$^{99}_{42}$Mo $_{57}$

1 Decay Scheme

Mo-99 disintegrates to the Tc-99 excited levels by beta minus emissions.
The 142 keV excited level (Tc-99m) has a half-life of 6,0067 h. At the equilibrium (t>60 h), the Tc-99m activity in relation to those of Mn-99 is:

Le molybdène 99 se désintègre par émission bêta moins vers les niveaux excités de technétium 99.
Une proportion p = 87,6 (19)% de désintégrations conduit au niveau excité de 142 keV (Tc-99m) de 6,0067 heures de période. Ce niveau excité est alimenté directement par émission bêta moins (82,1 (15)) % et aussi par des transitions gamma.
A l'équilibre (t>60 heures) l'activité de Tc-99m par rapport à celle de Mo-99 s'écrit:

A(Tc-99m) / A(Mo-99) = p × $T_{1/2}$(Mo-99) / [$T_{1/2}$(Mo-99) - $T_{1/2}$(Tc-99m)] = 0,963(21)
$T_{1/2}$(Mo-99) / [$T_{1/2}$(Mo-99) - $T_{1/2}$(Tc-99m)] = 1,1005 (8)
with p = 0,876(19)
For this evaluation Mo-99 and Tc-99m are considered in equilibrium
Pour cette évaluation Mo-99 et Tc-99m sont considérés à l'équilibre.

2 Nuclear Data

$T_{1/2}$(^{99}Mo)	:	2,7479	(6)	d
$T_{1/2}$(^{99}Tc)	:	211,5	(11)	10^3 a
Q^-(^{99}Mo)	:	1357,2	(10)	keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,15}$	158,3 (10)	0,0021 (3)	Allowed	8,65
$\beta^-_{0,14}$	185,2 (10)	0,0016 (4)	Allowed	8,91
$\beta^-_{0,13}$	215,3 (10)	0,111 (3)	Allowed	7,39
$\beta^-_{0,12}$	228,1 (10)	0,011 (1)	1st Forbidden	8,5
$\beta^-_{0,11}$	285 (1)	0,0027 (7)	2nd Forbidden	

