^{33}Mg β^- decay (90.3 ms) 2006AnZW,2008Tr07

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 199,1 (2025)	30-Sep-2024

Parent: ^{33}Mg: E=0.0; $J^\pi=3/2^-$; $T_{1/2}$=90.3 ms *10*; Q(β^-)=13460 *7*; %β^- decay=100

^{33}Mg-J^π,$T_{1/2}$: From the Adopted Levels of ^{33}Mg.

^{33}Mg-Q(β^-): From 2021Wa16. S(n)(^{33}Al)=5469 *10* (2021Wa16).

^{33}Mg-%β^- decay: %β^-n=15 *2* for the decay of ^{33}Mg; see detailed comments in ^{33}Mg Adopted Levels.

2006AnZW: ^{33}Mg source was produced by fragmentation of 78 MeV/nucleon ^{36}S primary beam at GANIL. Fragments were separated by the double-achromatic LISE3 spectrometer and focused onto a telescope detector of silicon and plastic scintillator detectors for ion identification and β detection, at the centre of TONNERRE array for detecting neutrons. γ rays were detected with two EXOGAM clover modules and a LEPS detector. Measured Eγ, Iγ, E(n), I(n), $\beta\gamma$-coin, βn-coin. Deduced levels, parent $T_{1/2}$, β-decay branching ratios, log *ft*, β-delayed neutron emission probability. Comparisons with shell-model calculations.

2008Tr07: ^{33}Mg source was produced in the reaction Be(^{48}Ca,X) with a 140 MeV/nucleon ^{48}Ca primary beam provided by NSCL at MSU. Fragments were separated by the A1900 fragment separator and transported and implanted into the double-sided silicon strip detector (DSSD) of the beta counting system (BCS) for detection of charged particles and β particles; γ rays were detected with 16 Ge detectors of the Segmented Germanium Array (SeGA). Measured Eγ, Iγ, Eβ, Iβ, $\gamma\gamma$-coin, implant-β(t). Deduced levels, J, π, parent $T_{1/2}$, β-decay branching ratios, log *ft*, configuration of ^{33}Mg ground state. Comparisons with Monte-Carlo shell-model (MCSM) calculations with SDPF-M interaction.

Others:

2017Ha23: measured half-life at Radioactive Ion Beam Lin in LanZhou (RIBLL).

2002Mo29: measured half-life at NSCL, MSU.

1984La03, 1984Gu19: Measured β-delayed neutrons, ^{33}Mg isotope half-life and βn coin, %β^-n, at CERN.

^{33}Mg also decays to ^{32}Al by delayed neutrons.

Based on shell-model calculations, 2008Tr07 propose 1p-1h and 3p-3h mixed configuration for g.s. of ^{33}Mg; and 0p-0h and 2p-2h mixed configuration for ^{33}Al g.s. with mostly 2p-2h low-lying excited states, which places ^{33}Al within the island of inversion.

The decay scheme is as that proposed by 2006AnZW, unless otherwise noted. The decay scheme proposed in 2008Tr07 is different and supports a positive parity of ^{33}Mg ground state, while a negative parity is adopted in Adopted Levels of ^{33}Mg, assigned by 2010Yo08 based on measured β-asymmetry in a NMR experiment. Moreover, the level scheme proposed by 2017Mu05 in ^{9}Be(^{34}Si,^{33}Alγ) agrees with the decay scheme in 2006AnZW but not that in 2008Tr07, in terms of the placements of their common γ rays.

The decay scheme is considered as incomplete due to a large gap (≈4.5 MeV) between the highest observed level at E=8870 and Q(β^-)value=13460 *7*.

^{33}Al Levels

A 2761 level from 2006AnZW based on a 2761 g.s. transition is omitted, since it is most likely from ^{32}Al, as pointed out by 2008Tr07.

3264 and 4310 levels proposed in 2008Tr07 are omitted, since their de-exciting transitions are placed differently by 2017Mu05 in ^{9}Be(^{34}Si,^{33}Alγ) based on $\gamma\gamma$-coin, while no $\gamma\gamma$-coin data are available in 2008Tr07 for those transitions.

E(level)†	J^π‡	$T_{1/2}$	Comments
0	$(5/2)^+$	41.5 ms *1*	$T_{1/2}$: from the Adopted Levels.
1618	$(5/2)^+$		
1647	$(5/2)^+$		
1838	$(1/2^+,3/2,5/2)$		
2096	$1/2^+$		E(level): level from re-placement of 2096γ in 2008Tr07, based on the placement in 2017Mu05; this level is also reported in 2006AnZW.
2365	$(1/2^+,3/2,5/2)$		E(level): level proposed in 2008Tr07; not reported in 2006AnZW. A 2366 level is tentatively proposed in 2017Mu05 based on a 2366γ.
2664	$(1/2^+,3/2,5/2)$		E(level): level from re-placement of 1046γ in 2008Tr07, based on the placement in 2017Mu05, which is adopted in Adopted Levels, Gammas.
2692	$(1/2^+,3/2,5/2^+)$		E(level): level from re-placement of 596γ and 2692γ in 2008Tr07, based on

Continued on next page (footnotes at end of table)

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^{33}Al Levels (continued)

E(level)†	Jπ‡	Comments
		placements in 2017Mu05.
3714?	(3/2⁻,5/2⁻)	E(level): reported only in 2008Tr07, proposed based on very weak 1618γ-2096γ-coin. It could be the same level as the 3702 level in (^{34}Si,^{33}Alγ) dataset (3704 in 2017Mu05).
4730	(3/2⁻,5/2⁻)	
5930	(1/2⁻,3/2⁻,5/2⁻)	
5980	(1/2⁻,3/2⁻,5/2⁻)	
6820	(1/2⁻,3/2⁻,5/2⁻)	
7250	(1/2⁻,3/2⁻,5/2⁻)	
7470	(1/2⁻,3/2⁻,5/2⁻)	
8870	(1/2⁻,3/2⁻,5/2⁻)	
5469+x		E(level): x<7991 *8* from Q(β^-)(^{33}Mg)-S(n)(^{33}Al), where Q(β^-)=13460 *7* and S(n)=5469 *10* from 2021Wa16. This represents a range of unobserved levels above 8870 level that subsequently decay to ^{32}Al and ^{31}Al via one- and two-neutron emissions, respectively.

† From Eγ data in 2008Tr07 and placements of γ transitions in Adopted Levels, Gammas, mostly taken from 2017Mu05 in (^{34}Si,^{33}Alγ), where Eγ are available, and from measured β-delayed neutrons in 2006AnZW for levels above S(n)=5469 *10*.

‡ From the Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ⁻†‡	Log *ft*	Comments
(4×10³# *4*)	5469+x	4.9 *21*		Iβ⁻: from adopted total %β⁻n=15 *2* for the decay of ^{33}Mg g.s. minus a sum of 10.1 *4* for measured β⁻n feedings to levels up to 8870 from 2006AnZW.
(4590 *7*)	8870	1.96 *5*	4.3	av Eβ=2073.6
(5990 *7*)	7470	0.90 *3*	5.2	av Eβ=2757
(6210 *7*)	7250	1.32 *4*	5.1	av Eβ=2864.7
(6640 *7*)	6820	0.71 *4*	5.5	av Eβ=3075.4
(7480 *7*)	5980	3.3 *3*	5.1	av Eβ=3487.3
(7530 *7*)	5930	1.9 *2*	5.3	av Eβ=3511.8
(8730 *7*)	4730	13 *3*	4.8	av Eβ=4101 Iβ⁻: other: 18 *2* in 2006AnZW.
(9746 *7*)	3714?	8 *2*	5.2	av Eβ=4600.3
(10768 *7*)	2692	9 *2*	5.4	av Eβ=5102.6
(10796 *7*)	2664	4 *1*	5.7	av Eβ=5116.3
(11095 *7*)	2365	7 *1*	5.5	av Eβ=5263.3
(11364 *7*)	2096	4 *2*	5.8	av Eβ=5395.6
(11622 *7*)	1838	6 *2*	5.7	av Eβ=5522.4 Iβ=6 *2*, log *ft*=5.69 *15* in figure 3 of 2008Tr07.
(11813 *7*)	1647	7 *1*	5.7	av Eβ=5616.3
(11842 *7*)	1618	12 *2*	5.5	av Eβ=5630.5
(13460 *7*)	0	15 *6*	5.6	av Eβ=6425.9 *34* Iβ⁻,Log *ft*: feeding to the g.s. is deduced from 100−ΣI(γ to g.s.)-%β⁻n, and considered as an upper limit due to possible unobserved weak transitions from higher-energy levels including unobserved levels in the large gap (≈4.5 MeV) between the highest observed level and Q(β^-)value. Quoted log *ft* should be considered as a lower limit.

