^{40}Ti ε decay (52.4 ms) 1998Bh12,1998Li46,1990De43

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 140, 1 (2017)	30-Sep-2015

Parent: ^{40}Ti: E=0; $J^\pi=0^+$; $T_{1/2}$=52.4 ms *3*; Q(ε)=11.67×10^3 *16*; %ε+%β^+ decay=100.0

^{40}Ti-$T_{1/2}$: From Adopted Levels of ^{40}Ti.

^{40}Ti-Q(ε): From 2012Wa38.

^{40}Ti decays to ^{39}Ca by εp (≈100%).

1998Bh12 (also 1998Le45,1997Tr11): ^{40}Ti ions were produced at GANIL by fragmentation of a 82.6 MeV/nucleon ^{50}Cr beam on a 272.4 mg/cm^2 nickel target. Fragments were separated and selected by the LISE3 spectrometer and then implanted into a stack of five Si surface-barrier detectors. γ rays were detected with five HPGe detectors. Measured E(p), I(p), Eγ, Iγ, pγ-coin, pβ-coin, decay time distribution. Deduced levels, decay branching ratios, reduced transition strengths, ^{40}Ti half-life. Comparisons with data from other measurements.

1998Li46 (also 2001Li56,1997Li25): ^{40}Ti ions were produced at GSI by fragmentation of a 500 MeV/nucleon ^{58}Ni beam from the heavy-ion synchrotron SIS on a 4 g/cm^2 ^{9}Be target. Fragments were separated by the separator FRS by energy loss determined by a multiple sampling ionization chamber (MUSIC) and mass-to-charge ratio determined with FRS. Selected ^{40}Ti ions were implanted into a stack of eight Si detectors. γ rays were detected with an array of 14 large-volume Crystal Ball NaI detectors. Measured E(p), I(p), Eγ, Iγ, pγ-coin, decay time distribution. Deduced levels, decay branching ratios, reduced transition strengths, ^{40}Ti half-life. Comparisons with data from other measurements.

Other measurements:

1990De43: ^{40}Ti isotope identified and four proton groups.

2001Gi01 (also 2001Gi02): four most intense proton groups reported. Also measured $T_{1/2}$.

Comparison of proton energies (E_p(lab))

	1998Bh12		1998Li46		2001Gi01		2007Do17		adopted		E_x	
p1			242	80					242	80	3221	62*
p1			400	60					400	60	3409	62
p1	747	36	759	60					750	36	3780	9*
p2			951	86					951	86	4517	12*
p1	1111	20	1157	60					1116	20	4129	21*
p1	1325	7	1322	25	1332	25	1329	19	1326	7	4358	8*
p1	1608	17	1580	40					1604	17	4649	11*
p0	1701	6	1705	10	1703	10	1695	19	1701	6	2275	7
p1	1849	14							1849	14	4895	15
p1	1957	21	1992	40					1965	21	5014	22*
p1	2027	28							2027	28	5080	29*
p0	2160	6	2167	10	2154	9	2159	18	2160	6	2746	7
p0	2341	10	2366	40					2342	10	2932	11
p0	2542	16	2518	46					2539	16	3134	17
p0			2609	60					2609	60	3221	62*
p0	2728	16	2733	40					2729	16	3329	17
p0	2957	47	2907	40					2928	40	3533	41
p0	3039	8	3045	40					3039	8	3647	9
p0	3170	8	3158	27					3169	8	3780	9*
p0	3242	41							3242	41	3856	42
p0	3443	21	3407	88					3441	21	4060	22
p0	3487	25							3487	25	4129	21*
p0	3639	8	3632	46					3639	8	4263	9
p0	3734	7	3731	10	3736	14	3744	20	3734	7	4358	8*
p0	3887	11	3972	100					3887	11	4517	12*
p0	4017	10							4017	10	4649	11*
p0	4184	18	4137	60					4180	18	4818	19
p0	4371	23	4347	74					4369	23	5013	22*
p0	4433	31	4481	88					4438	31	5080	29*
p0	4572	28							4572	28	5220	29
p0			4702	60					4702	60	5353	62
p0			4909	40					4909	40	5566	41
p0	5034	20	5107	60					5041	20	5701	21

p0			5213	80				5213	80	5878	82
p0	5336	19						5336	19	6004	20
p0			5448	60				5448	60	6119	62
p0			5740	60				5740	60	6418	62

