^{33}Na β^- decay (8.0 ms) 2001Nu02,1984Gu19

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 112, 1393 (2011)	31-Mar-2011

Parent: ^{33}Na: E=0.0; J^π=(3/2$^+$); $T_{1/2}$=8.0 ms *4*; Q(β^-)=19.94×10^3 *88*; %β^- decay=100.0

^{33}Na-Q(β^-): from 2009AuZZ. Other: 20.00×10^3 *88* (2003Au03).

^{33}Na-$T_{1/2}$: from timing of β, delayed neutrons and γ rays (2001Nu02). Other: 8.4 ms *4* (1984Gu19).

^{33}Na-J^π: From systematics of odd-Na nuclides (2002Ra16), 3/2$^+$ is favored. Shell-model calculations by 2001Nu02 predict 3/2$^+$ and 5/2$^+$ within 60 keV; and those of 2011GaZZ 3/2$^+$.

^{33}Na-%β^- decay: %β^-n=47 *6*, %β^-2n=13 *3* (2001Nu02).

2001Nu02, 2002Ra16 (also 2002Nu02,2004Co29): Measured Eγ, Iγ, half-life, $\gamma\gamma$, $\beta\gamma$ coin, $\beta\gamma\gamma$ coin, βnγ coin, nγ coin, delayed neutrons, ISOLDE facility. Shell-model calculations.

1984Gu19: Four unplaced γ rays reported.

Other:

2006AnZW: ^{33}Mg produced in fragmentation of ^{36}S beam at GANIL facility, measured γ and delayed neutrons from its decay.

^{33}Na also decays to ^{31}Mg by β^-2n (13% *3*) and to ^{32}Mg by β^-n (47% *6*); total.

All data are from 2001Nu02, unless otherwise stated.

The data on neutron energies are not available in detail to deduce all the level energies in ^{33}Mg populated by ^{33}Na β decay. Several γ rays are unplaced and there still could be unobserved transitions in the large energy gap allowed by the Q(β^-) value.

^{33}Mg Levels

E(level)	J^π[†]	Comments
0	3/2$^-$	
158.8?		E(level): 2001Nu02 propose a level at 158 keV with J^π=(7/2$^-$) from tentative placement of 546γ from 705 level to a 158 level, but no γ decay from this level was reported. The 546.2γ is now placed from a level of this energy, thus the existence of 158 level is suspect and it has been omitted in Adopted Levels.
484.1 *1*	(3/2$^-$)	
546.2 *1*		
705.0 *1*	(1/2$^+$,3/2$^+$,5/2$^+$)	J^π: 2001Nu02 propose (5/2$^+$).
1242.4 *1*	(1/2$^+$,3/2,5/2)	J^π: 2001Nu02 propose (1/2$^+$).
3780[‡]		E(level): from neutron group at 800 *60* keV.
4000[‡]		E(level): from neutron group at 1020 *80* keV.

[†] From Adopted Levels.

[‡] Decays to ^{32}Mg by neutron emission.

β^- radiations

E(decay)	E(level)	Iβ^-[†‡]	Log *ft*[†]	Comments
(1.87×10^4 *9*)	1242.4	2.9 *12*	6.0	av Eβ=9.04×10^3 *44*
(1.92×10^4 *9*)	705.0	7 *3*	5.6	av Eβ=9.30×10^3 *44*
(1.94×10^4 *9*)	546.2	9 *4*	5.5	
(1.95×10^4[#] *9*)	484.1	<1.2	>6.4	av Eβ=9.41×10^3 *44*
(1.99×10^4 *9*)	0	20 *10*	5.2	av Eβ=9.65×10^3 *44*

[†] The evaluators consider the level scheme as incomplete and tentative, thus all β branches are considered as upper limits and associated log *ft* values as lower limits.

[‡] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

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$\gamma(^{33}Mg)$

Iγ normalization: from absolute γ-intensity measurements (2001Nu02) using the activity of well-known ^{26}Na as standard, simultaneous detection of β and γ rays, and efficiencies of β- and γ-detectors.

E_γ	I_γ[†][#]	E_i(level)	J_i^π	E_f	J_f^π	Comments
221.0 *1*	8.7 *10*	705.0	(1/2$^+$,3/2$^+$,5/2$^+$)	484.1	(3/2$^-$)	E_γ,I_γ: doublet. The second component is assigned to a transition in ^{31}Mg populated by ^{33}Na β^-2n decay.
[x]297.9[‡] *1*	4.0 *4*					
484.1 *1*	18.7 *19*	484.1	(3/2$^-$)	0	3/2$^-$	Eγ=484.9 *10*, Iγ=14 *11* (1984Gu19).
546.2 *1*	40 *4*	546.2		0	3/2$^-$	2001Nu02 considered different scenarios for the placement of 546γ and proposed placement from 705 level to a 159 level as the probable one. However, this γ could also define a level of this energy, a possibility which 2001Nu02 considered less likely based on rather weak arguments. 2006El03 observed a 561 *17* γ in ^{1}H(^{34}Mg,^{33}Mgγ), which they suggested was most likely the same as 546.2γ in decay work, but no 704.9γ was seen in this study, which may imply that 546.2γ and 704.9γ de-excite different levels. In Adopted Levels, Gammas, the evaluators have defined a level at 546.2 keV. Eγ=546.5 *10*, Iγ=40 *13* (1984Gu19).
546.2[@]		705.0	(1/2$^+$,3/2$^+$,5/2$^+$)	158.8?		E_γ: tentative placement (2001Nu02), but the evaluators suggest that the main placement is from 546 level based on the observation of a 546γ in ^{1}H(^{34}Mg,^{33}Mgγ) (2006El03) but not the 704.9γ.
704.9 *1*	23.2 *21*	705.0	(1/2$^+$,3/2$^+$,5/2$^+$)	0	3/2$^-$	Eγ=704.3 *10*, Iγ=23 *11* (1984Gu19).
758.2 *1*	6.1 *7*	1242.4	(1/2$^+$,3/2,5/2)	484.1	(3/2$^-$)	
[x]845.7[‡] *2*	2.5 *4*					
[x]1011.3[‡] *2*	1.6 *4*					
1242.8 *2*	7.1 *19*	1242.4	(1/2$^+$,3/2,5/2)	0	3/2$^-$	Eγ=1242.6 *18*, Iγ=26 *10* (1984Gu19).
[x]1857.7[‡] *4*	4.1 *6*					
[x]1976.9 *5*	6.7 *19*					
[x]2236.9 *5*	7.0 *9*					

[†] Relative to 100 for 885.3γ in ^{32}Mg populated in β^-n decay of ^{33}Na.

[‡] The evaluators note that 1857.7-1011.3=846.4, which matches the gamma energy of 845.7 *2* keV within the uncertainty range and may suggest a level at 1011.3+845.7=1856 and another level either at 1011 or 846. The evaluators tentatively define a level at 1856.7 keV. Also 845.7-297.9=547.8 which is close in energy to 546.2γ.

[#] For absolute intensity per 100 decays, multiply by 0.22 *8*.

[@] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

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Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays