Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 184, 29 (2022)	24-Jun-2022

Q(β^-)=11829 *4*; S(n)=2312 *3*; S(p)=18886 *6*; Q(α)=−12600 *90* 2021Wa16
S(2n)=8652 *3*, S(2p)=36100 *150*, Q(β^-n)=4671 *4* (2021Wa16).

This nucleus is part of a set of nuclei around N=20 belonging to the "island of inversion" where the ground state is deformed from a spherical shell. The ground state and first excited state spins are critical in proving the intruder dominant configuration (2005Ma96).

Mass measurements: 2013Ch49, 2006Ga04 (also 2006Lu09 from the same group).

Other measurements:

2017Ha23: measured half-life of ^{31}Mg from implant-β(t). ^{31}Mg from ^{9}Be(^{40}Ar,X) reaction with E(^{40}Ar)=69.2 MeV/nucleon from the RIBLL facility at HIRFL, Lanzhou.

2012Yo01 (also 2010Yo08): first application of nuclear orientation method for study of isotope shifts in nuclei. Atomic isotope shifts measured using collinear laser spectroscopy and β-asymmetry with reference to ^{26}Mg for all measurements at CERN-ISOLDE. The data are consistent for ^{31}Mg being in the "Island of Inversion".

2012Kw02: production cross section measurement in fragmentation of ^{40}Ar beam at 140 MeV/nucleon with ^{9}Be, Ni and ^{181}Ta targets by time-of-flight and energy loss measurements at NSCL facility.

2012Zh06: ^{9}Be(^{40}Ar,X) E=57 MeV/nucleon, measured fragment yield, momentum distributions at HIRFL facility; deduced target dependence on production cross section.

2006Kh08: cross section and strong absorption radius measurement in Si(^{31}Mg,X) reaction at 52.25 MeV/nucleon.

2011Ne14: critical review of experimental data leading to ground and excited states in ^{31}Mg; comparison with calculated levels, J, π, magnetic moments, particle-hole nature using Antisymmetrized molecular dynamics (AMD) with the generator coordinate method.

Theoretical calculations: 35 primary references for structure and three for decay characteristics retrieved from the NSR database (www.nndc.bnl.gov/nsr/) are listed under 'document records'.

Additional information 1.

^{31}Mg Levels

Cross Reference (XREF) Flags

A	^{31}Na β^- decay (17.0 ms)	E	^{9}Be(^{32}Mg,^{31}Mgγ)
B	^{32}Na β^-n decay (13.2 ms)	F	^{9}Be(^{32}Al,^{31}Mgγ)
C	^{33}Na β^-2n decay (8.0 ms)	G	^{4}He(HI,xγ)
D	^{2}H(^{30}Mg,^{31}Mgγ)	H	Coulomb excitation

E(level)[†]	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0[#]	1/2$^+$	270 ms *2*	ABCDEFGH	%β^-=100; %β^-n=6.2 *19* (2008ReZZ,1995ReZZ) μ=−0.88340 *15* (2008Ko05,2005Ne01,2019StZV) The ground state is conjectured to be indicative of deformed 2p3h intruder state (2007Ki08); its 1/2$^+$ spin measurement and half-life can only be explained by a hole coupled to a deformed core of ^{32}Mg. In Nilsson configuration this corresponds to a K^π=1/2$^+$ component from the d$_{3/2}$ spherical orbit with 1/2[200] configuration (2007Ki08). J$^\pi$: spin from measured (2005Ne01) hyperfine splitting using β-NMR combined with a measurement of the g-factor of ^{31}Mg and compared to prediction using the isotope independent hyperfine field value for ^{25}Mg data; parity from measured l$_p$=0 for the Isobaric Analog Resonance (IAR) state in ^{31}Al (2014Im02). T$_{1/2}$: from 2017Ha23 (implant-β(t)). Other (less precise measurements): 235 ms *25* (2008ReZZ,1995ReZZ), 237 ms *25* (2005Ma86), 230 ms *20* (1984La03), and 250 ms *30* (1979De02). 1984La03 and 1979De02 are from the same research group but different methods were used to measure half-life.