Notes:
1. Adopted proton energy is from weighted average if applicable.
2. $E_x=E_p*1.0259+529.6$ *29*+$E_x(^{39}Ca)$.
$E_x(^{39}Ca)$=0 for decay to ^{39}Ca ground state (p0 mode),
$E_x(^{39}Ca)$=2468.5 *9* for p1 mode, 3026 *3* for p2 mode.
Values marked with (*) are the averages from two proton groups.

Comparison of proton intensities(%branching)

E_p	E_x	1998Bh12#		1998Li46		2001Gi01		2007Do17&		adopted*	
p1 242	3221			1.32	40					1.32	40
p1 400	3409			0.70	30					0.70	30
p1 750	3780	0.49	17	0.77	43					0.53	17
p2 951	4518			0.80	32					0.80	32
p1 1116	4129	0.53	13	0.77	42					0.55	13
p1 1326	4359	3.58	60	4.35	82	5.8	20	2.9	14	3.85	60
p1 1604	4649	0.38	18	0.40	20					0.39	18
p0 1702	2276	23.76	59	22.5	21	21.7	30	18.1	19	23.2	9
p1 1849	4895	1.41	32							1.41	32
p1 1965	5014	0.85	26	0.95	43					0.88	26
p1 2027	5080	0.44	11							0.44	11
p0 2160	2746	29.80	66	28.5	19	27.4	36	24.2	19	29.1	10
p0 2342	2933	1.94	41	0.60	18					1.94	41
p0 2539	3135	0.91	21	1.01	56					0.92	21
p0 2609	3221			1.05	42					1.05	42
p0 2729	3330	0.58	17	1.6	11					0.58	7
p0 2928	3534	0.11	11	0.69	28					0.69	28
p0 3039	3648	1.73	20	1.43	78					1.71	20
p0 3169	3780	2.09	23	3.4	16					2.12	23
p0 3242	3856	0.11	11							0.11	11
p0 3441	4060	0.43	14	0.57	30					0.46	14
p0 3487	4129	0.33	14							0.33	14
p0 3639	4264	2.05	22	1.09	27					2.05	22
p0 3734	4359	21.71	54	22.8	19	23.8	36	20.0	20	21.72	54
p0 3887	4518	1.83	28							1.83	28
p0 4017	4649	1.59	23	1.40	42					1.55	23
p0 4180	4819	0.72	17	1.27	53					0.77	17
p0 4369	5014	0.53	23	0.97	40					0.64	23
p0 4438	5080	0.42	24	0.73	22					0.59	22
p0 4572	5221	0.11	11							0.11	11
p0 4702	5354			0.55	21					0.55	21
p0 4909	5567			0.16	10					0.16	10
p0 5041	5702	0.24	9	0.41	30					0.25	9
p0 5213	5879			0.30	12					0.30	12
p0 5336	6005	0.21	7							0.21	7
p0 5448	6120			0.18	10					0.18	10
p0 5740	6419			0.11	6					0.11	6
sum of I_p:		99.9	16	101.4	44			95.8	13@	103.9	18

Notes:
*: Adopted proton intensity is from weighted average if applicable.
If data from 1998Bh12 and 1998Li46 are not consistent within error, value from 1998Bh12 is taken, unless otherwise noted.
@: total proton branching ratio reported in 2007Do17
#: Intensities are deduced by the evaluator from peak areas in Table2 of 1998Bh12 with the total 24106 implantations of ^{40}Ti.
&: 2007Do7 report a γ transition with Eγ=2467.3 *5* and Iγ=8.5 *54* in ^{39}Ca from its first excited state.

^{40}Sc Levels

E(level)[†]	J$^{\pi}$[‡]	E(p0)(lab)[#]	Comments
0	4$^-$		J$^{\pi}$: from Adopted Levels.
2276 *7*	1$^+$	1701[@] *6*	
2746 *7*	1$^+$	2160[@] *6*	
2933 *11*	1$^+$	2342 *10*	
3135 *17*	1$^+$	2539 *16*	
3221 *62*	1$^+$	2609[&] *60*	E(p0)(lab): E(p1)=242 *80* (in 1998Li46 only) to 2468.5 level in ^{39}Ca.
3330 *17*	1$^+$	2729 *16*	
3409 *62*	1$^+$	400[&] *60*	E(p0)(lab): value is for proton group to 2468.5 level in ^{39}Ca (p1 mode).
3534 *41*		2928 *40*	
3648 *9*	1$^+$	3039 *8*	
3780 *9*	1$^+$	3169 *8*	E(p0)(lab): E(p1)=750 *36* to 2468.5 level in ^{39}Ca.
3856? *42*		3242[a] *41*	
4060 *22*	1$^+$	3441 *21*	
4129 *21*	1$^+$	3487 *25*	E(p0)(lab): E(p1)=1116 *20* to 2468.5 level in ^{39}Ca.
4264 *9*	1$^+$	3639 *8*	
4359 *8*	0$^+$	3734[@] *7*	T=2 E(p0)(lab): E(p1)=1326 *7* to 2468.5 level in ^{39}Ca.
4518 *12*	1$^+$	3887[a] *11*	E(p0)(lab): E(p2)=951 *86* (in 1998Li46 only) to 3026 level in ^{39}Ca.
4649 *11*	1$^+$	4017 *10*	E(p0)(lab): E(p1)=1604 *17* to 2468.5 level in ^{39}Ca.
4819 *19*	1$^+$	4180 *18*	
4895? *15*		1849[ab] *14*	E(p0)(lab): proton group to 2468.5 level in ^{39}Ca (p1 mode).
5014 *22*	1$^+$	4369 *23*	E(p0)(lab): E(p1)=1965 *21* to 2468.5 level in ^{39}Ca.
5080 *29*	1$^+$	4438 *31*	E(p0)(lab): E(p1)=2027 *28* to 2468.5 level in ^{39}Ca (in 1998Bh12 only).
5221? *29*		4572[a] *28*	
5354 *62*	1$^+$	4702[&] *60*	
5567 *41*	1$^+$	4909[&] *40*	
5702 *21*	1$^+$	5041 *20*	
5879 *82*	1$^+$	5213[&] *80*	
6005 *20*	1$^+$	5336[a] *19*	
6120 *62*	1$^+$	5448[&] *60*	
6419 *62*	1$^+$	5740[&] *60*	

[†] Deduced by the evaluator from proton energies. See details in the table of "Comparison of proton intensities" above.

[‡] For excited states, the assignments are from allowed β decays from 0$^+$ as indicated by log *ft* values and are adopted in Adopted Levels.

[#] Weighted average of values from 1998Bh12 and 1998Li46 if applicable, unless otherwise noted. See details in the table of "Comparison of proton energies" above.

[@] Weighted average from 1998Bh12, 1998Li46, 2001Gi01 and 2007Do17.

[&] From 1998Li46 only.

[a] From 1998Bh12 only.

[b] This proton group is considered as suspect by the evaluator. With I(p)=1.4 in 1998Bh12, this group should have been seen by 1998Li46. In addition 1998Bh12 do not list, in their table III, a level at 4895 in ^{40}Sc corresponding to this proton group.

^{40}Ti ε decay (52.4 ms) 1998Bh12,1998Li46,1990De43 (continued)

