Nuclear Data Sheets for A = 22^{*}

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Abstract: Evaluated spectroscopic data and level schemes from radioactive decay and nuclear reaction studies are presented for ²²C, ²²N, ²²O, ²²F, ²²Ne, ²²Na, ²²Mg, ²²Al, and ²²Si. This evaluation for A=22 supersedes the earlier one by R. B. Firestone (2005Fi16).

Cutoff Date: All data received by April 1, 2015 have been evaluated. The NSR database (2014Pr09) (www.nndc.bnl.gov/nsr/) was the main source of bibliography during this evaluation.

General Policies and Organization of Material: see <http://www.nndc.bnl.gov/nds/NDSPolicies.pdf>.

Acknowledgments: This evaluation is benefited from earlier evaluations by R. B. Firestone (2005Fi16) and P. M. Endt (1998En04, 1990En08, 1978En02). Evaluator is thankful to the compilers of XUNDL datasets for initial entry from references (compilers): 2004Co11, 2004St08, 2005Se02, 2005We06, 2006Ac04, 2007Le28, 2007Su05, 2008He04, 2008So09, 2009Ch28, 2009He12, 2009St20, 2010Ac01, 2010Ch46, 2010Su03, 2011Ba27, 2011Ki26, 2011Sa15, 2011To14, 2012Bo09, 2013Be12, 2014Zh05, 2015Ma19 (B. Singh, S. Geraedts, B. Karamy, J. Roediger, J. Chen, E. Thiagalingam, M. Mitchell, and A. MacDonald (MacMaster) and 2009Ma68 (K. Abusaleem (U. of Jordan) and B. Singh (McMaster)). Also the evaluator is grateful to the reviewer for constructive comments and suggestions and also thankful to E.A. McCutchan for a thorough editorial review.

General Comments: The internal conversion coefficients (α) presented in this evaluation have been calculated using the computer code BrIcc (2008Ki07) based on Band–Raman tables of conversion coefficients. The Limitation of Relative Statistical Weight (LWM) averaging method (1985ZiZY) has been used for some discrepant datasets in this evaluation.

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Skeleton Scheme for A=22

Skeleton Scheme for A=22 (continued)

Ground-State and Isomeric-Level Properties					
Nuclide	Level	J π	T _{1/2}	Decay Modes	
^{22}C	0.0	0+	6.1 ms <i>+14-12</i>	% β^- =100; % β^- n=61 <i>+14-13</i> ; % β^- 2n<37	
^{22}N	0.0	(0-)	23 ms <i>3</i>	% β^- =100; % β^- n=34 <i>3</i> ; % β^- 2n=12 <i>3</i>	
^{22}O	0.0	0+	2.25 s <i>9</i>	% β^- =100; % β^- n<22	
^{22}F	0.0	(4+)	4.23 s <i>4</i>	% β^- =100; % β^- n<11	
^{22}Ne	0.0	0+	stable		
^{22}Na	0.0	3+	2.6018 y <i>22</i>	% ϵ +% β^+ =100	
^{22}Mg	0.0	0+	3.8755 s <i>12</i>	% ϵ +% β^+ =100	
^{22}Al	0.0	(4)+	91.1 ms <i>5</i>	% ϵ +% β^+ =100; % β^+ p=55 <i>3</i> ; % β^+ 2p=1.1 <i>I</i> ; % $\beta^+\alpha$ =0.038 <i>17</i>	
^{22}Si	0.0	0+	29 ms <i>2</i>	% ϵ +% β^+ =100; % β^+ p=32 <i>4</i>	
^{23}O	0.0	1/2+	97 ms <i>8</i>	% β^- n=7 <i>2</i> ; ...	
^{23}Al	0.0	5/2+	0.47 s <i>3</i>	% β^+ p=1.25 <i>5</i> ; ...	
^{23}Si	0.0	(5/2)+	42.3 ms <i>4</i>	% ϵ p=71.0; ...	

Adopted Levels

$Q(\beta^-)=21550$ 310; $S(n)=124$ SY; $S(p)=29420$ SY 2012Wa38.

$\Delta S(n)=470$ (syst), $\Delta S(p)=937$ (syst) 2012Wa38.

1986Po13: First observation of ^{22}C . Produced by $^{181}\text{Ta}(^{40}\text{Ar},x)$, $E=44$ MeV/A; Measured residual yields, TOF.

2010Ta04: $^1\text{H}(^{22}\text{C},^{22}\text{C}')$, $E=41$ MeV/nucleon; ^{22}C beam was produced from ^{40}Ar fragmentation by $\text{Ta}(^{40}\text{Ar},X)$, $E=63$

MeV/nucleon, reaction products were separated using RIPS fragment separator at RIKEN; Liquid hydrogen target;

Measured reaction cross section by transmission method, deduced rms radius.

 ^{22}C Levels

E(level)	$J\pi$	$T_{1/2}$	Comments
0 . 0	0 +	6 . 1 ms +14-12	<p>$\% \beta^- = 100$; $\% \beta^- n = 61 +14-13$; $\% \beta^- 2n < 37$. $T_{1/2}$: From 2003Yo02. Other value: 9 ms 3 (1998Yo06). $\% \beta^- n$: From 2003Yo02. Total neutron emission probability $p_n > 60$ (1998Yo06). $\% \beta^- 2n$: From 2003Yo02. Measured reaction cross section=1.34 b 27 (2010Ta04 – assuming no excited states in ^{22}C). Deduced rms radius=5.4 fm 9 (2010Ta04). Halo structure of ^{22}C is suggested in 2010Ta04 from comparison of measured reaction cross sections for ^{22}C, ^{20}C and ^{19}C isotopes and from deviation of systematic trend for measured rms radius in C isotopes. The two-valence neutrons in ^{22}C preferentially occupy the $1s_{1/2}$ orbital (from Glauber model calculation – 2010Ta04). Also supported in 2012Ko38 from two-neutron removal reaction studies of ^{22}C on a carbon target. Two-neutron removal cross section 266 mb 19, measured from the $\text{C}(^{22}\text{C},^{20}\text{C})$, $E=240$ MeV/A, knock-out reaction (2012Ko38).</p>

Adopted Levels, Gammas

$Q(\beta^-)=22760\ 200$; $S(n)=1280\ 210$; $S(p)=20894\ SY$; $Q(\alpha)=-2.22\times 10^4\ 3\ 2012\text{Wa}38$.

$\Delta S(p)=444(\text{syst})\ 2012\text{Wa}38$.

1979We10: First production of ^{22}N from fragmentation of ^{48}Ca beam, $E=212\ \text{MeV/nucleon}$, on beryllium target (890 mg/cm^2).

$^9\text{Be}(^{22}\text{N},^{21}\text{N}) - 2011\text{Ro}21$: Measured one neutron knock out cross section of $\sigma_{-1n}=97\ \text{mb}\ 34$ and suggest that the ground state of ^{22}N exhibits a halo structure. ^{22}N beam was produced from fragmentation of ^{40}Ar beam, $E=700\ \text{MeV/nucleon}$, on a Be target (4 g/cm^2) at GSI.

 ^{22}N Levels

Cross Reference (XREF) Flags

A $^9\text{Be}(^{26}\text{F},x)$

B $\text{C}(^{36}\text{S},X\gamma)$

E(level)	$J\pi^\dagger$	XREF	$T_{1/2}$	Comments
0.0	(0-)	B	23 ms 3	$\% \beta^- = 100$; $\% \beta^- n = 34\ 3$; $\% \beta^- 2n = 12\ 3$. $T_{1/2}$: Weighted average of 24.5 ms 65 (symmetric value of 24 ms +7-6 1990Mu06), 31 ms 5 (2001Pe14), 16.5 ms +85-48 (2003Yo02 - used symmetric value of 18.3 ms 66), 14 ms 6 (1995ReZZ), and 24 ms 3 (3198 γ -t), 22 ms 4 (1845n-t), 21 ms 7 (total β -t) - all from 2010Su03. Uncertainty is the lowest experimental value. 2010Su03 adopted a ^{22}N half-life of 20 ms 2, deduced (procedure not described) from measured values of neutron- (five), γ -ray (two) gated decay, and total β -decay (one) curves. $\% \beta^- n$: Weighted average of 35 5 (1990Mu06), 37 14 (2001Pe14), 41 +12-10 (2003Yo02), 33 3 (2010Su03), 34 14 (2008ReZZ). $\% \beta^- 2n$: From 2010Su03. Other: <13 (2003Yo02).
183 16	(1-)	B		
1017 25	(2-)	B		
1930 220	(3-)	A	<60 keV	E(level): unbound state, deduced from observed $E(n)(\text{c.m.})=650\ 50$ (width=60 keV). $S(n)(^{22}\text{N})=1280\ 210$ (2012Wa38). E(level), $J\pi$: first 3- state from shell-model predictions (2009St20).

† From comparison with shell-model calculations.

 $\gamma(^{22}\text{N})$

E(level)	$E_\gamma^\dagger$	I_γ
183	183 16	100
1017	834 19	100

† From $(^{36}\text{S},X\gamma)$.

 $^9\text{Be}(^{26}\text{F},x)\ 2009\text{St}20$

^{22}N was produced from fragmentation of ^{48}Ca primary beam with a Be target followed by separation using A1900 fragment separator and secondary beam of ^{26}F , 85 MeV/nucleon fragmentation. Measured neutrons (from the decay of excited states in ^{22}N) in coincidence with ^{21}N nuclei using the Modular Neutron Array (MoNA) at the NSCL, Michigan State University. Comparison with shell-model calculations. Monte Carlo simulations of the neutron spectrum.

 ^{22}N Levels

E(level)	$J\pi$	$T_{1/2}$	Comments
1930 220	3-	<60 keV	E(level): unbound state, $E(n)(\text{c.m.})=650\ 50$. $S(n)(^{22}\text{N})=1280\ 210$ (2012Wa38). E(level), $J\pi$: first 3- state from shell-model predictions (2009St20).

C($^{36}\text{S},\text{X}\gamma$) 2008So09

^{22}N was obtained from fragmentation of primary ^{36}S beam on carbon target (thickness 348 mg/cm²), E=77.5 MeV/nucleon, followed by product nuclei selection by ALPHA spectrometer at GANIL and secondary beams of fragments for fluorine to magnesium with energies varying from 54 to 65 MeV passed an "active" target composed of a plastic scintillator (103 mg/cm²) sandwiched between two carbon foils (51 mg/cm²) at the dispersive focus of the SPEG spectrometer. Fragments of secondary beam were collected and identified at the focal plane in the SPEG spectrometer and 525 ^{22}N nuclei were observed. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin using 74 BaF₂ crystals and four HPGe detectors.

 ^{22}N Levels

$E(\text{level})$	$J\pi^\dagger$
0.0	(0-)
183 16	(1-)
1017 25	(2-)

[†] From comparison with shell-model calculations.

 $\gamma(^{22}\text{N})$

$E\gamma$	$E(\text{level})$	$I\gamma$
183 16	183	100 22
834 19	1017	41 9

Level Scheme

Intensities:
relative $I\gamma$

Adopted Levels, Gammas

$Q(\beta^-)=6490\ 58$; $S(n)=6850\ 58$; $S(p)=23260\ 110$; $Q(\alpha)=-18060\ 64$ 2012Wa38.

Other reactions:

$^4\text{He}(^{22}\text{O}, ^{22}\text{O}')$: 2004TaZZ – Measured 3200– and 1400–keV γ -rays in cascade.

$^9\text{Be}(^{26}\text{Ne}, 2\text{px})$: 2008Fr10 – Studied neutron-unbound states in ^{22}O – not found.

$\text{C}(^{22}\text{O}, ^{22}\text{O})$: 2011Ka36 – Measured interaction cross section=1123 mb 24; uncertainty 18.5 mb (stat), 15.3 mb (syst).

Deduced rms matter radius=2.75 fm 15 using Fermi density and 2.75 fm 7 using harmonic oscillator density (Glauber model).

 ^{22}O Levels**Cross Reference (XREF) Flags**

A ^{22}N β^- Decay
 B $\text{Be}(^{36}\text{S}, \text{X}), ^{12}\text{C}(^{23}\text{O}, \text{x}\gamma)$
 C $^{22}\text{O}(\text{p}, \text{p}'), (\text{d}, \text{d}'\gamma)$
 D $^{197}\text{Au}(^{22}\text{O}, ^{22}\text{O}')$

E(level) [†]	J π [§]	XREF	T _{1/2}	Comments
0.0	0+	AB D	2.25 s 9	$\% \beta^- = 100$; $\% \beta^- n < 22$. T _{1/2} : From 2005We06. Other values: 2.25 s 15 (1989Hu07), 0.91 s 35 (1982Mu08), and 2.9 s 15 (1986Du07). $\% \beta^- n$: from 1991Re02. Other reference: 1979Ba31. XREF: D(3170). J π : 3199 γ E2 to 0+. T _{1/2} : From B(E2) $\uparrow$ =0.0021 8 $^{197}\text{Au}(^{22}\text{O}, ^{22}\text{O}')$ (2000Th11) and adopted γ -ray properties. Other: Also 0.56 ps 26 from B(E2) $\uparrow$ =0.0015 7 in 2000Th11.
3199 8	2+	ABCD	0.40 ps 15	
4584 9	(3+)	AB		
4909? 90	(0+)	B		
5800?		B		
6512 10	(2+)	AB		
6938 11	(4+)	B		
7649 $\ddagger$	(0-, 1-, 2-)	A		
8783 $\ddagger$	(0-, 1-, 2-)	A		
10554 $\ddagger$	(0-, 1-, 2-)	A		
13298 $\ddagger$	(0-, 1-, 2-)	A		

[†] From γ -ray energies. Levels at 7649 keV and above from ^{22}N β^- decay.