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Adopted Levels, Gammas (continued)

^{31}Mg Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
				μ: from collinear laser spectroscopy and β^-NMR spectroscopy at ISOLDE-CERN facility (2008Ko05,2005Ne01). Original value is −0.88355 *15* with respect to previously known $\mu(^{25}$Mg)=−0.85545 *8* (1951Al11) and the quoted value is with respect to the new adopted $\mu(^{25}$Mg)=−0.85533 *3* (2013An23,2019StZV). Other publications by the same group: 2006Ko55, 2005Ko41, 2005Ko50, 2001Ne16. Additional information 2. %β^-n from 2008ReZZ, 1995ReZZ. Other: %β^-n=1.7 *3* (1984La03,1984Gu19) is in disagreement. Systematics support higher value of 1995ReZZ. Theoretical values of %β^-n=1.0 (2019Mo01) and 0.31, 0.40 (2021Mi17) support the lower value. In the opinion of evaluators, better measurements are needed for %β^-n value. $\langle r_0\rangle^2$=1.199 fm^2 *14* (2006Kh08). $\delta\langle r^2\rangle(^{26}$Mg,^{31}Mg)=+0.710 fm^2 *13* (stat) *79* (syst) (2012Yo01). $\langle r^2\rangle^{1/2}$=3.1488 fm *20* (stat) *127* (syst) (2012Yo01).
49.93[#] *6*	3/2$^+$	12.0 ns *4*	ABCDEFGH	J^π: spin from β polarization asymmetry in ^{31}Na β^- decay (2019Ni04); allowed β feeding from 3/2$^+$ parent; measured L(p)=2 for the Isobaric Analog Resonance (IAR) state in ^{31}Al (2014Im02). Shell-model calculations in *sdpf* space support 3/2 since predicted 1/2$^+$ is the g.s. and the first 1/2$^-$ is predicted to occur at about 1.5 MeV (2005Ma96). 3/2$^+$ assignment for this level is indicative of a deformed 2p3h intruder state. In Nilsson configuration this corresponds to a K^π=3/2$^+$ component from the $d_{3/2}$ spherical orbit (2007Ki08). $T_{1/2}$: from βγ(t) in ^{31}Na β^- decay.
220.87[@] *6*	(3/2)$^-$	133 ps *8*	ABCDEFGH	J^π: 1/2$^-$,3/2$^-$ from measured l_p=1 for the Isobaric Analog Resonance (IAR) state in ^{31}Al (2014Im02); shell-model predictions (2007Ki08) and band assignment (2019Ni04) support 3/2$^-$. $T_{1/2}$: preliminary value from βγγ(t) in ^{31}Na β^- decay (2005Ma96).
460.78[@] *10*	(7/2$^-$)	10.5 ns *8*	AB EF	J^π: γ to (3/2)$^-$, shell-model prediction (2007Ki08) and band assignment (2019Ni04). $T_{1/2}$: preliminary value from βγγ(t) in ^{32}Na β^-n decay (2005Ma96).
673.09 *7*	3/2$^+$		A EF H	B(E2)↑=0.0021 *8* (2011Se05) J^π: spin from β polarization asymmetry in ^{31}Na β^- decay (2019Ni04); allowed β feeding from 3/2$^+$ parent.
941.92 *9*	(1/2$^-$,3/2$^-$)[‡]		A e G	J^π: probable 3/2$^-$ bandhead of theoretically predicted K^π=3/2$^-$, 3/2[321] band (2019Ni04).
944.03[#] *9*	5/2$^+$		AB eF H	B(E2)↑=0.0182 *20* (2011Se05) J^π: from β polarization asymmetry in ^{31}Na β^- decay (2019Ni04) from 3/2$^+$ parent. 2p3h state predicted by model calculations (2007Ki08).
1028.66 *9*	(1/2$^-$,3/2$^-$)[‡]		A	
1154.0 *5*	(7/2$^+$)		B EF	J^π: γ to (7/2$^-$); cross section in (^{32}Al,^{31}Mgγ) and model considerations (2007Ki08); 2005Ma96 proposed 11/2$^-$ based on another calculation.
1389.8 *10*			B	J^π: 5/2$^-$ from theoretical predictions (2011Ne14).
1435.94 *8*	(1/2$^-$,3/2$^-$)[‡]		A	
2015.14 *9*	5/2$^+$		A F	J^π: β polarization asymmetry in ^{31}Na β^- decay (2019Ni04) from 3/2$^+$ parent; also from cross section in (^{32}Al,^{31}Mgγ) and model considerations (2007Ki08).
2243.66 *6*	1/2$^+$		A E	J^π: β polarization asymmetry in ^{31}Na β^- decay (2019Ni04); allowed β feeding from 3/2$^+$ parent.