ε,β+ radiations

E(decay)	E(level)	Iβ+ @	Iε@	Log *ft*	I(ε+β+)†@	Comments
(5.25×10^3 *17*)	6419	0.11 *6*	0.00026 *15*	4.8 *3*	0.11‡ *6*	av Eβ=1937 *84*; εK=0.0021 *3*; εL=0.00021 *3*; εM+=3.7×10^{-5} *5*
(5.55×10^3 *17*)	6120	0.18 *10*	0.00035 *20*	4.8 *3*	0.18‡ *10*	av Eβ=2083 *84*; εK=0.00174 *22*; εL=0.000175 *22*; εM+=3.0×10^{-5} *4*
(5.67×10^3 *16*)	6005	0.21 *7*	0.00038 *13*	4.7 *2*	0.21# *7*	av Eβ=2139 *79*; εK=0.00162 *18*; εL=0.000163 *18*; εM+=2.8×10^{-5} *3*
(5.79×10^3 *18*)	5879	0.30 *12*	0.00050 *21*	4.6 *2*	0.30‡ *12*	av Eβ=2200 *88*; εK=0.00150 *18*; εL=0.000150 *19*; εM+=2.6×10^{-5} *3*
(5.97×10^3 *16*)	5702	0.25 *9*	0.00038 *14*	4.8 *2*	0.25 *9*	av Eβ=2286 *79*; εK=0.00134 *14*; εL=0.000135 *14*; εM+=2.30×10^{-5} *24*
(6.10×10^3 *17*)	5567	0.16 *10*	0.00022 *14*	5.0 *3*	0.16‡ *10*	av Eβ=2352 *81*; εK=0.00124 *13*; εL=0.000125 *13*; εM+=2.12×10^{-5} *22*
(6.32×10^3 *17*)	5354	0.55 *21*	0.0007 *3*	4.6 *2*	0.55‡ *21*	av Eβ=2457 *84*; εK=0.00110 *12*; εL=0.000110 *12*; εM+=1.88×10^{-5} *20*
(6.45×10^3& *16*)	5221?	0.11 *11*	0.00013 *13*	5.3 *5*	0.11# *11*	av Eβ=2522 *80*; εK=0.00102 *10*; εL=0.000102 *10*; εM+=1.74×10^{-5} *17*
(6.59×10^3 *16*)	5080	1.03 *25*	0.0011 *3*	4.4 *2*	1.03 *25*	av Eβ=2591 *80*; εK=0.00094 *9*; εL=9.5×10^{-5} *9*; εM+=1.62×10^{-5} *15* I(ε+β+): 0.59 *22* for E(p0)=4438 (average of 1998Li46 and 1998Bh12) and 0.44 *11* from E(p1)=2027 (1998Bh12 only).
(6.66×10^3 *16*)	5014	1.5 *3*	0.0015 *3*	4.3 *1*	1.5 *3*	av Eβ=2623 *80*; εK=0.00091 *9*; εL=9.2×10^{-5} *9*; εM+=1.56×10^{-5} *14* I(ε+β+): 0.64 *23* for E(p)=4369 and 0.88 *26* for E(p)=1965.
(6.78×10^3& *16*)	4895?	1.4 *3*	0.0014 *3*	4.3 *1*	1.4 *3*	av Eβ=2632 *79*; εK=0.00090 *8*; εL=9.1×10^{-5} *8*; εM+=1.55×10^{-5} *14*
(6.85×10^3 *16*)	4819	0.77 *17*		4.6 *1*	0.77 *17*	av Eβ=2719 *80*
(7.02×10^3 *16*)	4649	2.0 *3*	0.0017 *3*	4.3 *1*	1.98 *29*	av Eβ=2802 *79*; εK=0.00076 *7*; εL=7.6×10^{-5} *7*; εM+=1.30×10^{-5} *11* I(ε+β+): 1.59 *23* for E(p0)=4017 and 0.39 *18* for E(p1)=1604.
(7.15×10^3 *16*)	4518	2.6 *4*	0.0021 *4*	4.2 *1*	2.6 *4*	av Eβ=2867 *79*; εK=0.00071 *6*; εL=7.1×10^{-5} *6*; εM+=1.22×10^{-5} *10* I(ε+β+): 1.83 *28* for E(p0)=3887 (in 1998Li46 only) and 0.80 *32* for E(p2)=951 (in 1998Li46 only).
(7.31×10^3 *16*)	4359	25.6 *8*	0.0188 *16*	3.3 *1*	25.6 *8*	av Eβ=2945 *79*; εK=0.00066 *6*; εL=6.6×10^{-5} *6*; εM+=1.13×10^{-5} *9* I(ε+β+): 21.72 *54* for E(p0)=3734 and 3.85 *60* for E(p1)=1326.
(7.41×10^3 *16*)	4264	2.05 *22*	0.00144 *19*	4.4 *1*	2.05 *22*	av Eβ=2991 *79*; εK=0.00063 *5*; εL=6.3×10^{-5} *5*; εM+=1.08×10^{-5} *9*
(7.54×10^3 *16*)	4129	0.88 *19*		4.8 *1*	0.88 *19*	av Eβ=3058 *80* I(ε+β+): 0.33 *14* for E(p0)=3487 (in 1998Bh12 only) and 0.55 *13* for E(p1)=1116 (average of 1998Bh12 and 1998Li46).
(7.61×10^3 *16*)	4060	0.46 *14*		5.1 *2*	0.46 *14*	av Eβ=3092 *80*
(7.81×10^3& *17*)	3856?	0.11 *11*		5.8 *5*	0.11# *11*	av Eβ=3192 *82*
(7.89×10^3 *16*)	3780	2.6 *3*	0.00150 *20*	4.4 *1*	2.65 *29*	av Eβ=3230 *79*; εK=0.00051 *4*; εL=5.1×10^{-5} *4*; εM+=8.7×10^{-6} *7*