$\ddagger$ Level decays by neutrons.

[§] From comparison with shell model calculations (^{22}N β^- decay), except otherwise noted.

 $\gamma(^{22}\text{O})$

E(level)	E γ [†]	I γ [†]	Mult.	Comments
3199	3199 8	100	E2	Mult.: Assigned by evaluator based on B(E2) $\uparrow$ in $^{197}\text{Au}(^{22}\text{O}, ^{22}\text{O}')$ (2000Th11). B(E2)(W.u.)=1.2 5.
4584	1385 3	100		E γ : Weighted average of data from $(^{36}\text{S}, \text{X}), (^{23}\text{O}, \text{x}\gamma)$ and ^{22}N β^- decay.
4909?	1710 $\ddagger$ 90	100		
5800?	1216 $\ddagger$ § 2600 $\ddagger$ §			
6512	3312 5			E γ : From ^{22}N β^- decay. Other 3310 90 ($^{36}\text{S}, \text{X}), (^{23}\text{O}, \text{x}\gamma)$.
6938	2354 6 3710 90	100 35 75 35		

[†] From $(^{36}\text{S}, \text{X}), (^{23}\text{O}, \text{x}\gamma)$, except otherwise noted.

$\ddagger$ From level-energy difference.

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

^{22}N β^- Decay 2010Su03

Parent ^{22}N : $E=0.0$; $J\pi=(0-)$; $T_{1/2}=24$ ms 3; $Q(\text{g.s.})=22760$ 200; $\%\beta^-$ decay=100.

^{22}N beam was produced by fragmentation of a $E=140$ MeV/nucleon ^{48}Ca primary beam on a Be target and separated by A1900 fragment separator at NSCL facility. The secondary beam containing ^{22}N was implanted on a thin plastic implantation detector. Measured $E\gamma$, $I\gamma$, β , $\beta\gamma$ coin, β -delayed neutrons, $\beta(n)$ coin, and half-life using an array of sixteen neutron detectors and eight detectors from the Segmented Germanium Array (SeGA). Deduced level scheme of ^{22}O .

 ^{22}O Levels

$E(\text{level})^\dagger$	$J\pi^\S$	Comments
0.0	0+	
3198 8	2+	$J\pi$: From Adopted Levels.
4584 9	(3+)	
6511 10	(2+)	
7649 $\ddagger$	(0-, 1-, 2-)	
8783 $\ddagger$	(0-, 1-, 2-)	
10554 $\ddagger$	(0-, 1-, 2-)	$E(\text{level})$: 10545 in Fig. 7 and on page 5 (column one) is a typo.
13298 $\ddagger$	(0-, 1-, 2-)	

† From $E\gamma$'s.

$\ddagger$ Level decays by neutrons.

§ From comparison with shell model calculations (2010Su03), except otherwise noted.

 β^- radiations

$E\beta^-$	$E(\text{level})$	$I\beta^-^\dagger$	$\text{Log } ft$
(9460 200)	13298	9.6 16	4.4 1
(12210 200)	10554	6.6 7	5.1 1
(13980 200)	8783	13 1	5.1 1
(15110 200)	7649	12 3	5.3 1
(16250 200)	6511	2 1	6.2 2
(18180 200)	4584	7 3	5.9 2
(19560 200)	3198	15 3	5.8 1
(22760 200)	0.0	<31.6	>5.8

† From 2010Su03, calculated based on the shell model.

 $\gamma(^{22}\text{O})$

$E\gamma$	$E(\text{level})$	$I\gamma^\dagger$
1386 4	4584	7 3
3198 8	3198	24 3
3312 5	6511	2.0 10

† Absolute intensity per 100 decays.

Decay Scheme

$^{22}\text{O}(\text{p,p}'),(\text{d,d}'\gamma)$ 2006Be04,2006E105

Other: 2006E106.

inverse-kinematic reaction.

2006Be04: $^{22}\text{O}(\text{p,p}')$ – Target: Polypropylene $[(\text{CH}_2)_n]$, ^{22}O secondary beam, $E=46.6$ MeV/nucleon, produced by fragmentation of a primary beam of ^{36}S at 77 MeV/nucleon with a ^{12}C target at GANIL facility. Measured angular distributions of ^{22}O for elastic and inelastic (first $2+$) channels. Scattered ^{22}O nuclei identified in the focal plane of the SPEG spectrometer. The energy and angle of the recoiling protons were measured using MUST, an array of eight silicon-strip detectors, backed by Si(Li) diodes and CsI crystals. Coincidences recorded between SPEG plastic detector and MUST. DWBA analysis of angular distributions. Studied behavior of $N=14$ neutron gap far from stability.

2006E105,2006E106: $^{22}\text{O}(\text{d,d}'\gamma)$ – Target: CD_2 , ^{22}O secondary MeV/nucleon, produced by fragmentation of a primary beam of ^{40}Ar at 94 MeV/nucleon with a ^9Be target at RIKEN facility. The scattered particles were detected using silicon telescope, consists of four layers with thicknesses of 0.5, 0.5, 2, and 2 mm. Protons were detected by 156 CsI(Tl) scintillator crystals. For γ -ray detection 80 NaI(Tl) were used. Determined interaction cross section and derived "matter" deformation parameter.

 ^{22}O Levels

E(level)	$J\pi^\dagger$	Comments
0.0	0+	
3185 15	2+	E(level): From γ -ray energy (2006E105). Other: 3200 keV 200 (2006Be04). Deformation parameter $\beta(\text{p,p}')=0.26$ 4, smaller than those for ^{20}O and ^{18}O . This result indicates a weak neutron contribution to the $2+$ state (2006Be04). Deformation parameter $\beta(\text{d,d}')=0.23$ 2 and $^{22}\text{O}+^2\text{H}$ reaction cross section $\sigma(0^+ \rightarrow 2^+)=19$ mb 3 (2006E105).

 † From Adopted Levels. $\gamma(^{22}\text{O})$

E_γ	E(level)	Comments
3185 15	3185	E_γ : From 2006E105.

Level Scheme **$^{197}\text{Au}(^{22}\text{O},^{22}\text{O}')$ 2000Th11** $E=50.6$ MeV/A. Inelastic scattering of Radioactive Beam. ^{22}O Levels

E(level)	$J\pi$	$T_{1/2}$	Comments
0.0	0+		
3170 20	2+	0.40 ps 15	$B(E2)\uparrow=0.0021$ 8 (2000Th11). $T_{1/2}$: From $B(E2)\uparrow=0.0021$ 8 (2000Th11) and adopted γ -ray properties. Other: Also 0.56 ps 26 from $B(E2)\uparrow=0.0015$ 7 in 2000Th11.

$^{197}\text{Au}(^{22}\text{O}, ^{22}\text{O}')$ 2000Th11 (continued) $\gamma(^{22}\text{O})$

E_γ	E(level)	Mult.
3170 20	3170	E2

Level Scheme

$\text{Be}(^{36}\text{S}, \text{X}), ^{12}\text{C}(^{23}\text{O}, \text{xn}\gamma)$ 2004St08, 2004Co11

$\text{Be}(^{36}\text{S}, \text{x})$ E=77.5 MeV/A: 2004St08, 2004St10. SPEG spectrometer measured recoil TOF, ΔE , and focal plane position.

HPGe and BaF_2 detectors, $\gamma\gamma$ coincidences. Other references: 2000Az01, 2001Be09, 2002Az01, 2002Gu08.

$^{12}\text{C}(^{23}\text{O}, ^{22}\text{Ox})$, E=938 MeV/A: 2004Co11; Measured one-neutron removal σ , E_γ , I_γ , (particle) γ -coincidence, longitudinal momentum distribution.

 ^{22}O Levels

E(level) [†]	$J\pi^{\ddagger}$	Comments
0.0	0+	
3199 8	(2+)	
4582 9	(3+)	
4909? 90	(0+)	
5800?	(1-, 0-)	$J\pi$: From 2004Co11.
6509 90	(2+)	
6936 10	(4+)	

[†] From E_γ 's.

[‡] From shell model calculations.

 $\gamma(^{22}\text{O})$

$E_\gamma^{\dagger}$	E(level)	$I_\gamma^{\ddagger}$	Comments
1218 [‡]	5800?		
1383 4	4582	43 8	
1710 [§] 90	4909?	12 6	E_γ, I_γ : Tentatively observed in BaF_2 only.
2354 6	6936	20 7	
2600 [‡]	5800?		
3199 8	3199	100 15	
3310 90	6509	<17	E_γ, I_γ : Observed in BaF_2 only.
3710 90	6936	15 7	E_γ, I_γ : Observed in BaF_2 only.

[†] From HPGe measurements (2004St08), except as noted.

[‡] From level-energy difference; transition shown in level scheme figure 2 in 2004Co11.

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

Be($^{36}\text{S},\text{X}$), $^{12}\text{C}(^{23}\text{O},\text{x}\text{n}\gamma)$ 2004St08,2004Co11 (continued)

Level Scheme

 Intensities: relative I γ

Adopted Levels, Gammas

$Q(\beta^-)=10818$ 12; $S(n)=5230$ 13; $S(p)=12558$ 17; $Q(\alpha)=-12745$ 22 2012Wa38.

 ^{22}F Levels

Cross Reference (XREF) Flags

A ^{22}O β^- Decay
 B ^{23}O β^-n Decay
 C $^9\text{Be}(^{14}\text{C},p\gamma)$
 D $^{22}\text{Ne}(t,^3\text{He})$
 E $^{22}\text{Ne}(^7\text{Li},^7\text{Be})$

E(level) [†]	J π [§]	XREF	T _{1/2}	Comments
0.0	(4+)	ABCDE	4.23 s 4	% β^- =100; % β^-n <11 (1991Re02). J π : Also log ft =4.8 in ^{22}F β^- decay to (4)+ state in ^{22}Ne at 5523 keV level. Other possibility (3+), log ft =5.3 to 3+ state at 5641 keV level in ^{22}Ne . T _{1/2} : from 1974Da02, others: 4.24 s 8 (1973Gu05), 4.0 s 4 (1965Va06). μ =2.6944 4; Q =0.003 2. μ , Q : β^- -NMR (2010Mi13,2014StZZ).
71.65 20	(3+) [#]	A C		
310 30	(2+)	D		
709.1 3	(2+) [#]	ABCDE	57 fs 28	
1413.2 9	(5+)	CDE	27 fs 14	
1627.1 4	1+	A C E	66 fs 10	J π : log ft =4.6 from 0+, inconsistent with J π =(3+) suggested in (t, ^3He) (1988Cl04). XREF: D(1637). J π : From (t, ^3He). 1560.5 γ to (3+), 1632.6 γ to (4+). XREF: E(2030).
1632.4 8	(3+)	CD	34 fs 21	J π : log ft =3.8 from 0+ and the angular distribution of 1862.6 γ consistent with J π =1+ assignment (2007Le28-($^{14}\text{C},p\gamma$)). Inconsistent with J π =4+,5+ suggested in (t, ^3He) (1988Cl04). XREF: D(2590).
2006.6 11	(2+) [#]	CDE	55 fs 14	J π : Suggested in 1988Cl04-($^3\text{He},t$). No comparable state consistent with the suggested J π were identified in 2007Le28 ($^{14}\text{C},p\gamma$).
2571.7 5	1+	A C	53 fs 28	E(level),J π : 2007Le28 assumes this state corresponds to a level at 2986 keV of charge exchange reactions. However, 2759.4 γ angular distribution rules out E2 decay. 2759.4 γ to (3+).
2580 30	4+, 5+	DE		XREF: D(2986). E(level): From ($^7\text{Li},^7\text{Be}$).
2832.2 9	(4+)	C	37 fs 28	XREF: E(3390). J π : Inconsistent with J π =4+ suggested in 1988Cl04 ($^3\text{He},t$).
2881 26	(2+)	D		
2920 30	(1+, 0+)	DE		
3170 30	(0+, 1+)	D		
3376.4 11	(1+, 2+) [#]	CDE	44 fs 21	
3581.6 10	(5+) [#]	CD	76 fs 21	
3980 50	(2+, 3+)	D		
4200 40	(4+, 5+)	D		
4366 $\frac{1}{2}$ 30	(3+, 4+)	DE		
4630 $\frac{1}{2}$ 30	(2+, 3+)	DE		
4780 40	(2+, 3+)	D		
4883 $\frac{1}{2}$ 30	(2+, 3+)	DE		
5238 $\frac{1}{2}$ 30	(0+, 1+)	DE		
5590 40		D		
5750 40		D		
6595 40		D		

[†] From least-squares fit to γ -ray energies, assuming $\Delta E=1$ keV – for unquoted uncertainties. Levels from charge exchange reaction data sets are noted.