[†] From a least-squares fit to γ-ray energies.

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Adopted Levels, Gammas (continued)

^{31}Mg Levels (continued)

‡ Assignments proposed by 2019Ni04 in ^{31}Na β^- decay, based on high log *ft* values, and consistency of ratio of intensities of γ rays from each level with Weisskopf estimates for E1 and M1 transitions. However, evaluators notes that no lifetime data are available.
\# Member of K^π=1/2$^+$, ν1/2[200] sequence (2019Ni04).
@ Member of K^π=1/2$^-$, ν1/2[330] sequence (2019Ni04).

$\gamma(^{31}$Mg)

E_i(level)	J^π_i	E_γ‡	I_γ‡	E_f	J^π_f	Mult.	α†	Comments
49.93	3/2$^+$	49.9 *1*	100	0.0	1/2$^+$	[M1]	0.01325 *20*	B(M1)(W.u.)=0.0106 *21* E_γ: others: 50.0 *5* from ^{32}Na β^-n decay and 50.1 *2* from ^{33}Na β^-2n decay.
220.87	(3/2)$^-$	171.1 *1*	100 *5*	49.93	3/2$^+$	[E1]	1.04×10^{-3} *2*	B(E1)(W.u.)=0.00073 *8* α(K)=0.000974 *14*; α(L)=6.25×10^{-5} *9*; α(M)=2.303×10^{-6} *33* E_γ: weighted average of 170.9 *1* from ^{31}Na β^- decay, 171.0 *5* from ^{32}Na β^-n decay, 171.2 *1* from ^{33}Na β^-2n decay, and 169.6 *15* from (HI,xγ). I_γ: from (^{32}Al,^{31}Mgγ). Others: 100 *8* (2019Ni04), 100 *6* (1993Kl02) and 100 *7* (1984Gu19) in ^{31}Na β^- decay, 100 *22* from ^{32}Na β^-n decay, 100 *12* from ^{33}Na β^-2n decay, and 100 *6* from (^{32}Mg,^{31}Mgγ).
		220.9 *1*	35.5 *20*	0.0	1/2$^+$	[E1]	0.000465 *7*	B(E1)(W.u.)=0.000139 *18* α=0.000465 *7*; α(K)=0.000436 *6*; α(L)=2.80×10^{-5} *4*; α(M)=1.034×10^{-6} *15* E_γ: weighted average of 220.8 *1* from ^{31}Na β^- decay, 221.0 *5* from ^{32}Na β^-n decay, 221.0 *1* from ^{33}Na β^-2n decay, and 221.9 *8* from (HI,xγ). I_γ: weighted average of 37.1 *25* (2019Ni04), 40.6 *32* (1993Kl02), and 44 *5* (1984Gu19) in ^{31}Na β^- decay, 40 *6* from ^{33}Na β^-2n decay, 34.0 *26* from (^{32}Mg,^{31}Mgγ), and 31.4 *20* from (^{32}Al,^{31}Mgγ). Other: 49 *10* from ^{32}Na β^-n decay.
460.78	(7/2$^-$)	239.9 *1*	100	220.87	(3/2)$^-$	[E2]	2.31×10^{-3} *3*	B(E2)(W.u.)=11.7 *9* E_γ: other: 240.0 *5* from ^{32}Na β^-n decay.
673.09	3/2$^+$	452.4 *2*	10.8 *13*	220.87	(3/2)$^-$	[E1]		E_γ: other: 452.6 *6* from (^{32}Al,^{31}Mgγ). I_γ: weighted average of 10.6 *13* (2019Ni04) and 12.6 *35* (1993Kl02) in ^{31}Na β^- decay. Other: 20.6 *28* from (^{32}Al,^{31}Mgγ) is discrepant.
		623.1 *1*	100 *6*	49.93	3/2$^+$	[M1,E2]		B(E2)↓=0.0024 *12* (2011Se05) B(E2)(W.u.)=4.1 *20* E_γ: other: 623.3 *5* from (^{32}Al,^{31}Mgγ).

