0HR	M	
75-RE-182-M	A0070.002	64.HR	12.7HR	G	
75-RE-182-M	A0070.003	64.HR	12.7HR	G	
75-RE-182-M	A0070.004	64.HR	12.7HR	G	
75-RE-182-M	A0168.167	64.HR	12.7HR		
75-RE-182-M	A0194.185	64.HR	12.7HR	!	
75-RE-182-M	A0195.094	64.HR	12.7HR	G	
75-RE-182-M	A0195.145	64.HR	12.7HR	G	

93-NP-236	40898.002	22.5HR	153E+3YR	M
93-NP-236	A0322.005	22.HR	153E+3YR	M
93-NP-236	A0528.003	22.5HR	153E+3YR	M
93-NP-236	V1002.599	22.5HR	153E+3YR	
93-NP-236-G	10294.002	22.HR	153E+3YR	
93-NP-236-G	12251.004	5000.YR	153E+3YR	
93-NP-236-G	12251.005	5000.YR	153E+3YR	
99-ES-250	A0410.004	0.09D	8.6HR	
104-RF-261-M1	E2324.001	68.SEC	1.9SEC	
104-RF-261-M1	E2371.002	68.SEC	1.9SEC	
104-RF-261-M1	E2371.003	68.SEC	1.9SEC	
104-RF-261-M1	E2371.004	68.SEC	1.9SEC	
104-RF-261-M1	E2438.002	68.SEC	1.9SEC	
104-RF-261-M1	E2438.006	68.SEC	1.9SEC	
104-RF-261-M2	E2324.001	1.9SEC	78SEC	
104-RF-261-M2	E2371.002	2.6SEC	78SEC	
104-RF-261-M2	E2371.003	2.6SEC	78SEC	
104-RF-261-M2	E2371.004	2.6SEC	78SEC	
104-RF-261-M2	E2438.003	1.9SEC	78SEC	
104-RF-261-M2	E2438.006	1.9SEC	78SEC	
106-SG-265-M2	E2371.003	14.4SEC	8.9SEC	
106-SG-265-M2	E2371.004	14.4SEC	8.9SEC	