[‡] Average of data from (t, ^3He) and ($^7\text{Li},^7\text{Be}$). Uncertainty is the lowest experimental value.

[§] From $^{22}\text{Ne}(t,^3\text{He})$ based on angular distribution measurements and DWBA, except where noted.

[#] Assigned in 2007Le28 ($^{14}\text{C},p\gamma$), based on $\gamma(\theta)$ measurement and γ placement in the level scheme.

Adopted Levels, Gammas (continued)

$\gamma(^{22}\text{F})$				
E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult.	Comments
71.65	71.6 $\frac{\ddagger}{2}$	100 $\frac{\ddagger}{2}$		
709.1	637.4 $\frac{\ddagger}{2}$	100 $\frac{\ddagger}{2}$ 7	[M1]	δ : nearly zero from $\gamma(\theta)$ ($^{14}\text{C}, p\gamma$) – 2007Le28) for 2+ assignment for 710 level. B(M1)(W.u.)=1.5 8.
1413.2	1414.2	100		
1627.1	918.0 $\frac{\ddagger}{2}$	100 $\frac{\ddagger}{2}$		
1632.4	1560.5	47 7		
	1632.6	100 10		
2006.6	1297.5	100		
2571.7	944 $\frac{\ddagger}{2}$	4.8 $\frac{\ddagger}{2}$ 16		
	1862.6 $\frac{\ddagger}{2}$ 3	100 $\frac{\ddagger}{2}$ 11		
	2499 $\frac{\ddagger}{2}$	2.4 $\frac{\ddagger}{2}$ 16		
2832.2	2759.4	100		
3376.4	2667.2	100		
3581.6	748.3	13.1 4		
	2169.2	100 12		

$\dagger$ From ($^{14}\text{C}, p\gamma$), except otherwise noted.

$\ddagger$ From ^{22}O β^- decay.

 ^{22}O β^- Decay 1989Hu07,2005We06

Parent ^{22}O : E=0; $J\pi=0+$; $T_{1/2}=2.25$ s 9; Q(g.s.)=6490 58; % β^- decay=100.

1989Hu07: Source produced by Be($^{40}\text{Ar}, x$) E=60 MeV/A, mass separated by LISE mass spectrometer. HPGe, $\gamma\gamma$ and $\beta\gamma$ coincidences.

2005We06: Mass separated $^{12}\text{C}^{22}\text{O}$ molecular beam from the ISOLDE facility; ^{22}O obtained from fission of uranium by 1.4 GeV protons. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\beta\gamma$ coin using Ge detector for γ rays and plastic scintillator for β rays.

 ^{22}F Levels

E(level) †	$J\pi^\ddagger$	$T_{1/2}^\ddagger$
0.0	(4+)	4.23 s 4
71.6 2	(3+)	
709.0 3	(2+)	
1627.0 4	1+	
2571.5 4	1+	

$\dagger$ From γ -ray energies.

$\ddagger$ From Adopted Levels.

 β^- radiations

$E\beta^-$	E(level)	$I\beta^{-\dagger\ddagger}$	Log ft
(3920 60)	2571.5	68 8	3.8 1
(4860 60)	1627.0	31 5	4.6 1

$\dagger$ From γ -ray intensity balance.

$\ddagger$ Absolute intensity per 100 decays.

 $\gamma(^{22}\text{F})$

$I\gamma$ normalization: Sum of $I\gamma$ feeding the g.s. =100.

$E\gamma^\dagger$	E(level)	$I\gamma^{\ddagger\$}$	Comments
71.6 2	71.6	102 33	
637.4 2	709.0	100 7	

Continued on next page (footnotes at end of table)

^{22}O β^- Decay 1989Hu07,2005We06 (continued) $\gamma(^{22}\text{F})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^{\ddagger\S}$	Comments
709.6# 3	709.0	13 3	$E\gamma$: Listed in 1989Hu07 without placement and no coincidence with other γ rays. This γ ray is identified by 2005We06 as sum peak of 71.6 γ and 637.4 γ and summation accounts its full intensity. Also reported in coincidence with 1862 γ in 2005We06.
918.0 2	1627.0	34 4	
944	2571.5	3 1	$E\gamma, I\gamma$: From 2005We06.
1862.6 3	2571.5	63 7	$I\gamma$: From 2005We06. Other value: 56 7 (1989Hu07).
$\times$ 1874.2 10		9 4	$E\gamma$: Reported in 1989Hu07 without placement. No 1874 γ seen by 2005We06.
2499	2571.5	1.5 10	$E\gamma, I\gamma$: From 2005We06.

† From 1989Hu07, except otherwise noted.

‡ From 1989Hu07, except otherwise noted. Intensity not corrected for summing in 1989Hu07. 2005We06 corrected intensity for summing from simulation, applicable for 2499 γ (1862.6 γ + 637.4 γ). Reported intensities in 1989Hu07 and 2005We06 are statistically consistent.

§ For absolute intensity per 100 decays, multiply by 1.0 4.

Placement of transition in the level scheme is uncertain.

$\times$ γ ray not placed in level scheme.

Decay Scheme

^{23}O β^-n Decay 2007Su05

Parent ^{23}O : $E=0$; $J\pi=1/2^+$; $T_{1/2}=97$ ms 8; $Q(g.s.)=3760$ 90; β^-n decay=7 2.

$^{23}\text{O}-T_{1/2}$: from weighted average of six $\gamma(t)$ data (2007Su05).

$^{23}\text{O}-Q(\beta^-n)$: from 2012Wa38.

$^{23}\text{O}-\beta^-n$ decay: $\beta^-n=7$ 2 (2007Su05). Other value: 32 7 (1990Mu06).

^{23}O beam was produced from a primary beam of ^{48}Ca at 140 MeV/nucleon on a ^9Be target. The fragments were separated by A1900 fragment separator. The beam of ^{23}O was used in a pulsed mode of 300 ms timing. The detection system consisted of implantation detector (3 mm plastic scintillator), an array of 16 neutron time-of-flight detectors and eight γ -ray detectors of segmented germanium array. ^{23}O identification was achieved by time-of-flight and energy loss information in silicon detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, (particle) γ coin, β , $\gamma\beta$ coin, delayed neutrons, isotopic half-life by timing of γ rays, β rays and delayed neutrons.

 ^{22}F Levels

E(level) †	$J\pi^\dagger$
0.0	(4+)
71.65 20	(3+)
709.1 3	(2+)

† From Adopted Levels.

^{23}O β^- n Decay 2007Su05 (continued) $\gamma(^{22}\text{F})$

E_γ	E(level)	$I_\gamma^\dagger$
638 3	709.1	1.5 8

 † Absolute intensity per 100 decay. **$^9\text{Be}(^{14}\text{C}, p\gamma)$ 2007Le28**

^{14}C beam, E=22 MeV beam. Protons detected with segmented ΔE -E Si telescope. Measured E_γ , I_γ , $p\gamma$ coin, $p\gamma\gamma$ coin, $p\gamma(\theta)$ using Compton suppressed HPGe detectors arranged with one four-crystal clover detector and a single crystal detector at 90° , two clover detectors at 35° and three single detectors at 135° . Measured lifetimes by DSAM.

 ^{22}F Levels

$E(\text{level})^\dagger$	$J\pi^\S$	$T_{1/2}^\ddagger$	Comments
0.0	(4+)		
72.6 4	3+ [#]		
709.9 7	2+ [#]	57 fs 28	
1413.5 5	(5+)	27 fs 14	
1628.0 8	1+	66 fs 10	
1632.9 4	(3+)	34 fs 21	
2007.5 8	2+ [#]	55 fs 14	
2571.2 8	1+ [#]	53 fs 28	
2833.0 6	(4+)	37 fs 28	$J\pi$: 2759.4 γ angular distribution rules out E2 decay.
3377.3 8	1+, 2+ [#]	44 fs 21	
3582.0 6	5+ [#]	76 fs 21	

 † From least-squares fit to γ -ray energies, assuming $\Delta E=0.5$ keV. ‡ Measured using Doppler Shift Attenuation Method (DSAM) (2007Le28). § From Adopted Levels, except otherwise noted. $^\#$ Assigned in 2007Le28, based on $\gamma(\theta)$ measurement and γ placement in the level scheme. $\gamma(^{22}\text{F})$

E_γ	E(level)	I_γ	Comments
72.1	72.6	120 5	I_γ : 72.1 γ intensity is lower than expectation (2007Le28), probably because of uncertain relative efficiency of the detector at low energy γ ray.
637.3	709.9	100	δ : nearly zero from $\gamma(\theta)$ (2007Le28) for 2+ assignment for 709.9 keV level.
748.3	3582.0	3.4 1	
918.1	1628.0	35 3	
1297.5	2007.5	14 2	
1414.2	1413.5	32 2	
1560.5	1632.9	14 2	

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$^9\text{Be}(^{14}\text{C},\text{p}\gamma)$ 2007Le28 (continued) $\gamma(^{22}\text{F})$ (continued)

E_γ	E(level)	I_γ
1632.6	1632.9	30 3
1861.2	2571.2	13 2
2169.2	3582.0	26 3
2667.2	3377.3	19 3
2759.4	2833.0	14 2

Level Scheme

Intensities: relative I_γ **$^{22}\text{Ne}(\text{t},^3\text{He})$ 1988C104** $^{22}\text{Ne}(\text{t},^3\text{He})$, E=33.4 MeV. E- Δ E particle telescope. Angular distribution, DWBA analysis, shell model calculations.Other: 1969St07: $^{22}\text{Ne}(\text{t},^3\text{He})$, E=22 MeV. E- Δ E particle telescope. ^{22}F Levels

E(level) [†]	$J\pi^{\ddagger}$	Comments
0.0	4+	
310 30	2+, 3+	E(level): Shell model predicts 3+ level at 200 keV which may possibly be the 71.6-keV adopted level.
708? 20	3+, 2+	
1411 22	5+	
1637 22	(3+)	
2000 24	(2+)	
2590 26	4+	
2881 26	(2+)	
2986 29	(1+, 0+)	
3167 32	(0+, 1+)	
3374 28	4+	
3592 32	5+	
3975 48	(2+, 3+)	
4198 35	(4+, 5+)	
4372 31	(3+, 4+)	
4615 35	(2+, 3+)	
4779 38	(2+, 3+)	
4888 35	(2+, 3+)	
5210 34	(0+, 1+)	
5586 37		
5753 37		
6595 41		

Footnotes continued on next page

²²Ne(t, ³He) 1988Cl04 (continued)

²²F Levels (continued)

[†] Level energies increased 50 keV by evaluator (2005Fi16).
[‡] Suggested by authors on the basis of angular distributions and DWBA.

²²Ne(⁷Li, ⁷Be) 1989Or04

²²Ne(⁷Li, ⁷Be) E=54–108 MeV. Magnetic spectrometer, enriched targets.

²²F Levels

<u>E(level)</u>	<u>E(level)</u>	<u>E(level)</u>
0 . 0	2030 20	4360 30
710 10	2580 30	4650 40
1430 20	2920 30	4880 30
1640 20	3390 30	5260 30

Adopted Levels, Gammas

$Q(\beta^-) = -2842.20$ 17; $S(n) = 10364.26$ 4; $S(p) = 15266.1$ 18; $Q(\alpha) = -9666.81$ 2 2012Wa38.

2006As01: No evidence of excited state population in ^{22}Ne from $^9\text{Be}(^{18}\text{O}, \alpha^{14}\text{C})$, $(^{18}\text{O}, ^{10}\text{Be}^{12}\text{C})$, and $(^{18}\text{O}, ^9\text{Be}^{13}\text{C})$ reactions.

Other reaction: $^{22}\text{Ne}(\alpha, \alpha')$: 1971OI01, 1984Sa28, 1987Su09.

