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^-)=15368 *14*; S(n)=4300 *15*; S(p)=1.832×10^4 *25*; Q(α)=−1.531×10^4 *12* 2021Wa16
S(2n)=6577 *16*, S(2p)=42480 *530*, Q(β^-n)=13056 *14* (2021Wa16).
Q(β^-2n)=6716 *14* and Q(β^-3n)=3053 *14* deduced by evaluators from masses in 2021Wa16.
Mass measurements: 2017Ga20, 2013Ch49, 2007Ju03, 1991Or01, 1991Zh24, 1987Gi05, 1975Th08.
Isotopic identification, yield and half-life measurements:
1969Kl08: E=24 GeV, ^{31}Na first identified in Ir(p,X) and U(p,X) reactions.
1972Kl04: U(p,X) E=24 GeV, measured production σ and half-life of ^{31}Na.
1972RiZJ: ^{238}U(p,F), measured half-life and yield.
1974Ro31: Measured half-life, %β^-n.
1979We10: Be(^{48}Ca,X) E=212 MeV/nucleon, measured cross section.
1979Sy01: ^{12}C(^{40}Ar,X) E=205 MeV/nucleon, measured cross section.
1979De02: U(p,X) E=24 GeV, mass spectroscopy.
1980De26: Measured two neutron emission.
1981ZiZW: ^{31}Na from U(p,X) E=600 MeV, measured beta-delayed neutron activity, deduced strength functions at ISOLDE-CERN facility.
1984Gu19: ^{31}Na from Ir(p,X) E(p)=10 GeV, CERN.
1984La03: Measured β-delayed neutron emission.
1997Ha11: U(p,X) E=1 GeV, measured yield.
1999Dl01, 1997Ta22: Ta(^{36}S,X) E=78 MeV/nucleon; LISE-GANIL facility, measured cross section, half-life.
1998NoZW, 1998NoZZ: Ta(^{40}Ar,X) E=95 MeV/nucleon, measured half-life.
1999YoZW: Ta(^{48}Ca,X) E=70 MeV/nucleon, measured half-life, %β-n (preliminary results).
2001Pe14: Be(^{36}S,X) E=75 MeV/nucleon; LISE-GANIL facility, measured cross section, half-life, %β-n.
2006Tr02: measured yield of ^{31}Na in Be(^{48}Ca,X) E=12.3 MeV/nucleon.
2006Kh08: Si(^{31}Na,X) E=30-65 MeV/nucleon, measured cross section, deduced radii, isospin dependence.
2012Kw02: ^{9}Be,Ni,^{181}Ta(^{40}Ar,X) E=140 MeV/nucleon at NSCL. Measured fission fragment spectra.
2015Mo17: ^{9}Be(^{40}Ar,X) E=95 MeV/nucleon at RIKEN. Measured momentum distributions of fragments.
2017Ha23: ^{9}Be(^{40}Ar,X) E=69.2 MeV/nucleon at HIRFL, Lanzhou. Measured implant-β(t). Deduced $T_{1/2}$.
Measurements of hyperfine structure, isotope shifts: 2000Ke09 (β^-NMR method), 1996Ke08 (β^-NMR method), 1982To05, 1978Hu12 (laser spectroscopy).
Measurements of rms radii: 1998Su07, 1997Su04, 1995Su18.
Theoretical calculations: 41 primary references for structure and five for decay characteristics retrieved from the NSR database (www.nndc.bnl.gov/nsr/) are listed under ‘document records’.
Additional information 1.

^{31}Na Levels

Cross Reference (XREF) Flags

A	^{1}H(^{31}Na,^{31}Na′γ)
B	^{4}He(HI,xγ)
C	^{12}C(^{32}Na,^{31}Naγ)
D	^{197}Au(^{31}Na,^{31}Na′γ)

E(level)†	J$^\pi$	$T_{1/2}$	XREF	Comments
0.0‡	3/2$^+$	17.0 ms *4*	ABCD	%β^-=100; %β^-n=39 *5*; %β^-2n=0.7 *1*; %β^-3n<0.05 (1984Gu19) μ=+2.298 *2* (2000Ke09,2000Ge20) rms charge radius ($\langle r^2\rangle)^{1/2}$=3.170 fm *89* (2013An02). %β^-2n=0.9 *2* and %β^-n=37.1 *59* are deduced from %β^-n+%β^-2n=38 *6* (1984La03) and