Continued on next page (footnotes at end of table)

^{40}Ti ε decay (52.4 ms) 1998Bh12,1998Li46,1990De43 (continued)

ε,β+ radiations (continued)

E(decay)	E(level)	Iβ+ @	Iε@	Log *ft*	I(ε+β+)†@	Comments
						I(ε+β+): 2.12 *23* for E(p0)=3169 and 0.53 *17* for E(p1)=750.
(8.02×10^3 *16*)	3648	1.71 *20*		4.7 *1*	1.71 *20*	av Eβ=3295 *79*
(8.14×10^3 *17*)	3534	0.7 *3*		5.1 *2*	0.7 *3*	av Eβ=3351 *82* I(ε+β+): from 1998Li46. Other: 0.11 *11* from 1998Bh12.
(8.26×10^3 *17*)	3409	0.7 *3*		5.1 *2*	0.7‡ *3*	av Eβ=3413 *85*
(8.34×10^3 *16*)	3330	0.58 *17*		5.2 *2*	0.58 *17*	av Eβ=3452 *80* I(ε+β+): from 1998Bh12. Other: 1.6 *11* from 1998Li46.
(8.45×10^3 *17*)	3221	2.4 *6*	0.0011 *3*	4.6 *1*	2.4‡ *6*	av Eβ=3506 *85*; εK=0.00040 *3*; εL=4.0×10^{-5} *3*; εM+=6.9×10^{-6} *5* I(ε+β+): 1.1 *4* for E(p0)=2609 and 1.3 *4* for E(p1)=242 in 1998Li46.
(8.54×10^3 *16*)	3135	0.92 *21*		5.1 *1*	0.92 *21*	av Eβ=3548 *80*
(8.74×10^3 *16*)	2933	1.9 *4*		4.8 *1*	1.9 *4*	av Eβ=3648 *80* I(ε+β+): from 1998Bh12. Other: 0.60 *18* from 1998Li46.
(8.92×10^3 *16*)	2746	29.1 *7*	0.0109 *7*	3.67 *5*	29.1 *10*	av Eβ=3740 *80*; εK=0.000335 *21*; εL=3.36×10^{-5} *21*; εM+=5.7×10^{-6} *4*
(9.39×10^3 *16*)	2276	23.2 *9*	0.0073 *5*	3.89 *5*	23.2 *6*	av Eβ=3973 *80*; εK=0.000282 *17*; εL=2.83×10^{-5} *17*; εM+=4.8×10^{-6} *3*

† Deduced by evaluator from proton decay intensities from each level. The adopted proton intensities are from weighted average of values in 1998Bh12, 1998Li46, 2001Gi01 and 2007Do17 if available, unless otherwise noted. See details in the table of "Comparison of proton energies" above.

‡ From 1998Li46 only.

From 1998Bh12 only.

@ Absolute intensity per 100 decays.

& Existence of this branch is questionable.