 ^{22}Ne Levels**Cross Reference (XREF) Flags**

A ^{22}F β^- Decay
 B ^{22}Na β^+ Decay
 C $^4\text{He}(^{19}\text{F}, p\gamma)$
 D $^{11}\text{B}(^{13}\text{C}, d)$
 E $^{12}\text{C}(^{18}\text{O}, ^8\text{Be}), ^{14}\text{C}(^{18}\text{O}, ^{10}\text{Be})$
 F $^{14}\text{C}(^{12}\text{C}, \alpha)$
 G $^{18}\text{O}(\alpha, \gamma)$
 H $^{18}\text{O}(\alpha, n)$: Res
 I $^{18}\text{O}(^4\text{He}, ^4\text{He}')$: Res

J $^{18}\text{O}(^6\text{Li}, d)$
 K $^{18}\text{O}(^7\text{Li}, t), (^7\text{Li}, t\gamma)$
 L $^{19}\text{F}(\alpha, p\gamma)$
 M $^{20}\text{Ne}(t, p)$
 N $^{20}\text{Ne}(t, p\gamma)$
 O Others:
 $^{21}\text{Ne}(n, \gamma)$ E=thermal
 $^{21}\text{Ne}(n, \gamma)$: Res
 $^{21}\text{Ne}(d, p)$

$^{22}\text{Ne}(\gamma, \gamma')$
 $^{22}\text{Ne}(e, e')$
 $^{22}\text{Ne}(p, p')$
 Coulomb Excitation
 $^{23}\text{Na}(d, ^3\text{He})$
 $^{23}\text{Na}(t, \alpha)$
 $^{26}\text{Mg}(d, ^6\text{Li})$
 $^{26}\text{Mg}(^3\text{He}, ^7\text{Be})$
 $^{150}\text{Nd}(^{26}\text{Mg}, ^{22}\text{Ne}\gamma)$

E(level) [†]	J π	XREF	T _{1/2} ^f	Comments
0.0 ^b	0+ ^b e	ABCD GH JKLMNO	stable	$\delta\langle r^2 \rangle(^{20}\text{Ne}, ^{22}\text{Ne}) = -0.321 \text{ fm}^2$ 4 (stat) 43 (syst) (2011Ma48, 2008Ge07). Absolute ^{22}Ne charge radius = 2.952 fm 9 (2008Ge07) deduced with respect to known ^{20}Ne charge radius = 3.006 fm 5. J π : From optical spectroscopy (1927Ha01); L=0 in ($^6\text{Li}, d$), ($^7\text{Li}, t$), and (t,p); natural parity. $\mu = +0.65$ 2; $Q = -0.19$ 4. E(level): From γ -ray energy. J π : E2 to 0+; L=2 in ($^6\text{Li}, d$), ($^7\text{Li}, t$), and (t,p); natural parity. μ : Recoil into Vacuum, Differential method (1977Ho01, 2014StZZ). Q: Coulomb Excitation Reorientation (1981Sp07, 2014StZZ). T _{1/2} : From mean lifetime 5.19 ps 7: weighted average of mean lifetimes – 5.16 ps 13 (1984Bh03), 5.1 ps 2 (1983Ko01), 4.6 ps 6 (1979Ma13), 5.15 ps 31 (1979Fo02), 5.2 ps 3 (1977Ho01), 5.62 ps 20 (1977Ra01), 4.9 ps 7 (1977Og03), 5.15 ps 14 (1977Sc36), 4.9 ps 4 (1974OI01), 5.4 ps 4 (1973An01), 5.5 ps 10 (1973Si31), 5.9 ps 11 (1972Sn01), 5.9 ps 6 (1972Sz05), 3.6 ps 7 (1970Na07), 4.6 ps 5 (1969Jo10), 6.1 ps 5 (1969ScZV), and 3.1 ps 11 (1960An07). $\mu = +2.2$ 6. J π : L=4 in ($^6\text{Li}, d$); natural parity. μ : Tilted Foil hyperfine field integral perturbed angular correlation (1984Ba10, 2014StZZ). T _{1/2} : From mean lifetime 324 fs 6: weighted average of mean lifetimes – 324 fs 9 (1979Fo02), 311 fs 17 (1978Fi04), 328 fs 10 (1978Ek01), 285 fs 50 (1974Fi16), 360 fs 50 (1972Br17 – average of measurements with 39 different slowing down materials), 270 fs 90 (1968Ku05), 400 fs 110 (1967Wa13), and 390 fs 80 (1964Es02). J π : E2 to 0+; L=2 in ($^6\text{Li}, d$), ($^7\text{Li}, t$), and L=(2) in (t,p); natural parity. T _{1/2} : From (e,e') – 1979Ma13. Other values: <11 fs (1979Al01–($^{19}\text{F}, p\gamma)$), <30 ($\alpha, p\gamma$), while 37 fs 6 (1993OI05 – ($\alpha, p\gamma$)) is higher compared to other values.
1274.537 ^b 7	2+ ^b e	AB D G JKLMNO	3.60 ps 5	
3357.2 [‡] b 5	4+ ^b e	A D G JKLMNO	225 fs 4	
4456.2 9	2+ ^e	A CD G JKLMNO	3.7 fs ^h 25	

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Adopted Levels, Gammas (continued) ^{22}Ne Levels (continued)

E(level) [†]	J π	XREF			T _{1/2} ^f	Comments
5146.0 9	2 ⁻ e	CD	G	KLMNO	0.8 ps 2	J π : E1 to 2+, L=1,3 in (t,p); unnatural parity. T _{1/2} : From mean lifetime 1.1 ps 2: weighted average of mean lifetimes – 1.2 ps 3 (1975Me19), 1.15 ps 45 (1976Fi02), 1.3 ps 5 (1979Al01), and 0.9 ps 4 (1993O105).
5329.6 13	1 ⁺ e	D	G	L NO	1.2 fs 3	E(level): Weighted average of data from (e,e'), (γ,γ'), and ($\alpha,\gamma\gamma$). J π : M1+E2 to 2+, J π =1+ in (e,e') (1974Ma43); (unnatural parity). T _{1/2} : From mean lifetime 1.7 ps 3: Weighted average of 1.7 fs 3 (e,e') (1979Ma13) and 1.8 fs 7 (γ,γ') (1984Be26).
5363.4 11	2 ⁺ e	D		JKLMNO	69 fs ^h 12	J π : E2 to 0+; L=2 in (t,p); natural parity. T _{1/2} : <20 fs in 1976Fi02 – reason for this discrepancy is unknown.
5523.3 [±] 6	(4) ⁺ e	A CD		JKLMNO	21 fs 3	J π : L=4 in (⁶ Li,d), (t,p); natural parity; J=3 in ¹¹ B(¹³ C,d). T _{1/2} : From mean lifetime 30 fs 4: Weighted average of 27 fs 4 (1979Al01) and 37 fs 6 (1993O105). Uncertainty – lower experimental value.
5641.2 [±] 7	3 ⁺ e	A CD		KLMNO	<3 fs ^h	J π : M1 to 2+; L=2 in (d,p); unnatural parity.
5910.1 9	3 ⁻ e	A D		JKLMNO	32 fs 11	E(level): From (n, γ). J π : E1 to 2+; L=3 in (⁶ Li,d); natural parity; γ to 4+. T _{1/2} : From mean lifetime 46 fs 16: Weighted average of 51 fs 23 (1976Fi02) and 44 fs 16 (1993O105). Uncertainty – lower experimental value.
6119.9 16	2 ⁺ e	D		JKLMNO	14 fs 7	J π : L=2 in (t,p); natural parity. T _{1/2} : From (e,e'). Other value: 24 fs 9 (1993O105).
6235 2	0 ⁺ e			JKLM O	236 fs ^h 83	J π : L=0 in (⁶ Li,d), (⁷ Li,t), and (t,p); natural parity.
6311.0 ^b 10	(6 ⁺) ^b	CD	G	L O	49 fs 4	T _{1/2} : From mean lifetime 70 fs 6: Weighted average of 78 fs 15 (1976Fi02), 70 fs 10 (1979Al01), and 69 fs 6 (1993O105). Uncertainty – lowest experimental value.
6345.1 [±] 10	4 ⁺ e	A CD	G	KLMNO	13 fs ^h 3	J π : L=4 in (t,p), natural parity.
6635.8 8	(3,4) ⁺	CD		LM O	49 fs ^h 21	J π : M1+E2 to 4+, γ to 2+, L=2 in (d,p).
6689.0 11	1 ⁻ e			KLM O	243 fs ^h 132	J π : L=1 in (t,p); natural parity.
6819.4 16	2 ⁺	CD		KLM O	<3 fs ^h	J π : L=2 in (t,p), (⁷ Li,t); natural parity.
6853.5 16	(1 ⁺)	D	G	LM O	0.38 fs [§] 16	J π : M1 to 0+ and 2+, also from $\sigma(\theta)$ and DWIA calculation in (P,P').
6900 2	0 ⁺			KLM O	76 fs ^h 8	J π : L=0 in (⁷ Li,t).
7051 3	1 ⁻ e	D		KLMNO	100 fs ^h 30	J π : L=1 in (t,p); natural parity.
7341.1 11	0 ⁺ e	D		JKL NO	<3 fs ^h	J π : L=0 in (⁷ Li,t), (⁶ Li,d) for doublet; natural parity for doublet. γ -rays to 1+ and 2+.
7341.2 [±] 11	(4) ⁺ e	A D		LM	35 fs ^h 21	J π : L=(4) in (t,p); natural parity.
7405.9 7	(3) ⁻ e	D		KLM O	32 fs ^h 10	J π : L=1 in (d,p), E1 to 2+ ($\alpha,\gamma\gamma$), γ -ray feeding from 4+ state at 8855; natural parity for doublet. Another possibility 1 ⁻ , as suggested in 1993O105 – ($\alpha,\gamma\gamma$), less likely considering γ feeding from 4+.
7423.0 [±] 9	(5 ⁺)	A D		LM O	<3 fs ^h	J π : From ($\alpha,\gamma\gamma$) (1993O105), based on $\gamma(0)$ and Hauser-Feshbach calculations.
7469? 2	1, 2			L O	55 fs ^h 21	J π : From ($\alpha,\gamma\gamma$). 1559 γ to 3 ⁻ .
7489 5	1 ⁻ e		G	KLMNO		J π : L=1 in (⁷ Li,t) and (t,p); natural parity.
7643.1 13	2 ⁺	D		JKLM O	470 as ^j 200	J π : L=2 in (⁷ Li,t); 7641 γ E2 to 0+.
7663.7 9	(2) ⁻			LM O		XREF: O(7630). J π : L=1 in (d,p); also from (e,e').
7722.0 11	3 ⁻ e	D		JKLM O		J π : L=3 (⁶ Li,d), (⁷ Li,t), and (t,p); natural parity.
7921 2	(2) ⁺ e	D		KLM O		J π : L=2 in (t,p); natural parity. J=3 in (¹³ C,d).
8076.9 14	(4) ⁺	D		KLM O		J π : L=2 in (d,p); J=3 in (¹³ C,d); γ -ray transitions to 2+, 4+, (6 ⁺).
8134.3 4	2 ⁺ e	D		JKLM O		J π : L=2 in (t,p); natural parity.
8162.2 13	2 ⁺ , 3, 4 ⁺			LM O		J π : γ 's to 2+ and 4+.
8375.9 16	(3) ⁻	D		KLM O		J π : L=3 in (t,p); natural parity; γ transitions to 2+, 4+. But J=5 in (¹³ C,d).
8452 7				O		

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Adopted Levels, Gammas (continued) ^{22}Ne Levels (continued)