† From γ-ray intensity balance at each level for levels below S(n)=5469 *10*, and from 2006AnZW based on measured β-delayed neutrons for levels above S(n), unless otherwise noted. Due to the incompleteness of this decay scheme, quoted values are considered as approximate by the evaluators, and the same for the associated log *ft* values.

‡ Absolute intensity per 100 decays.

Estimated for a range of levels.

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$\gamma(^{33}Al)$

Iγ normalization: The absolute (per 100 decays of ^{33}Mg) gamma-ray intensities are given by 2008Tr07 from the total number of ^{33}Mg implants and measured γ-ray detector efficiencies.

E_γ [†]	I_γ [†‡]	E_i(level)	J_i^π	E_f	J_f^π	Comments
596	5 *1*	2692	$(1/2^+,3/2,5/2^+)$	2096	$1/2^+$	E_γ: placement from 2017Mu05; placed from a 4310 level in 2008Tr07.
1046	4 *1*	2664	$(1/2^+,3/2,5/2)$	1618	$(5/2)^+$	E_γ: placement from 2017Mu05; placed from a 4310 level in 2008Tr07.
[x]1466[#]	3 *1*					Placed from the 4730 level to a 3264 level in 2008Tr07, however, neither this γ or the 3264 level is seen in 2006AnZW or other studies like 2017Mu05. The 1647γ placed from the 3264 level in 2008Tr07 is placed from the 1647 level in both 2006AnZW and 2017Mu05, which is adopted in Adopted Levels, Gammas. Since this γ is not shown in the γ spectrum and not seen in γγ-coin in 2008Tr07, the evaluators consider this γ questionable.
1618	16 *2*	1618	$(5/2)^+$	0	$(5/2)^+$	
1647	7 *1*	1647	$(5/2)^+$	0	$(5/2)^+$	E_γ: placement from 2006AnZW and 2017Mu05; placed from a 3264 level in 2008Tr07.
1838	9 *2*	1838	$(1/2^+,3/2,5/2)$	0	$(5/2)^+$	
2096	9 *2*	2096	$1/2^+$	0	$(5/2)^+$	E_γ: placement from 2006AnZW and 2017Mu05; placed from a 3714 level in 2008Tr07. It could be a doublet of 2080γ from 3704 level and 2101γ from 2101 level in 2017Mu05.
2096[#]		3714?	$(3/2^-,5/2^-)$	1618	$(5/2)^+$	E_γ: placement from 2008Tr07. It could be a doublet of 2080γ from 3704 level and 2101γ from 2101 level in 2017Mu05.
2365	7 *1*	2365	$(1/2^+,3/2,5/2)$	0	$(5/2)^+$	
2692	4 *2*	2692	$(1/2^+,3/2,5/2^+)$	0	$(5/2)^+$	E_γ: placement by the evaluators based on placement of 596γ; placed from a 4310 level in 2008Tr07; not reported in 2006AnZW and 2017Mu05. I_γ: not listed by 2008Tr07, deduced by the evaluators from intensity balance=13 *2* at 4310 level quoted in FIG.3 of 2008Tr07.
2892	3 *1*	4730	$(3/2^-,5/2^-)$	1838	$(1/2^+,3/2,5/2)$	E_γ: other: 2897 (2006AnZW).
3714[#]	8 *2*	3714?	$(3/2^-,5/2^-)$	0	$(5/2)^+$	E_γ: reported only in 2008Tr07.
4730	10 *3*	4730	$(3/2^-,5/2^-)$	0	$(5/2)^+$	E_γ: other: 4735 (2006AnZW).

[†] From 2008Tr07.
[‡] Absolute intensity per 100 decays.
[#] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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Decay Scheme

Intensities: I_γ per 100 parent decays