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,10}$	353,1 (10)	0,134 (5)	1st Forbidden	7,97
$\beta^-_{0,9}$	436,6 (10)	16,45 (30)	Allowed	6,21
$\beta^-_{0,6}$	685,7 (10)	0,052 (5)	1st Forbidden	9,46
$\beta^-_{0,5}$	822,8 (10)	0,0010 (2)		
$\beta^-_{0,4}$	848,1 (10)	1,18 (3)	1st Forbidden	8,38
$\beta^-_{0,2}$	1214,5 (10)	82,1 (15)	1st Forbidden	7,1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{2,1}$(Tc)	2,1726 (4)	86,8 (19)	E3			119 (3) 10^8	135 (4) 10^8
$\gamma_{3,1}$(Tc)	40,5833 (2)	5,30 (19)	M1+1,4(2)%E2	3,50 (8)	0,560 (13)	0,104 (3)	4,19 (10)
$\gamma_{1,0}$(Tc)	140,511 (1)	92,1 (19)	M1+3,2(3)%E2	0,104 (3)	0,0129 (4)	0,00236 (7)	0,119 (3)
$\gamma_{2,0}$(Tc)	142,683 (1)	0,88 (6)	M4	29,3 (6)	9,35 (20)	1,86 (6)	40,9 (8)
$\gamma_{9,7}$(Tc)	158,782 (15)	0,0145 (9)					
$\gamma_{6,4}$(Tc)	162,370 (15)	0,0114 (6)					
$\gamma_{3,0}$(Tc)	181,094 (2)	6,91 (13)	E2	0,125 (3)	0,0191 (4)	0,00353 (7)	0,149 (3)
$\gamma_{10,7}$(Tc)	242,29 (8)	0,0014 (3)	(E1)	0,0093 (2)	0,00106 (2)	0,000193 (6)	0,0106 (2)
$\gamma_{9,6}$(Tc)	249,03 (3)	0,0035 (4)					
$\gamma_{4,2}$(Tc)	366,422 (15)	1,21 (3)	M1	0,00802 (16)	0,00093 (2)	0,000170 (4)	0,00915 (18)
$\gamma_{13,7}$(Tc)	380,13 (8)	0,0092 (6)	M1+63(22)%E2	0,0091 (7)	0,00113 (8)	0,00021 (2)	0,0105 (8)
$\gamma_{5,2}$(Tc)	391,7 (4)	0,0025 (6)					
$\gamma_{14,7}$(Tc)	410,27 (10)	0,0016 (4)	M1+20%E2	0,0065 (6)	0,00076 (7)	0,00014 (1)	0,0074 (7)
$\gamma_{9,4}$(Tc)	411,492 (15)	0,0162 (15)	E1	0,00226 (6)	0,000256 (5)	0,0000467 (9)	0,00257 (5)
$\gamma_{12,6}$(Tc)	457,60 (3)	0,0075 (6)	M1+72%E2	0,0054 (4)	0,00066 (5)	0,00012 (1)	0,0063 (7)
$\gamma_{13,6}$(Tc)	469,63 (7)	0,0027 (5)					
$\gamma_{6,2}$(Tc)	528,790 (15)	0,0543 (21)	M1	0,00331 (7)	0,000379 (8)	0,00006930 (14)	0,00378 (8)
$\gamma_{11,5}$(Tc)	537,79 (15)	0,0015 (5)					
$\gamma_{7,3}$(Tc)	580,51 (5)	0,0036 (4)					
$\gamma_{8,3}$(Tc)	581,30 (12)	0,00010 (5)					
$\gamma_{12,4}$(Tc)	620,03 (5)	0,0024 (6)					
$\gamma_{8,1}$(Tc)	621,773 (24)	0,0263 (10)	M1(+E2)	0,00227 (7)	0,000259 (8)	0,0000473 (14)	0,00258 (8)
$\gamma_{15,4}$(Tc)	689,6 (9)	0,00042 (20)					
$\gamma_{9,3}$(Tc)	739,503 (17)	12,14 (15)	E2+7,6%M1	0,00151 (3)	0,000178 (5)	0,000032 (1)	0,00173 (4)
$\gamma_{7,0}$(Tc)	761,77 (8)	0,0023 (13)					
$\gamma_{9,2}$(Tc)	777,924 (20)	4,28 (8)	E1	0,000518 (10)	0,0000580 (12)	0,00001057 (2)	0,000589 (12)
$\gamma_{10,3}$(Tc)	822,976 (15)	0,1322 (30)	E1	0,000461 (9)	0,000052 (1)	0,0000094 (2)	0,000524 (11)
$\gamma_{10,2}$(Tc)	861,2 (9)	0,0007 (2)					
$\gamma_{13,3}$(Tc)	960,759 (20)	0,095 (3)	(M1)				0,0010 (1)
$\gamma_{12,2}$(Tc)	986,45 (4)	0,0014 (1)					
$\gamma_{13,1}$(Tc)	1001,348 (18)	0,0043 (4)	(E2)				0,0008 (1)
$\gamma_{15,3}$(Tc)	1017,0 (5)	0,0007 (2)					
$\gamma_{15,2}$(Tc)	1056,20 (5)	0,00103 (9)					
$\gamma_{11,0}$(Tc)	1072,2 (4)	0,0012 (5)					

3 Atomic Data

3.1 Tc

ω_K	:	0,782	(4)
$\bar{\omega}_L$	:	0,0415	(10)
$\bar{\omega}_M$	:	0,0010	(1)
n_{KL}	:	1,014	(4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	18,251		52,59
	$K\alpha_1$	18,3672		100
	$K\beta_3$	20,599	}	
	$K\beta_1$	20,619	}	
	$K\beta_5''$	20,789	}	26,58
	$K\beta_2$	21,005	}	
	$K\beta_4$	21,042	}	4,2
X_L				
	$L\alpha$	2,424 –		
	$L\beta$	2,537 –		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	14,858 – 15,582	100
KLX	17,418 – 18,365	40,3
KXY	19,956 – 21,040	4,07
Auger L	1,60 – 3,04	736