E(level) [†]	J π	XREF		T _{1/2} ^f	Comments
8489.6 12	2+	D	KLM O		XREF: M(8500). J π : L=2 in (t,p).
8561.4 [§] 19	(1,2)+		LM O	0.35 fs [§] 13	J π : L=2 in (d,p), γ to 0+ and 1-.
8573 10			O		
8596.0 9		D	KLM O		
8741.0 14	(3)-	D	LM O		J π : L=3 in (t,p); but J=5 in (^{13}C ,d).
8855.3 15	(4)+		LM O		J π : L=2 in (d,p); γ transitions to (3)-, (6)+.
8900.3 16		D G	L O		J π : Reported as doublet of 1- and (4,5)+ in 1998En04.
8976 3		D	J LM		
9045 3	(2+,3-)		LM O		J π : γ 's to 4+, 1-.
9097 3	(1 to 3)-	D	J LM O		J π : L=1 in (d,p); possible γ -ray branch to 2+ (1976Fi02).
9178 3	1+		O	84 as [§] 3	XREF: O(9140). E(level): Other values: 9165 3 (1979Be10 - (γ,γ')), 9170 4 (1976Fi02 - ($\alpha,\text{p}\gamma$)), 9179 10 (1974Fi07 - (t,p)). J π : From (pol γ,γ'). J π : L=4 in (t,p); but J=5 in (^{13}C ,d). J π : L=2 in (t,p); γ transitions to 1-,2- states.
9178.1 7	(4)+	D	J LM O		
9229 3	2+		J LM O		
9250 3			L		
9324 2		D	L		
9508 [#] 10		D	J LM		
9541 10	2+		M		J π : L=2 in (t,p).
9625 12	5	D	J L		XREF: D(9640)L(9609). E(level): Average of data from ($\alpha,\text{p}\gamma$), (^6Li ,d), and (^{13}C ,d). J π : From ($\alpha,\text{p}\gamma$) (1976Br06).
9654 10		D	M		XREF: D(9630).
9725 [@] 10	(3-)		J LM		XREF: L(9697). J π : L=(3) in (^7Li ,t). J π : L=(2) in (^7Li ,t). J π : L=(0) in (^7Li ,t). J π : L=2 in (t,p). J π : L=1 in (^6Li ,d), γ to 0+.
9841 [#] 10	(2+)		J LM		J π : From (α,γ) angular distributions.
10066 [@] 10	(0+)		J M		J π : Suggested in 1994Gi01, 9018 γ D to 2+.
10137 [@] 10	2+		J LM		E(level): From (t,p).
10208.5 ^{&} 10	1-	G	J LM O	<2 keV ^{&}	J π : 6,8 in ($\alpha,\text{p}\gamma$).
10280.4 ^{&} 10	(0+,1-,2+)	G	J L	<2 keV ^{&}	E(level): From (n, γ): res.
10294.8 ^{&} 10	(2+)	G	M	<2 keV ^{&}	J π : 6,8 in ($\alpha,\text{p}\gamma$).
10384 15			J LM O		E(level): From (n, γ): res.
10416.4 3			J LM O		J π : L=3 in (t,p).
10462.5 5	3-		M O		E(level): From (n, γ): res.
10501.6 3	2+		M O		J π : L=2 in (t,p).
10544.9 4	2+		M O		E(level): From (n, γ): res.
10616 ^a 3	(5-)	GH J	LM	6 keV	J π : L=2 in (t,p).
10696 4		G J		<4 keV ^{&}	J π : From $\alpha\gamma$ angular distribution measurements (α,γ). J π =2+ in (α,n): Res - no discussion is presented in 2013Be12 - and the source of this discrepancy is not clear.
10706 6	3-	GH	M	<10 keV ^{&}	E(level): From (α,γ). XREF: M(10720). E(level): From (α,γ). J π : From (α,n): Res.
10749 3	5-,4+	GH	L	6 keV	E(level): From (α,n). J π : 5- in (α,γ); 4+ in (α,n): Res. Natural parity listed in 1990En08 Table 22.11 for this state.
10857 ^a 3	3-	GH J	M	6 keV	J π : L=3 in (t,p).
10890 10	1+		O		J π : From $\sigma(\theta)$ and DWIA calculation in (p,p').
10921 ^a 3	1-	GH	M	24 keV	J π : L=1 in (t,p); γ transitions to 0+, 2+ states.
11032 ^{&} 6	(8+,6+)	GH J	L O	<10 keV ^{&}	J π : 8+ in ($\alpha,\text{p}\gamma$), (8+,6+) in (α,γ), 6+ in (α,n).
11064 10	2+		M		J π : L=2 in (t,p).
11130 ^{&} 5	6,7	G J	L	<5 keV ^{&}	J π : From ($\alpha,\text{p}\gamma$), angular correlation measurements.
11172	3-	H			J π : From (α,n): Res, based on best-fit R-matrix parameters.
11194 ^a 3	2+	GH	M	7 keV	J π : From (α,n): Res, based on best-fit R-matrix parameters.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{22}Ne Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} ^f	Comments
11269 ^a 5	(3-)	GH J M	12 keV	J π : From (α ,n):Res based on R-matrix fit. In 1978Tr05 (α , γ) - J π =2+,3+,4+ from $\alpha\gamma$ angular distribution measurements.
11323	5-	H		J π : From (α ,n):Res based on R-matrix fit.
11431 ^a 8	1-	GH M	48 keV	J π : From (α ,n):Res based on R-matrix fit. Natural parity in 1978Tr05 (α , γ).
11465 ^a 3	(1-)	GH	<3 keV	J π : From 1978Tr05,1970Ch18 (α , γ). 2013Be12 (α ,n):Res suggested 4+ without any discussion about this discrepancy.
11518	(2+)	H		J π : From (α ,n):Res based on R-matrix fit.
11522 8	7-	G LM		E(level): Weighted average of data 11533 10 (1994Ma37) and 11520 15 (1974Fl07) in (t,p), and 11482 20 (α , γ). J π : From (α , γ), angular correlation measurements. Natural parity listed in 1990En08 - Table 22.11.
11577 5		GH M	18 keV	E(level): From (α ,n).
11656 10		M		
11686 5	(2+)	GH	9 keV	E(level),J π : From (α , γ).
11708 15	(2+) ^c	HI M	5 keV ^c	E(level): From (t,p). J π : J π =0+ reported in (α ,n):Res, no discussion about the discrepancy.
11745		G	41 keV	
11751	1-	G	8 keV	
11772 [#] 10	3-	I M		J π : L=3 in (t,p). Inconsistent with 1- in (^4He , $^4\text{He}'$).
11892 6	1	G I M O	10 keV ^c	E(level): Weighted average of data from 11886 10 (α , γ), 11907 10 and 11895 15 (t,p), and 11880 10 (^4He , $^4\text{He}'$). J π : 1+ in (p,p'), 1- in (^4He , $^4\text{He}'$) and (α , γ).
12000 10	1+			
12020 10	0+ ^c	I	68 keV ^c	
12071 15		M		
12218 15		M		
12250 10	0+ ^c	I	76 keV ^c	
12280 10	1- ^c	G I	51 keV ^c	
12390 10	3-	I M	99 keV ^c	J π : L=3 in (t,p), Inconsistent with 2+ in (^4He , $^4\text{He}'$).
12450 20	(0+, 1-)	M		J π : L=0,1 in (t,p).
12570 10	(1-) ^c	I O	105 keV ^c	
12610 10	(2+) ^c	I	124 keV ^c	
12643 15		M		
12700 10	3- ^c	I	15 keV ^c	
12800 10	2+ ^c	I	50 keV ^c	
12820 10	1- ^c	I	170 keV ^c	
12862 15	(3-)	I M	145 keV ⁱ	XREF: I(12840). J π : L=(3) in (t,p). J π =1- in (^4He , $^4\text{He}'$):res.
12900 10	3- ^c	I M	39 keV ^c	E(level): Average of data from (t,p) and (^4He , $^4\text{He}'$).
12990 10	0+ ^c	I	80 keV ^c	
13030 10	2+ ^c	I	90 keV ^c	
13078 20		M		
13190 10	3- ^c	I	79 keV ^c	
13210 10	0+ ^c	I	81 keV ^c	
13274 20		M		
13392 8	3- ^c	I M	58 keV ^c	E(level): Average of data from (t,p) and (^4He , $^4\text{He}'$).
13460 10		O		
13490 10	4+ ^c	I	29 keV ^c	
13540 10	0+ ^c	I	96 keV ^c	
13570 10	3- ^c	I	136 keV ^c	
13650 10	(3-) ^c	I	48 keV ^c	
13670 10	(2+) ^c	I	41 keV ^c	
13690 10	(5-) ^c	I	50 keV ^c	
13730 10	4+ ^c	I	57 keV ^c	
13820 10	(2+) ^c	I	51 keV ^c	
13880 10	4+ ^c	I O	46 keV ^c	XREF: O(13890).
14060 20		O		
14470		E		
15580 40		O		

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Adopted Levels, Gammas (continued) ^{22}Ne Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} ^f	Comments
16510 10			O	
17000 100		F		
17480 100		E		
18430 100		EF	≈ 330 keVg	E(level): Average of data from ($^{18}\text{O}, ^8\text{Be}$), $^{14}\text{C}(^{18}\text{O}, ^{10}\text{Be})$ and ($^{12}\text{C}, \alpha$).
19280 20	(7-) ^c	F I	88 keV ^c	XREF: F(19130).
19450 100	(6+)	E		J π : Based on α - α angular distribution measurements (2006Yi01).
19560 20	(7-) ^c	I	75 keV ^c	
19890 100	(10+)	E		J π : Based on α - α angular distribution measurements (2006Yi01).
20000 100	(9-) ^d	F	≈ 270 keV	
20700 100	(11-) ^c	F	≈ 340 keV ^c	
20850 20	(9-) ^c	I	110 keV ^c	
21840 20	(9-) ^c	EF I	170 keV ^c	XREF: F(21600). E(level): From ($^4\text{He}, ^4\text{He}'$):res. Γ - Other value: ~ 350 keV ($^{12}\text{C}, \alpha$).
22200 100	(12+) ^d	F	≈ 250 keVg	
22900 100		F	≈ 290 keVg	
24140 200		F I		XREF: F(24000).
25000 100	(9-) ^d	F	≈ 350 keVg	
25900 100		F		
26890 200		F I		XREF: F(27000).

[†] From $^{19}\text{F}(\alpha, p\gamma)$, except otherwise noted.[‡] From ^{22}F β^- decay.[§] From (γ, γ').

From (t, p).

@ Average of data from (t, p) and ($^6\text{Li}, d$). Uncertainty - lowest experimental value.& From (α, γ).^a Weighted average of data from (α, γ) and (α, n). Uncertainty - lowest experimental value.^b Identified as member of a rotational band based on 0+ g.s. in $^{196}\text{F}i02$ ($\alpha, p\gamma$).^c From $^{18}\text{O}(^4\text{He}, ^4\text{He}')$:res. J π assignments are based on double differential cross section measurements and fitting.^d From ($^{12}\text{C}, \alpha$). J π assignments are based on the analysis of double (α, α) angular correlations with the residual ^{18}O nucleus in the 0+ ground state.^e Natural/Unnatural parity quoted in comment column from 1971O101 - $\sigma(180^\circ)$ (α, α').^f Γ_0 values from (α, n):res, except otherwise noted.^g From ($^{12}\text{C}, \alpha$).^h From 1993O105 ($\alpha, p\gamma$).ⁱ From ($^4\text{He}, ^4\text{He}'$):Re.^j From (e, e'). $\gamma(^{22}\text{Ne})$

E(level)	E γ [†]	I γ [#]	Mult. [#]	δ ^a	Comments
1274.537	1274.537 7	100	E2		E γ , Mult.: From ^{22}Na β^+ decay. B(E2)(W.u.)=12.76 18.
3357.2	2082.6 $\frac{3}{2}$ 5	100	E2		B(E2)(W.u.)=17.5 4.
4456.2	1099 [§]				
	3181.4	100.0 21	M1+E2	+0.09 2	δ : Average of +0.11 3 (1994Br11 - also possibility of a large value), +0.08 2 (1967Bu01). B(M1)(W.u.)=0.18 12; B(E2)(W.u.)=1.0 8. B(E2)(W.u.)=0.7 5.
5146.0	4455.7	3.1 21	E2		
	689.8	89 ^{&} 6	E1+M2	-0.29 2	δ : Other value: +0.04 8 (1967Bu01). B(E1)(W.u.)=0.0014 4; B(M2)(W.u.)=1.2 $\times 10^3$ 4.
	3871.1	100 ^{&} 6	E1+M2	+0.96 18	δ : Other value: +0.10 10 1972Ho52. B(E1)(W.u.)=5.1 $\times 10^{-6}$ 17; B(M2)(W.u.)=1.4 5.
5329.6	4054.6	50 12	M1+E2	+1.9 5	δ : Weighted average of -1.7 10 (1972Ho52) and -2.0 6 (1993O105). B(M1)(W.u.)=0.020 11; B(E2)(W.u.)=31 12.
	5328.9	100 12	[M1]		B(M1)(W.u.)=0.081 25.