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Adopted Levels, Gammas (continued)

$\gamma(^{31}Mg)$ (continued)

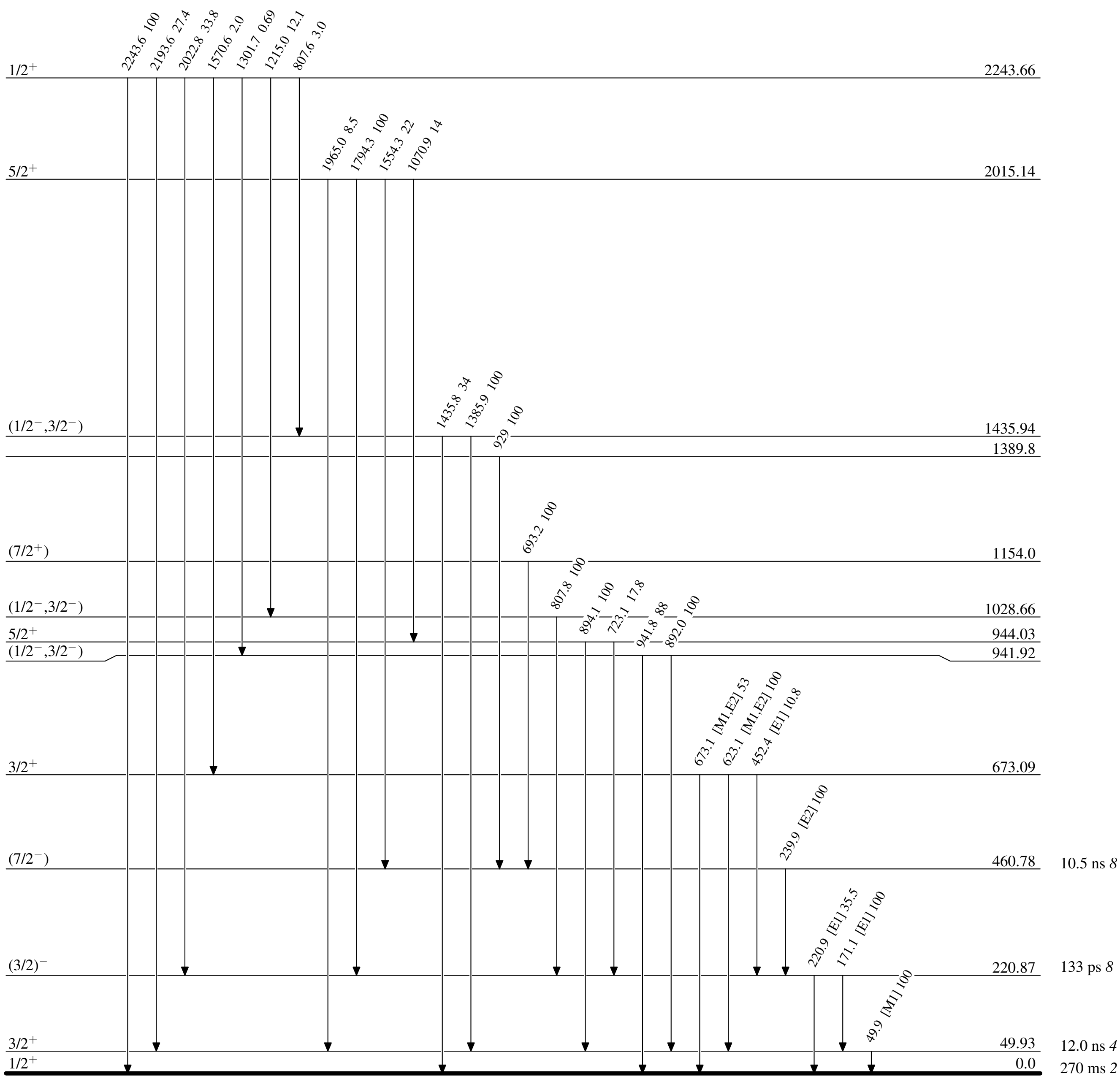
E_i(level)	J^π_i	E_γ‡	I_γ‡	E_f	J^π_f	Mult.	Comments
							I_γ: from (^{32}Al,^{31}Mgγ). Others: 100 *13* (2019Ni04), 100 *8* (1993Kl02) and 100 *8* (1984Gu19) in ^{31}Na β^- decay.
673.09	3/2$^+$	673.1 *1*	53 *4*	0.0	1/2$^+$	[M1,E2]	B(E2)↓=0.0011 *5* (2011Se05) E_γ: other: 673.2 *7* from (^{32}Al,^{31}Mgγ). I_γ: unweighted average of 64 *4* (2019Ni04), 50 *4* (1993Kl02) and 43.5 *35* (1984Gu19) in ^{31}Na β^- decay, and 53 *4* from (^{32}Al,^{31}Mgγ).
941.92	(1/2$^-$,3/2$^-$)	892.0 *1*	100 *13*	49.93	3/2$^+$		E_γ: other: 892.7 *6* from (HI,xγ).
		941.8 *2*	88 *30*	0.0	1/2$^+$		
944.03	5/2$^+$	723.1 *1*	17.8 *33*	220.87	(3/2)$^-$		E_γ: other: 724 from Coulomb excitation. I_γ: weighted average of 17.0 *23* (2019Ni04) from ^{31}Na β^- decay and 32 *10* from Coulomb excitation.
		894.1 *1*	100 *16*	49.93	3/2$^+$		E_γ: others: 894.3 *5* from ^{32}Na β^-n decay and 894.4 *13* from (^{32}Al,^{31}Mgγ).
1028.66	(1/2$^-$,3/2$^-$)	807.8 *1*	100	220.87	(3/2)$^-$		
1154.0	(7/2$^+$)	693.2 *5*	100	460.78	(7/2$^-$)		E_γ: weighted average of 693.5 *5* from ^{32}Na β^-n decay and 692.6 *8* from (^{32}Al,^{31}Mgγ).
1389.8		929	100	460.78	(7/2$^-$)		E_γ: from ^{31}Na β^-n decay only.
1435.94	(1/2$^-$,3/2$^-$)	1385.9 *1*	100 *11*	49.93	3/2$^+$		
		1435.8 *2*	34 *8*	0.0	1/2$^+$		
2015.14	5/2$^+$	1070.9 *2*	14 *4*	944.03	5/2$^+$		E_γ: other: 1072.7 *19* from (^{32}Al,^{31}Mgγ). I_γ: unweighted average of 17.6 *30* (2019Ni04) in ^{31}Na β^- decay and 10.1 *16* from (^{32}Al,^{31}Mgγ).
		1554.3 *1*	22 *3*	460.78	(7/2$^-$)		E_γ: other: 1555.7 *22* from (^{32}Al,^{31}Mgγ). I_γ: weighted average of 20.6 *30* (2019Ni04) and 24.0 *30* from (^{32}Al,^{31}Mgγ).
		1794.3 *1*	100 *12*	220.87	(3/2)$^-$		E_γ: other: 1793.4 *18* from (^{32}Al,^{31}Mgγ).
		1965.0 *2*	8.5 *18*	49.93	3/2$^+$		
2243.66	1/2$^+$	807.6 *1*	3.0 *13*	1435.94	(1/2$^-$,3/2$^-$)		
		1215.0 *1*	12.1 *9*	1028.66	(1/2$^-$,3/2$^-$)		I_γ: weighted average of 12.6 *9* (2019Ni04), 11.6 *12* (1993Kl02), 11.6 *11* (1984Gu19), and 22 *7* (1979De02) in ^{31}Na β^- decay.
		1301.7 *2*	0.69 *15*	941.92	(1/2$^-$,3/2$^-$)		
		1570.6 *2*	2.0 *4*	673.09	3/2$^+$		
		2022.8 *1*	33.8 *19*	220.87	(3/2)$^-$		I_γ: weighted average of 33.3 *19* (2019Ni04), 33.7 *35* (1993Kl02), and 36 *4* (1984Gu19) in ^{31}Na β^- decay. Other: 32 *21* from (^{32}Mg,^{31}Mgγ).
		2193.6 *1*	27.4 *19*	49.93	3/2$^+$		I_γ: weighted average of 25.9 *19* (2019Ni04), 30.2 *35* (1993Kl02), 30 *4* (1984Gu19), and 29 *9* (1979De02) in ^{31}Na β^- decay. Other: 37 *21* from (^{32}Mg,^{31}Mgγ).
		2243.6 *1*	100 *6*	0.0	1/2$^+$		

† Additional information 3.
‡ From ^{31}Na β-decay, except as noted.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



$^{31}_{12}Mg_{19}$