4 Electron Emissions

		Energy keV		Electrons per 100 disint.
e_{AL}	(Tc)	1,60 - 3,04		15,87 (26)
e_{AK}	(Tc)			3,1 (1)
	KLL	14,858 - 15,582	}	
	KLX	17,418 - 18,365	}	
	KXY	19,956 - 21,040	}	
$ec_{2,1\ M}$	(Tc)	1,6286 - 1,9197		83 (2)
$ec_{2,1\ N}$	(Tc)	2,1046 - 2,1706		10,0 (4)
$ec_{3,1\ K}$	(Tc)	19,540 (3)		3,58 (12)
$ec_{3,1\ L}$	(Tc)	37,542 - 37,907		0,57 (2)
$ec_{3,1\ M}$	(Tc)	40,040 - 40,331		0,106 (4)
$ec_{1,0\ K}$	(Tc)	119,467 (1)		9,2 (3)
$ec_{2,0\ K}$	(Tc)	121,631 (25)		0,62 (5)
$ec_{1,0\ L}$	(Tc)	137,4685 - 137,8341		1,18 (4)
$ec_{2,0\ L}$	(Tc)	139,6325 - 139,9981		0,198 (17)
$ec_{1,0\ M}$	(Tc)	139,9670 - 140,2581		0,231 (7)
$ec_{3,0\ K}$	(Tc)	160,024 (8)		0,756 (28)
$ec_{3,0\ L}$	(Tc)	178,0255 - 178,3911		0,115 (4)
$\beta^-_{0,15}$	max:	158,3 (10)		0,0021 (3)
$\beta^-_{0,15}$	avg:	43,3 (4)		
$\beta^-_{0,14}$	max:	185,2 (10)		0,0016 (4)
$\beta^-_{0,14}$	avg:	51,0 (4)		
$\beta^-_{0,13}$	max:	215,3 (10)		0,111 (3)
$\beta^-_{0,13}$	avg:	59,8 (3)		
$\beta^-_{0,12}$	max:	228,1 (10)		0,011 (1)
$\beta^-_{0,12}$	avg:	69,3 (3)		
$\beta^-_{0,11}$	max:	285 (1)		0,0027 (7)
$\beta^-_{0,11}$	avg:	82 (1)		
$\beta^-_{0,10}$	max:	353,1 (10)		0,134 (5)
$\beta^-_{0,10}$	avg:	104,3 (3)		
$\beta^-_{0,9}$	max:	436,6 (10)		16,45 (30)
$\beta^-_{0,9}$	avg:	133,0 (3)		
$\beta^-_{0,6}$	max:	685,7 (10)		0,052 (5)
$\beta^-_{0,6}$	avg:	225,4 (4)		
$\beta^-_{0,5}$	max:	822,8 (10)		0,0010 (2)
$\beta^-_{0,5}$	avg:	279 (2)		
$\beta^-_{0,4}$	max:	848,1 (10)		1,18 (3)
$\beta^-_{0,4}$	avg:	289,7 (3)		
$\beta^-_{0,2}$	max:	1214,5 (10)		82,1 (15)
$\beta^-_{0,2}$	avg:	442,7 (3)		

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Tc)	2,424 — 2,537		0,697 (17)	
XKα_2	(Tc)	18,251		3,19 (9)	} Kα
XKα_1	(Tc)	18,3672		6,06 (16)	}
XKβ_3	(Tc)	20,599	}		
XKβ_1	(Tc)	20,619	}	1,61 (5)	Kβ_1'
XKβ_5''	(Tc)	20,789	}		
XKβ_2	(Tc)	21,005	}		
XKβ_4	(Tc)	21,042	}	0,254 (11)	Kβ_2'

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{2,1}$(Tc)	2,1726 (4)	7×10^{-9}
$\gamma_{3,1}$(Tc)	40,58323 (17)	1,022 (27)
$\gamma_{1,0}$(Tc)	140,511 (1)	89,6 (17)
$\gamma_{2,0}$(Tc)	142,675 (25)	0,0211 (17)
$\gamma_{9,7}$(Tc)	158,782 (15)	0,0145 (9)
$\gamma_{6,4}$(Tc)	162,370 (15)	0,0114 (6)
$\gamma_{3,0}$(Tc)	181,068 (8)	6,01 (11)
$\gamma_{10,7}$(Tc)	242,29 (8)	0,0014 (3)
$\gamma_{9,6}$(Tc)	249,03 (3)	0,0035 (4)
$\gamma_{4,2}$(Tc)	366,421 (15)	1,194 (23)
$\gamma_{13,7}$(Tc)	380,13 (8)	0,0091 (5)
$\gamma_{5,2}$(Tc)	391,7 (4)	0,0025 (6)
$\gamma_{14,7}$(Tc)	410,27 (10)	0,0016 (4)
$\gamma_{9,4}$(Tc)	411,491 (15)	0,0161 (12)
$\gamma_{12,6}$(Tc)	457,60 (3)	0,0074 (6)
$\gamma_{13,6}$(Tc)	469,63 (7)	0,0027 (5)
$\gamma_{6,2}$(Tc)	528,788 (15)	0,0541 (19)
$\gamma_{11,5}$(Tc)	537,79 (15)	0,0015 (5)
$\gamma_{7,3}$(Tc)	580,51 (5)	0,0036 (4)
$\gamma_{8,3}$(Tc)	581,30 (12)	0,00010 (5)
$\gamma_{12,4}$(Tc)	620,03 (5)	0,0024 (6)
$\gamma_{8,1}$(Tc)	621,773 (24)	0,0262 (10)
$\gamma_{15,4}$(Tc)	689,6 (9)	0,00042 (18)
$\gamma_{9,3}$(Tc)	739,500 (17)	12,12 (15)
$\gamma_{7,0}$(Tc)	761,77 (8)	0,0023 (13)

	Energy keV	Photons per 100 disint.
$\gamma_{9,2}$(Tc)	777,921 (20)	4,28 (8)
$\gamma_{10,3}$(Tc)	822,972 (15)	0,1321 (29)
$\gamma_{10,2}$(Tc)	861,2 (9)	0,0007 (2)
$\gamma_{13,3}$(Tc)	960,754 (20)	0,095 (3)
$\gamma_{12,2}$(Tc)	986,44 (4)	0,0014 (1)
$\gamma_{13,1}$(Tc)	1001,343 (18)	0,0043 (4)
$\gamma_{15,3}$(Tc)	1017,0 (5)	0,0007 (2)
$\gamma_{15,2}$(Tc)	1056,20 (5)	0,00103 (9)
$\gamma_{11,0}$(Tc)	1072,2 (4)	0,0012 (5)

6 Main Production Modes

{ Mo − 98(n,γ)Mo − 99 σ : 0,130 (6) barns
Possible impurities : Nb − 93m

{ Fission product
Possible impurities : None

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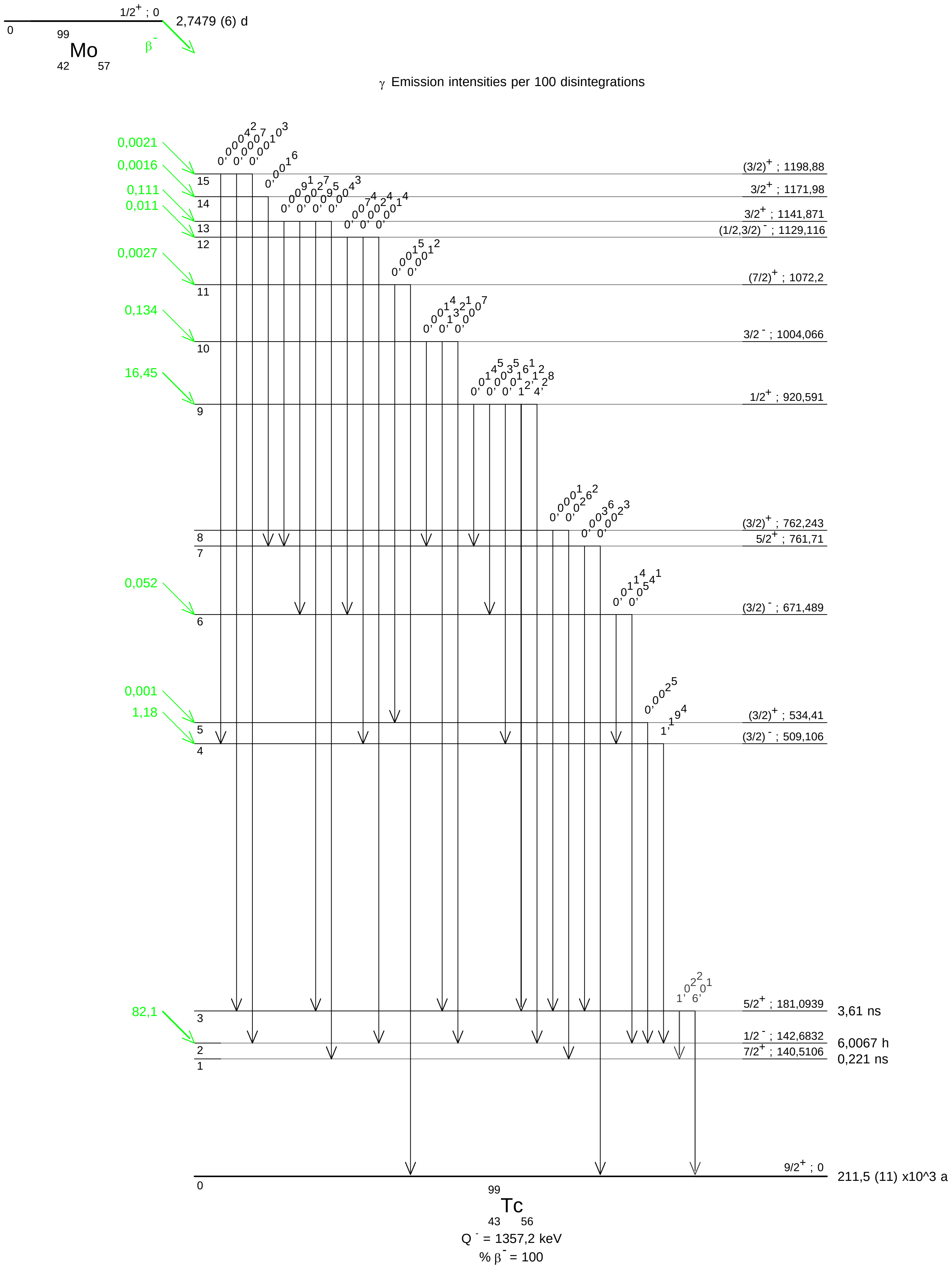
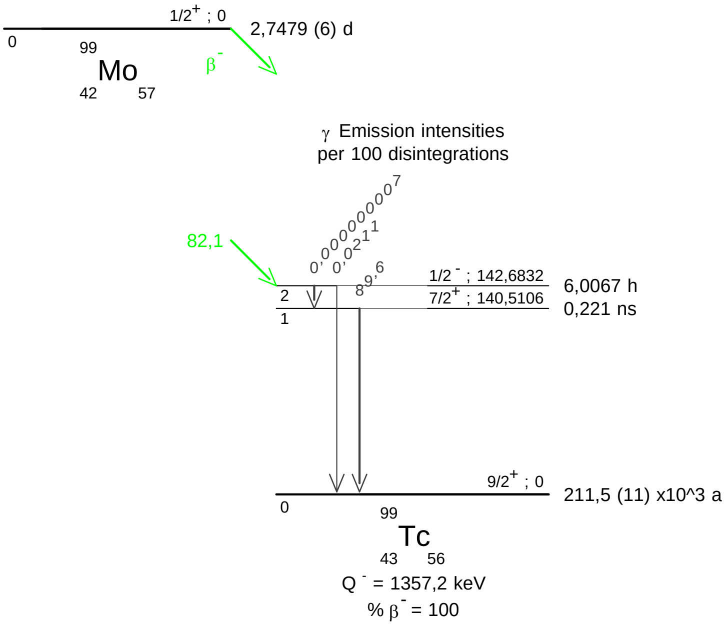

1/2+ ; 0
0
99 Mo 42 57
2,7479 (6) d
β-
γ Emission intensities per 100 disintegrations
0,0021
0,0016
0,111
0,011
0,0027
0,134
16,45
0,052
0,001
1,18
82,1
(3/2)+ ; 1198,88
3/2+ ; 1171,98
3/2+ ; 1141,871
(1/2,3/2)- ; 1129,116
(7/2)+ ; 1072,2
3/2- ; 1004,066
1/2+ ; 920,591
(3/2)+ ; 762,243
5/2+ ; 761,71
(3/2)- ; 671,489
(3/2)+ ; 534,41
(3/2)- ; 509,106
5/2+ ; 181,0939
3,61 ns
1/2- ; 142,6832
6,0067 h
7/2+ ; 140,5106
0,221 ns
9/2+ ; 0
211,5 (11) x10^3 a
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
99 Tc 43 56
Q- = 1357,2 keV
% β- = 100


1/2+ ; 0
2,7479 (6) d
0
99
Mo
42
57
β-
γ Emission intensities
per 100 disintegrations
82,1
89,6
2
1
1/2- ; 142,6832
7/2+ ; 140,5106
6,0067 h
0,221 ns
9/2+ ; 0
211,5 (11) x10^3 a
0
99
Tc
43
56
Q- = 1357,2 keV
% β- = 100