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Ne})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\#}$	Mult.#	$\delta^{\#a}$	Comments
5363.4	4088.4	100 4	M1+E2	-0.19 4	δ : Weighted average of -0.12 6 (1993Ol05), -0.25 8 (1968Ku05), and -0.27 8 (1976Fi02). B(M1)(W.u.)=0.0039 8; B(E2)(W.u.)=0.06 3.
5523.3	5362.7	16 4	[E2]		B(E2)(W.u.)=0.070 22.
	2166.1 $\frac{1}{2}$ 5	100.0 $\frac{1}{2}$ 6	M1		δ : -0.04 3 (1993Ol05) and -0.07 12 (1968Ku05) both in (α ,p γ). B(M1)(W.u.)=0.102 15.
5641.2	4247.9 $\frac{3}{2}$ 10	1.6 $\frac{3}{2}$ 3	E2		B(E2)(W.u.)=0.084 20.
	2283.9 $\frac{3}{2}$ 7	45 $\frac{3}{2}$ 3	M1(+E2)	-0.12 17	I_{γ} : Other value: 30 4 in (t,p γ). δ : From 1968Ku05 (α ,p γ). B(M1)(W.u.)>0.18.
	4366.1 $\frac{1}{2}$ 10	100 $\frac{1}{2}$ 3	M1+E2	+0.15 2	δ : Weighted average of +0.18 3 (1968Ku05), +0.19 4 (1967Bu01), +0.13 3 (1972Ho52), and +0.16 3 (1976Br06). B(M1)(W.u.)>0.059; B(E2)(W.u.)>0.36.
5910.1	1453.8	21 6	E1(+M2)	+0.19 10	B(E1)(W.u.)=(0.0013 6); B(M2)(W.u.)=(100 50).
	2552.7	21 6			
	4635.0	100 6	E1+M2	+0.17 6	δ : Other value: 0.02 2 (1976Br06). B(E1)(W.u.)=0.00019 7; B(M2)(W.u.)=1.1 9.
6119.9	1663.6	10.3 & 13	M1+E2	+1.1 3	B(M1)(W.u.)=0.012 8; B(E2)(W.u.)=38 22.
	4844.8	100 & 4	M1+E2	+2.3 3	δ : also an alternate value: -0.11 4 (1993Ol05). B(M1)(W.u.)=0.0017 10; B(E2)(W.u.)=2.7 14.
	6119.0	18 & 3	E2		Mult.: From (e,e') based on B(E2). B(E2)(W.u.)=0.18 10.
6235	905	100			
6311.0	2953.6	100	[E2]		B(E2)(W.u.)=14.0 12.
6345.1	2987.7 $\frac{1}{2}$ 9	100	M1+E2	+0.68 16	B(M1)(W.u.)=0.043 12; B(E2)(W.u.)=16 7.
6635.8	3278.3	89 6	M1+E2	-0.9 3	B(M1)(W.u.)=0.0033 18; B(E2)(W.u.)=1.8 10.
	5360.6	100 6			
6689.0	5413.7	45 9	[E1]		B(E1)(W.u.)=7. $\times 10^{-6}$ 4.
	6687.9	100 9	(E1)		B(E1)(W.u.)=8. $\times 10^{-6}$ 5.
6819.4	1455.9	43 16			
	1673.3	57 16			
	2363.1	100 16	M1+E2	+2.5 4	B(M1)(W.u.)>0.021; B(E2)(W.u.)>210.
	5544.1	70 16	M1		δ : +0.10 10 1993Ol05 (α ,p γ). B(M1)(W.u.)>0.011.
6853.5	5578.2	85 8	M1+E2	+1.3 5	B(M1)(W.u.)=0.06 4; B(E2)(W.u.)=22 12.
	6852.3	100 8	M1		B(M1)(W.u.)=0.10 5.
6900	5624.7	100	E2		B(E2)(W.u.)=0.36 4.
7051	5776	100.0 & 11	[E1]		B(E1)(W.u.)=4.1 $\times 10^{-5}$ 13.
	7050	9.9 & 11	[E1]		B(E1)(W.u.)=2.2 $\times 10^{-6}$ 7.
7341.1	2011.4	100 8	(M1)		B(M1)(W.u.)>0.51.
	2884.7	75 8	(E2)		B(E2)(W.u.)>110.
7341.2	1430.9	100 6			E_{γ} : γ -ray not seen in ^{22}F β^{-} decay. I_{γ} from (α ,p γ).
	3983.5 $\frac{1}{2}$ 10	96 6	M1+E2	-0.7 3	B(M1)(W.u.)=0.0033 22; B(E2)(W.u.)=0.7 6.
7405.9	2259.8	100 3	M1+E2	+1.3 4	B(M1)(W.u.)=0.014 7; B(E2)(W.u.)=33 13.
	6130.4	56 3	E1		B(E1)(W.u.)=4.2 $\times 10^{-5}$ 14.
7423.0	1900.0 $\frac{1}{2}$ 6	100			
7469?	1559	100			
7489	1369	10 6			
	2125	10 6			
	6213	23 6			
	7487	100 6	E1		
7643.1	3186.7	42 5			
	6367.6	100 5	M1+E2	-0.08 5	δ : From 1976Fi02.
	7641.7	12 5	E2		
7663.7	1428.7	100			
7722.0	1602.0	19 16			
	2198.6	25 16			
	2575.8	22 16			
	3265.5	100 16			
	4364.3	78 16			
	6446.5	69 16			
7921	580	20 15			
	1102	29 15			

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Ne})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\#}$	Mult.#	$\delta^{\#a}$	Comments
7921	2398	33 15			
	6645	100 15			
8076.9	1765.8	50 22			
	2713.3	36 22			
	4719.1	100 22			
	6801.2	92 22			
8134.3	1314.9	8 3			
	6858.6	100 3	M1+E2	-0.48 5	I_{γ} : From 1976Fi02 ($\alpha, p\gamma$).
8162.2	1342.8	8 8			
	4804.4	44 8			
	6886.5	100 8			
8375.9	712.2	8 7			
	5018.1	100 7			
	7100.1	28 7			
8489.6	412.7	32 32			
	1148.4	100 32			
	2254.5	82 32			
	2848.2	71 32			
	5131.8	71 32			
8561.4	1872.3	72 12			
	8559.6	100 12			
8596.0	519.1	100 6			
	3449.7	20 6			
8741.0	1399.6	19 12			
	1689.9	28 12			
	4284.3	100 12			
	5383.1	28 12			
8855.3	1449.3	39 10			
	2544.1	100 10			
8900.3	1477.2	54 33			
	1559.0	100 33			
	2211.2	71 33			
	2589.1	79 33			
	3258.8	54 33			
	3536.6	58 33			
8976	1312	56 11			
	1925	100 11			
9045	1402	71 24			
	1994	92 24			
	5687	100 24			
9178	9176	100			E_{γ} : placement in (γ, γ).
9178.1	3267.6	64 11			
	4721.3	25 11			
	5819.9	100 11			
9229	1565	79 9			
	2178	100 9			
9250	1528	100 11			
	3130	56 11			
9324	1602	100			
9625	3314	45			
	6267	100			
10208.5	8932.0	25@ 6			
	10206.0	100@ 6	E1		
10280.4	2791.2	23@ 7			
	3426.6	45@ 9			
	4950.2	100@ 12			
	5823.4	2@ 1			
	9003.9	57@ 12			
10294.8	2805.6	19@ 5			
	3441.0	16@ 5			
	4964.6	30@ 7			
	5837.8	11@ 4			
	9018.3	100@ 12	D	δ : 0.04 5 in (α, γ).	

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Ne})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\#$	E(level)	$E\gamma^\dagger$	$I\gamma^\#$
10416.4	4071		11130	4818	100
10616	4270	100@ 8	11194	2294	100@ 4
	7258	52@ 8		9917	18@ 4
10696	7337	100	11269	6122	100@ 15
10706	9429	100		7910	81@ 15
10749	4437	100@ 10	11431	10154	100
	7390	92@ 10	11465	6320	100@ 4
10857	9580	100		10190	33@ 4
10921	9644	100@ 9		11464	49@ 4
	10918	79@ 9	11522	5221	100
11032	4721§				

† From level energy difference, recoil energy subtracted, except otherwise noted.

‡ From ^{22}F β^- decay, except otherwise noted.

§ Placement from ($^{26}\text{Mg}, ^{22}\text{Ne}\gamma$).

From 1993OI05 ($\alpha, p\gamma$), except otherwise noted.

@ From (α, γ).

& From ($t, p\gamma$).

a From ($\alpha, p\gamma$), except otherwise noted.

 ^{22}F β^- Decay 1974Da02, 1973Gu05

Parent ^{22}F : $E=0.0$; $J\pi=(4+)$; $T_{1/2}=4.23$ s 4; $Q(\text{g.s.})=10818$ 12; $\%\beta^-$ decay=100.

Other: 2005We06.

Decay scheme from 1974Da02. Excess apparent feeding to the 1275- and 3357-keV levels indicated by the intensity balance is probably due to missing beta feeding to higher levels that deexcite by weak gamma rays. About 10% of the decay intensity was not observed.

1973Gu05: Source produced by $^{181}\text{Ta}(^{22}\text{Ne}, ^{22}\text{F})$ $E=174$ MeV. Mass separated recoils collected on a foil. $E-\Delta E$ scintillation beta spectrometer, Ge(Li) gamma detector.

1974Da02: Source produced by $^{18}\text{O}(^6\text{Li}, 2p)$ $E=26$ MeV. Pneumatic target shuttle system. Measured γ , $\gamma\gamma$ - and $\gamma\beta$ -coincidence with Ge(Li) gamma detector and NE102 plastic scintillator beta detector.

 ^{22}Ne Levels

E(level) †	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0	0+	stable	
1274.577 7	2+		
3357.2 5	4+		
4456.2 9	2+		E(level): From Adopted Levels.
5523.3 6	(4)+		
5641.2 7	3+		
5910.1 9	3-		E(level): From Adopted Levels.
6345.1 10	4+		
7341.1 11	(4)+		
7423.4 9	(5+)		

† From least-squares fit to γ -ray energies, except otherwise noted.

‡ From Adopted Levels.

 β^- radiations

$E\beta^-$	E(level)	$I\beta^-^\ddagger$	Log ft	Comments
(3477 12)	7341.1	2.45 22	5.30 4	av $E\beta=1560$ 15.
3480 170	7423.4	8.7 4	4.70 2	av $E\beta=1521$ 15.
4670 170	6345.1	7.0 3	5.34 2	av $E\beta=2046$ 15.
(5177 12)	5641.2	16.4 7	5.26 2	av $E\beta=2391$ 15.
5500 150	5523.3	53.9 6	4.79 1	av $E\beta=2449$ 15.

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^{22}Na β^+ Decay

Parent ^{22}Na : $E=0.0$; $J\pi=3+$; $T_{1/2}=2.6018$ y 22; $Q(\text{g.s.})=2842.20$ 17; % β^+ decay=100.

Decay scheme from the Table de Radionuclides – CEA ISBN 2 7272 0200 8, except as noted. Produced by $^{19}\text{F}(\alpha, n)$, $^{24}\text{Mg}(d, \alpha)$.

Others: 2009Si18, 2008Li02, 2008Ru01, 2006Li34, 1983Ba41, 1976Ma38, 1968Le03.

 ^{22}Ne Levels

KLL Auger electron data from 2007In06

The absolute energy of the $\text{KL}_2\text{L}_3(^1\text{D})$ Auger transition is 824.5 eV 19 relative to Fermi level. This energy is higher by about 20 eV compared to that obtained in experiments with free Ne atoms.

Transitions	Relative energies (in eV)	Relative intensities ($\text{KL}_i\text{L}_j / \Sigma\text{KLL}$, %)
$\text{KL}_1\text{L}_1(^1\text{S})$	-56.0 2	6.2 4
$\text{KL}_1\text{L}_2(^1\text{P})$	-32.7 1	16.8 7
$\text{KL}_1\text{L}_3(^3\text{P})$	-21.9 2	6.8 5
$\text{KL}_2\text{L}_2(^1\text{S})$	-4.3 5	8.5 10
$\text{KL}_2\text{L}_3(^1\text{D})$	0	61.7 17
Unknown	+18.5 5	2.8 5

E(level)	$J\pi$	$T_{1/2}$
0.0	0+	stable
1274.53 7	2+	

 β^+, ϵ Data

$E\epsilon$	E(level)	$I\beta^{+\dagger}$	$I\epsilon^\dagger$	Log ft	$I(\epsilon+\beta^+)^\dagger$	Comments
(1567.67 19)	1274.53	90.326 15	9.618 15	7.41	99.944 14	av $E\beta=215.54$ 21; $\epsilon K=0.0888$ 3; $\epsilon L=0.00735$ 3. $\epsilon/\beta+=0.1071$ 5, weighted average of measured values: 0.1084 27 (2009Na08), 0.1050 29 (1990Ku11), 0.1075 25 (1986Sy01), 0.1079 3 (1983Ba41), 0.1128 57 (1977Bo10); 0.1077 6 (1976Ma38), 0.1042 10 (1968We02), 0.1048 7 (1967Le07), 0.1041 10 (1964Wi04), 0.112 4 (1959Ra09), and 0.110 6 (1954Sh31). Theoretical value $\epsilon/\beta+=0.1152$ 3 (1978Fi11). Note $I\epsilon/I\beta+=0.1064$ 2, $I\epsilon$ and $I\beta+$ obtained using the Log ft code available at NNDC, BNL website.
(2842.20 17)	0.0	0.056 14		14.92 ^{2u}	0.056 14	1996Sa06 measured $I\epsilon=0.07$ 2. av $E\beta=835.00$ 23; $\epsilon K=0.016184$ 17.

[†] Absolute intensity per 100 decays.

 $\gamma(^{22}\text{Ne})$

$I\gamma$ normalization: From $\Sigma I(\gamma+ce)$ to (g.s.)=100.

$E\gamma$	E(level)	$I\gamma^\dagger$	Mult.	α	Comments
1274.537 7	1274.53	99.940 14	E2	2.8×10^{-5} 3	$E\gamma$: From 2000He14. α : $\alpha(\text{tot})=6.8 \times 10^{-4}$, from experimental value of 1985HaZA. Interpolated value is 6.8×10^{-6} from tables of 1976Ba63. Internal pair formation coefficient $\alpha_\pi=2.1 \times 10^{-5}$ 3 (1979Sc31). $\alpha=\alpha(\text{tot})+\alpha_\pi$.

[†] Absolute intensity per 100 decays.

$^{11}\text{B}(^{13}\text{C},\text{d})$ 1983Sz03 (continued) **^{22}Ne Levels (continued)**

E(level) [†]	J π [§]	E(level) [†]	J π [§]	E(level) [†]	J π [§]
4460	2	9720	6	14130	
5140	2	9860	5	14230	
5340 [‡]	2, 1	10120		14340	
5520	3	10190	4	14420	
5640	3	10310	5	14540	
5910	2, 3	10420	7	14600	
6120	2	10660	6	14690	
6310 [‡]	6, 4	10780	6	14840	7
6660 [‡]	3, 3	11020	8	14910	7
6840 [‡]	2, 1	11140	7	15250	6
7050		11260	7, 8	15350	7
7340 [‡]	5, 3	11500		15460	10
7420 [‡]	4, 3	11640	6	15570	
7540		11740	6	15670	7
7640		11870		15800	8
7720	3	12040	7	15990	8
7920	3	12120		16050	7
8080	3	12170	6	16250	6 [#]
8140	4, 3	12330	6	17200	8
8380	4	12390	7	17390	8
8500	5, 4	12560		17480	
8580		12690		17580	8
8740	5	12880		17760	9, 4
8890		13000	8	18010	
9070	4, 3	13260	7	18080	
9180	5	13470	6	18170	
9340		13720	7	18280	
9500	5	13880	8		
9640	4, 3	14030	7		

[†] From 1983Sz03.[‡] Doublet.[§] From angular distribution measurements.[#] In 1983Sz03, also an spin assignment 5+5 used for a possible doublet. **$^{12}\text{C}(^{18}\text{O}, ^8\text{Be}), ^{14}\text{C}(^{18}\text{O}, ^{10}\text{Be})$ 2006Fr16, 2006Yi01, 2002Cu04**

2006Fr16, 2006Yi01: $^{12}\text{C}(^{18}\text{O}, ^8\text{Be})$: Target: Self-supported ^{12}C of thickness 120 $\mu\text{g}/\text{cm}^2$; Projectile: ^{18}O , E=140 MeV; breakup fragments of ^{22}Ne into $^{18}\text{O} + \alpha$ and $^{14}\text{C} + ^8\text{Be}$ were detected using two charged-particle telescopes; one for light ions and the other for heavy ions. The light-ion telescope consisted of $\Delta\text{E}+\text{E}$ Si and a CsI detectors – energy resolution ≤ 500 keV, and the heavy-ion telescope was composed of two elements, a gas ΔE detector and a silicon-strip stopping detector – energy resolution similar to that of the light-ion telescope; deduced resonance states from the resonant particle spectroscopy approach. In 2006Fr16, ^{22}Ne resonance states are reported from $^{14}\text{C} + ^8\text{Be}$ and in 2006Yi01 from $^{18}\text{O} + \alpha$ breakup measurements. 2006Yi01 concludes that α -cluster structure is suppressed in ^{22}Ne compared with that in ^{20}Ne .

2002Cu04: $^{14}\text{C}(^{18}\text{O}, ^{10}\text{Be})$: Target: ^{14}C of thickness 413 $\mu\text{g}/\text{cm}^2$ mounted between two thin (≈ 10 $\mu\text{g}/\text{cm}^2$) layers of formvar; Projectile: ^{18}O , E=102 MeV; breakup fragments of ^{22}Ne into ^{18}O and α were detected using two identical telescopes consisted of $\Delta\text{E}+\text{E}$ silicon detectors (68 and 1000 μm thick); deduced resonance states of ^{22}Ne .

 ^{22}Ne Levels

E(level) [†]	J π [@]	Comments
12800? [#]		
14470 [§]		
15050? 100		E(level): Tentative level as it coincides with a possible contaminant from the decay of ^{20}Ne to $^{16}\text{O} + \alpha$. Not adopted.
17480 100		
17800 [#]		
18420 100		

Continued on next page (footnotes at end of table)

$^{12}\text{C}(^{18}\text{O}, ^8\text{Be}), ^{14}\text{C}(^{18}\text{O}, ^{10}\text{Be})$ 2006Fr16, 2006Yi01, 2002Cu04 (continued) **^{22}Ne Levels (continued)**

E(level) [†]	$J\pi^{\textcircled{a}}$	Comments
18700?#		
19450 100	(6)+	
19890 100	(10)+	E(level): Other: 20000 (2002Cu04).
20900#		
21960 100	(9)–	
23300#		
24140 [‡] 200		
26890 [‡] 200		

[†] From 2006Yi01 ($^{18}\text{O} + \alpha$ measurements), except otherwise noted.

[‡] From 2006Fr16 ($^{14}\text{C} + ^8\text{Be}$ measurements).

§ From 2002Cu04.

Level noted as tentative in 2002Cu04, also not reported in 2006Yi01 and so not adopted by evaluator.

[ⓐ] From 2006Yi01 ($^{18}\text{O} + \alpha$ measurements) based on angular distribution measurements.

 $^{14}\text{C}(^{12}\text{C}, \alpha)$ 2011To14, 2011To07

2011To14, 2011To07: Target: 80% enriched in ^{14}C self-supporting carbon foil of thickness 280 $\mu\text{g}/\text{cm}^2$. Projectile: ^{12}C beam, E=44 MeV. The primary α -particles were detected with two 10 mm² silicon detectors at forward angles and α -particle from ^{22}Ne decay were detected by ΔE -E telescopes of a position-sensitive gas proportional counter as ΔE detector and 10 silicon PIN diodes as E detectors at angles from 34° to 74°. Measured $\sigma(E_{\alpha}, \theta)$, $\alpha\alpha(\theta)$. Deduced levels, $J\pi$.

 ^{22}Ne Levels

E(level)	$J\pi^{\text{‡}}$	Γ	Comments
17000 [†] 100			
18450 100		≈330 keV	
19130 [†] 100			
20000 100	9–	≈270 keV	
20700§ 100	11–	≈340 keV	
21600§ 100	9–	≈350 keV	
22200 100	12+	≈250 keV	E(level): yrast state.
22900 100		≈290 keV	
24000 [†] 100			
25000 100	9–	≈350 keV	
25900 [†] 100			
27000 [†] 100			

[†] Unresolved group of levels.

[‡] From the analysis of double (α, α) angular correlations with the residual ^{18}O nucleus in the 0+ ground state.

§ Member of α -cluster rotational band.

 $^{18}\text{O}(\alpha, \gamma)$ 1978Tr05, 1990Vo06

$^{18}\text{O}(\alpha, \gamma)$, E=0.6–2.3 MeV.

1978Tr05: Measured $E_{\gamma}, I_{\gamma}, I_{\gamma}(\sigma), I_{\gamma}(E)$; Enriched ^{18}O targets. Ge(Li) detector.

Other references: 1990Vo06: $^{18}\text{O}(\alpha, \gamma)$, E < 0.78 MeV. Measured resonance γ -ray yields.

1968Gr07: $^{18}\text{O}(\alpha, \gamma)$, E=11, 89, 12, 28 MeV.

1970Ch18: $^{18}\text{O}(\alpha, \gamma)$, E=1.6–5.0 MeV. Measured $\sigma(E; E_{\gamma}, \theta(\gamma))$.

1994Gi01: $^{18}\text{O}(\alpha, \gamma)$, E < 1 MeV. Measured $\gamma(\theta)$.

$^{18}\text{O}(\alpha, \gamma)$ 1978Tr05, 1990Vo06 (continued) ^{22}Ne Levels

E(level) [‡]	J π [†]	T _{1/2} [#]	S ^a	Comments
0.0				
(1275)				
(3358)				
(4456)				
(5146)				
(5329)				
(6311)				
(6345)				
(6854)				
(7489)				
(8900)				
10208.5 [§] 10	1-	<2 keV	0.230 25	E α (lab)=662.1 keV 10 (1990Vo06).
10280.4 [§] 10	0+, 1-, 2+	<2 keV	0.56 6	E α (lab)=749.9 keV 10 (1990Vo06).
10294.8 [§] 10	2+	<2 keV	1.20 12	E α (lab)=767.6 keV 10 (1990Vo06).
10617 5	5-			
10696 4		<4 keV@		
10706 6		<10 keV@		
10752 4	5-			
10860 4				
10925 5	1-			
11032 6	(8+, 6+)	<10 keV@		
11130 5		<5 keV@		
11196 4		7 keV&		
11272 5	2+, 3+, 4+	7 keV&		
11428 10	+	47 keV		
11470 5	1-	<3 keV@		
11519&		6 keV&		
11577&		16 keV&		
11686 5	2+			J π : From 1970Ch18.
11745&		41 keV&		
11751&	1-	8 keV&		J π : From 1970Ch18.
11886 10	1-			J π : From $\gamma(\theta)$ measurements in 1968Gr07.
12280 10	1-			J π : From $\gamma(\theta)$ measurements in 1968Gr07.

[†] Values reported from $\alpha\gamma$ angular distribution (1978Tr05).[‡] From 1978Tr05 for E<11500 and from 1968Gr07, 1970Ch18 for E>11500, except as noted.[§] Deduced using E α (lab) (1990Vo06) and reaction Q value of 9666.81 keV 2 (2012Wa38).[#] From 1990Vo06, except otherwise noted.

@ From 1978Tr05.

& From 1970Ch18.

^a From 1990Vo06. Astrophysical S factor. $\gamma(^{22}\text{Ne})$

E(level)	E γ [†]	I γ	Mult.	δ	Comments
10208.5	8932 [‡]	25 [‡] 6			
	10206 [‡]	100 [‡] 6			
10280.4	2791 [‡]	23 [‡] 7			
	3426 [‡]	45 [‡] 9			
	4951 [‡]	100 [‡] 12			
	5824 [‡]	2 [‡] 1			
	9003 [‡]	57 [‡] 12			
10294.8	2806 [‡]	19 [‡] 5			
	3441 [‡]	16 [‡] 5			
	4965 [‡]	30 [‡] 7			
	5838 [‡]	11 [‡] 4			
	9018	100 12	D+Q	0.04 5	δ : From 1994Gi01.
10617	4270	100 8			
	7260	52 8			
10696	7340	100			
10706	9430	100			

Continued on next page (footnotes at end of table)

$^{18}\text{O}(\alpha, \gamma)$ 1978Tr05,1990Vo06 (continued) **$\gamma(^{22}\text{Ne})$ (continued)**

E(level)	$E_{\gamma}^{\dagger}$	I_{γ}	E(level)	$E_{\gamma}^{\dagger}$	I_{γ}	E(level)	$E_{\gamma}^{\dagger}$	I_{γ}
10752	4440	100 10	11032	4720	100	11272	7910	81 15
	7390	92 10	11130	4820	100	11428	10150	100
10860	9585	100	11196	2300	100 4	11470	6320	100 4
10925	9650	100 9		9920	18 4		10190	33 4
	10925	79 9	11272	6120	100 15		11470	49 4

[†] Not reported by authors. Calculated from level energy differences, recoil energy subtracted.

[‡] From 1990Vo06. E_{γ} deduced from level energy difference and recoil energy subtracted.

 $^{18}\text{O}(\alpha, n)$: Res 2013Be12,1973Ba10

2013Be12: $E(\alpha)$ =1280–2300 keV provided by the 4 MV KN accelerator at the University of Notre Dame Nuclear Science Laboratory. Target= ^{18}O (97.2%). Measured E_{γ} , I_{γ} , $E(n)$, neutron yield, $(n)\gamma$ -coin, $\sigma(E)$ using a HPGe detector and 20 ^3He counters. Deduced levels, J, π , single-particle widths, L, s.

1973Ba10: $^{18}\text{O}(\alpha, n)$, E =1–5 MeV, measured $\sigma(E)$, deduced resonances, level-width.

 ^{22}Ne Levels

E(level) [‡]	J π [#]	$\Gamma^{\dagger}$	Comments
10615 3	2+	6 keV	$\Gamma(\alpha)$ =0.133 eV for $l=2$, $s=0$; $\Gamma(n0)$ =1.47 keV for $l=0$, $s=2$. J π : (5–) in Adopted Levels. Source of this discrepancy is not clear.
10713 §	3–		$\Gamma(\alpha)$ =0.0445 eV for $l=3$, $s=0$; $\Gamma(n0)$ =1.7 keV for $l=1$, $s=2$.
10749 3	4+	6 keV	E(level): Other value: 10751 (2013Be12). $\Gamma(\alpha)$ =0.225 eV for $l=4$, $s=0$; $\Gamma(n0)$ =1.6 keV for $l=2$, $s=2$.
10853 3	3–	6 keV	$\Gamma(\alpha)$ =0.224 eV for $l=3$, $s=0$; $\Gamma(n1)$ =1.9 keV for $l=1$, $s=2$; $\Gamma(n1)$ =45.8 eV for $l=1$, $s=3$; $\Gamma(n0)$ =1.7 keV for $l=1$, $s=2$.
10919 3	1–	24 keV	E(level): Other value: 10922 (2013Be12). $\Gamma(\alpha)$ =10.5 eV for $l=1$, $s=0$; $\Gamma(n1)$ =6.1 keV for $l=1$, $s=2$; $\Gamma(n0)$ =14.1 keV for $l=1$, $s=1$; $\Gamma(n0)$ =6.6 keV for $l=1$, $s=2$.
11030 §	6+		$\Gamma(\alpha)$ =0.0014 eV for $l=6$, $s=0$; $\Gamma(n1)$ =9.3 eV for $l=4$, $s=3$; $\Gamma(n0)$ =9.0 eV for $l=4$, $s=2$. J π : (8+,6+) in Adopted Levels.
11172 §	3–		$\Gamma(\alpha)$ =0.359 eV for $l=3$, $s=0$; $\Gamma(n1)$ =19.3 keV for $l=1$, $s=2$; $\Gamma(n1)$ =476 eV for $l=1$, $s=3$.
11192 3	2+	7 keV	E(level): Other value: 11195 (2013Be12). $\Gamma(\alpha)$ =13.8 eV for $l=2$, $s=0$; $\Gamma(n1)$ =440 eV for $l=0$, $s=2$; $\Gamma(n0)$ =4.8 keV for $l=0$, $s=2$.
11266 5	3–	12 keV	E(level): Other value: 11268 (2013Be12). $\Gamma(\alpha)$ =1.6 eV for $l=3$, $s=0$; $\Gamma(n1)$ =412 eV for $l=1$, $s=2$; $\Gamma(n1)$ =10.2 eV for $l=1$, $s=3$; $\Gamma(n0)$ =1.2 keV for $l=1$, $s=2$.
11323 §	5–		$\Gamma(\alpha)$ =0.098 eV for $l=5$, $s=0$; $\Gamma(n0)$ =7.4 keV for $l=3$, $s=2$.
11434 8	1–	48 keV	E(level): Other value: 11432 (2013Be12). $\Gamma(\alpha)$ =126 eV for $l=1$, $s=0$; $\Gamma(n1)$ =25.0 keV for $l=1$, $s=2$; $\Gamma(n0)$ =10.2 keV for $l=1$, $s=1$; $\Gamma(n0)$ =5.1 keV for $l=1$, $s=2$.
11463 3	4+	≤ 3 keV	J π : 1– in Adopted Levels considering γ -ray transitions. $\Gamma(\alpha)$ =49.9 eV for $l=4$, $s=0$; $\Gamma(n1)$ =1.0 keV for $l=2$, $s=2$; $\Gamma(n1)$ =1.0 keV for $l=2$, $s=3$; $\Gamma(n0)$ =2.5 keV for $l=2$, $s=2$.
11518 §	2+		$\Gamma(\alpha)$ =4.6 eV for $l=2$, $s=0$; $\Gamma(n1)$ =1.6 keV for $l=0$, $s=2$; $\Gamma(n0)$ =1.5 keV for $l=0$, $s=2$.
11577 5		18 keV	
11685 5		9 keV	
11709 §	0+		$\Gamma(\alpha)$ =3.3 keV for $l=0$, $s=0$; $\Gamma(n1)$ =199 keV for $l=2$, $s=2$; $\Gamma(n0)$ =476 keV for $l=2$, $s=2$.