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{31}Na Levels (continued)

E(level)†	J^π	XREF	Comments
			%β^-2n/(%β^-n+%β^-2n)=0.023 *5* (1980De26) by neutron counting; %β^-2n=0.7 *1* and %β^-n=40 *5* are from 2019Ni04 by γ counting based on known absolute γ-ray intensities in the daughter nuclei ^{31}Al (2005Ma86), ^{30}Al (2008Hi05,2016Ol06), ^{29}Al (1984Gu19) of ^{31}Na β, βn and β2n decays, respectively. Adopted values are weighted averages of above values. Others: %β^-n+%β^-2n=30 *8* (1974Ro31); %β^-n=40 *12* and %β^-2n<1.5 (1984Gu19); %β^-=40 *14* (2008ReZZ). Upper limit of 0.05% in 1984Gu19 for β^-3n decay mode was based on non-observation of long-lived activity of ^{28}Mg (1984Gu19 mention ^{28}Al, which seems a misprint). J^π: spin from β^--NMR on polarized nuclei (2000Ke09,2000Ge20); parity from allowed β-feeding to 1/2$^+$ g.s. in ^{31}Mg. Note that shell-model calculations by 2000Ke09 suggest that 3/2$^+$ level is 454 keV above the 5/2$^+$ g.s., in contradiction to the measured J=3/2 and magnetic moment. $T_{1/2}$: weighted average of following measured $T_{1/2}$ values in ms: 16.6 *4* (2017Ha23), 18 *2* (2001Pe14, earlier values from the same group: 16.9 *18* (1999Dl01), 18 *2* (1997Ta22)), 19 *4* (1998NoZW, 1999YoZW), 17.0 *4* (1984La03), 17.7 *5* (1981ThZV), 16.9 *7* (1974Ro31, average of 21 *3* from β counting, 20 *5* from neutron counting and 16.6 *7* from ion counting). Others: 17.7 *10* (1972Kl04) and 16.5 *4* (1969Kl08), earlier values from the same group as 1974Ro31; 11.5 ms *73* (2008ReZZ). μ: from β^--NMR method, with g(^{31}Na g.s.)/g(^{26}Na g.s.)=1.61206 *12* (2000Ke09,2000Ge20). Other: +2.305 *8* (1978Hu12, atomic-beam laser spectroscopy; also adopted by 2019StZV). Note that measurement in 2000Ke09 may not have been considered in 2019StZV evaluation, as the value from 2000Ke09 was not listed in the previous 2014StZZ compilation.
375.1‡ *7*	(5/2$^+$)	ABCD	B(E2)↑=0.031 *+17−13* (2002Pr12,2001Pr01) β_2=0.59 *10* (2001Pr01) β_2 from ^{197}Au(^{31}Na,^{31}Na$'\gamma$) reaction. J^π: Coulomb excitation from 3/2$^+$; 7/2$^+$ is unlikely since cross section measurement in ^{197}Au(^{31}Na,^{31}Na$'\gamma$) implies unrealistic β_2=0.94 (2001Pr01); 5/2$^+$ from shell-model predictions (2010Do05).
1162.9 *10*	(7/2$^+$)	BC	J^π: from comparison with shell-model predictions (2010Do05).

† From Eγ data.
‡ Possible member of K^π=3/2$^+$ band (2001Pr01).

γ(^{31}Na)

E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Comments
375.1	(5/2$^+$)	375.1 *7*	100	0.0	3/2$^+$	E_γ: others: 370 *12* (2006El03), 376 *4* (2010Do05) and 350 *20* (2001Pr01), from ^{1}H(^{31}Na,^{31}Na$'\gamma$), ^{12}C(^{32}Na,^{31}Naγ) and ^{197}Au(^{31}Na,^{31}Na$'\gamma$), respectively.
1162.9	(7/2$^+$)	787.8 *7*	100	375.1	(5/2$^+$)	E_γ: other: 787 *8* from ^{12}C(^{32}Na,^{31}Naγ) (2010Do05).

† From ^{4}He(HI,Xγ) (2006FuZX).

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level