[†] From 1973Ba10. Values from 2013Be12 are listed in comment column. l and s are relative angular momentum and channel spin, respectively (2013Be12).

[‡] From 1973Ba10, except otherwise noted. Excited energies deduced from $E\alpha$ *0.818 08 + 9667.0 keV in 1973Ba10.

§ From 2013Be12.

From 2013Be12, based on best-fit R-matrix parameters. Some of the proposed assignments are in disagreement with earlier values. Evaluator noted those difference in this data set and Adopted Levels.

$^{18}\text{O}(^4\text{He}, ^4\text{He}')$: Res 2004Go03, 1964Po02

Others: 2001Ro29, 1968Go08.

2004Go03, 2001Ro29: $^{18}\text{O}(^4\text{He}, ^4\text{He}')$ in inverse kinematics. ^{18}O beam, $E=80$ MeV entered a large scattering chamber through 3 μm thick Havar foil. The chamber was filled with helium gas of 99.9% purity. Recoiling α particles were detected by an array of 20 silicon detectors positioned in the forward direction including 0° . A gas pressure of 370 Torr used to stop the ^{18}O beam before the 0° detector. Deduced resonance states, $J\pi$, width, α -cluster doublet levels, etc. Same research group in 2004Go03 and 2001Ro29.

1964Po02: Target ^{18}O prepared by oxidizing tungsten with water vapor enriched to greater than 97% ^{18}O and evaporating the W_4O_{11} onto 25 $\mu\text{g}/\text{cm}^2$ carbon backings; Projectile: α , $E=2.40$ MeV; Experimental data were taken on two separate occasions: First – scattered α particles were detected at $\theta_{\text{c.m.}}=90.0^\circ$, 125.3° , 140.7° , and 152.3° by a scintillation counter and second – at 140.7° and 164.4° with a Si surface barrier detector; Measured E_{res} and deduced excited resonance energy levels, spin and parity, resonance widths.

 ^{22}Ne Levels

E(level) [†]	$J\pi$ [#]	Γ_{tot} [@]	$\Gamma_{\alpha}/\Gamma_{\text{tot}}\%$	Comments
11700 [‡]	2+ [‡]	5 keV [‡]	10 [‡]	
11760 [‡]	1- [‡]	11 keV [‡]	28 [‡]	
11880 10	1-	10 keV	56	
12020 10	0+	68 keV	66	
12250 10	0+	76 keV	100	
12280 10	1-	51 keV	10	
12390 10	2+	99 keV	6	
12570 10	1-	105 keV	35	E(level): Other: 12580 keV 20 (2001Ro29).
12610 10	(2+)	124 keV	4	
12700 10	3-	15 keV	6	
12800 10	2+	50 keV	12	
12820 10	1-	170 keV	53	E(level): Other: 12840 keV 20 (2001Ro29).
12890 10	3-	39 keV	9	
12990 10	0+	80 keV	40	
13030 10	2+	90 keV	29	
13190 10	3-	79 keV	39	
13210 10	0+	81 keV	39	
13400 10	3-	58 keV	39	
13490 10	4+	29 keV	10	
13540 10	0+	96 keV	77	
13570 10	3-	136 keV	12	
13650 10	(3-)	48 keV	16	
13670 10	(2+)	41 keV	12	
13690 10	(5-)	50 keV	4	
13730 10	4+	57 keV	7	
13820 10	(2+)	51 keV	7	
13880 10	4+	46 keV	7	
19280 [§] 20	(7-) [§]	88 keV ^{§&}	25 [§]	
19560 [§] 20	(7-) [§]	75 keV ^{§&}	23 [§]	
20850 [§] 20	9- [§]	110 keV ^{§&}	15 [§]	
21840 [§] 20	9- [§]	170 keV ^{§&}	22 [§]	

[†] From 2004Go03, except otherwise noted.

[‡] From 1964Po02.

[§] From 2001Ro29.

[#] From double differential cross section measurements and fitting (2004Go03, 2001Ro29).

[@] From 2004Go03, except otherwise noted. In center-of-mass system. The uncertainty of the widths for the low-spin (broad) states is 20%, and for high-spin (narrow) states up to 70% (2004Go03).

[&] The precision of the evaluated width is better than 25%, except for states with $J\pi=7-$ (2001Ro29).

$^{18}\text{O}(^6\text{Li},\text{d})$ 1994Gi01,1982Ta151994Gi01: $^{18}\text{O}(^6\text{Li},\text{d})$, E=32 MeV, measured $\sigma(\theta)$.1982Ta15: $^{18}\text{O}(^6\text{Li},\text{d})$, E=72 MeV, measured $\sigma(\theta)$.1977An03: $^{18}\text{O}(^6\text{Li},\text{d})$, E=32 MeV, measured $\sigma(\theta)$. **^{22}Ne Levels**

E(level) [†]	J π [†]	L [†]	S ^{†‡}	E(level) [†]	J π [†]	L [†]	S ^{†‡}
0.0	0+	0	1.0	9214 12			
1270	2+	2	0.64	9315 10	(1-, 5-, 6+)	(6)	1.5, 0.5, 1
3360	4+	4	0.40	9525 [#] 10			
4460	2+	2	0.16	9630 12			
5360	2+	2	0.04	9717 10	(2+, 3-)	(3)	2.5, 1.1
5520	4+	4	0.04	9837 15	(1-, 2+, 3-)	(2)	2.7, 1.05
5910	3-	3	0.03	10053 15	(0+, 1-)	(0)	15, 4.7
6120	2+	2		10132 12	(2+, 3-, 4+)	(4)	1.9, 1.0.85
6240	0+	0	0.86	10207 10	1-	1	3.5
7340	0+	0	0.75	10293 [#] 10			
7630	2+	2	0.30	10422 10			
7720	3-	3	0.12	10607 12			
8140	2+	2	0.16	10697 [#] 15			
≈ 8628 §	(2+, 3-)	(2)	7.5, 3	10839 22			
≈ 8763 §	3-	3	0.4	11026 12			
8989 10	4+	4	2	11139 12	5 to 8	(6)	1, 2.5, 3, 31
9090 10	(3-)	3	1.5	≈ 11248 §			
9168 10	(5-, 6+)	(5)	1.3, 3.7				

[†] E<4500 from 1982Ta15, 4500–8140 from 1977An03, >8200 from 1994Gi01.[‡] Relative spectroscopic factor S_{α} from DWBA analysis.

§ Approximate because the position of the deuteron group was at the end of the detector.

Unresolved.

 $^{18}\text{O}(^7\text{Li},\text{t}),(^7\text{Li},\text{t}\gamma)$ 1972Sc29,1976Fi02

Others: 1983Ko01, 1969Sc07.

 $J\pi(^{18}\text{O})=0+$.1972Sc29,1969Sc07: $^{18}\text{O}(^7\text{Li},\text{t})$, E=12 MeV. Measured $\sigma(\text{Et},\theta)$.1976Fi02: $^{18}\text{O}(^7\text{Li},\text{t}\gamma)$, E=13,14 MeV. Measured $\gamma(\theta)$.1983Ko01: $^7\text{Li}(^{18}\text{O},\text{t}\gamma)$ E=10–60 MeV. Measured half-life by recoil distance method, HPGe detector. **^{22}Ne Levels**

E(level) [†]	J π [§]	T _{1/2}	L [†]	Comments
0.0	0+		0	
1274.49 8	2+	3.5 ps 2	2	E(level): From γ -ray energy. T _{1/2} : From 1983Ko01, measured by recoil distance method.
3340 25			4 [‡]	
4460 25	2+		2	
5160 25				
5330	1+			E(level), J π : From 1976Fi02.
5370 25				
5540 25				
5660 25				
5930 25				
6110 25			(3) [‡]	
6240 25	0+		0	
6340 25			6 [‡]	
6700 25				
6820 25	2+		2	
6900 25	0+		0	
7060 25	1-		1	
7340 25	0+		0	
7410 25				

Continued on next page (footnotes at end of table)

$^{18}\text{O}({}^7\text{Li,t}),({}^7\text{Li,t}\gamma)$ 1972Sc29,1976Fi02 (continued) **^{22}Ne Levels (continued)**

E(level) [†]	J π [§]	L [†]	Comments
7490 25	1-	1	
7640 25	2+	2	
7730 25	3-	3	
7920 25			
8080 25			
8140 25	2+	2	
8380 25			
8500 25			
8590 25		2 $\frac{1}{2}$	E(level): γ transitions not listed – multiple placements from different levels.

[†] From 1972Sc29, except otherwise noted.[‡] Quoted from Fig. 2 in 1972Sc29.[§] From L values. **$\gamma(^{22}\text{Ne})$**

E(level)	E γ [†]	I γ [‡]	Mult. ^{‡§}	δ [‡]	Comments
1274.49	1274.49 8		Q		A ₂ /A ₀ =0.00 8, A ₄ /A ₀ =0.03 13. E γ : From 1983Ko01.
5330	4055	31 6	D+Q		A ₂ /A ₀ =-0.03 11, A ₄ /A ₀ =0.01 16.
	5330	69 6	D		A ₂ /A ₀ =-0.01 6, A ₄ /A ₀ =-0.02 8.
5370	4090				
	5370				
7340	2010	83 3	D		A ₂ /A ₀ =0.09 9, A ₄ /A ₀ =-0.08 13.
	2880	17 3			
7490	7490		D		A ₂ /A ₀ =-0.72 5, A ₄ /A ₀ =-0.03 8.
7640	6360		(M1+E2)	0.08 5	A ₂ /A ₀ =0.30 6, A ₄ /A ₀ =-0.03 8.
	7640		Q		A ₂ /A ₀ =0.64 16, A ₄ /A ₀ =-0.81 24.
7730	3270	50 4			
	4390	23 2			
	6450	15 4	D+Q		A ₂ /A ₀ =0.09 10, A ₄ /A ₀ =-0.14 15.
8140	6860		(M1+E2)	0.48 5	A ₂ /A ₀ =-0.13 5, A ₄ /A ₀ =-0.11 7.

[†] From level energy difference, except otherwise noted. Not corrected for recoil energy.[‡] From 1976Fi02.[§] From angular distribution coefficients (1976Fi02) and mixing ratios.

$^{18}\text{O}(^7\text{Li,t}),(^7\text{Li,t})$ 1972Sc29,1976Fi02 (continued)

Level Scheme

Intensities: % photon branching from
each level **$^{19}\text{F}(\alpha,\text{p}\gamma)$ 1993Ol05,1976Br06,1976Fi02**1976Br06: $^{19}\text{F}(\alpha,\text{p}\gamma)$, $E=20.0$ MeV measured $\sigma(E,\text{Ep},E\gamma,\theta)$.1976Fi02: $^{19}\text{F}(\alpha,\text{p}\gamma)$, $E=12.0,15.0,18.5,19.0$ MeV. Measured $\text{p}\gamma(\theta)$, DSA.1993Ol05: $^{19}\text{F}(\alpha,\text{p}\gamma)$, $E=12$ MeV, measured γp .

Other references: 1970Br28,1974Fi16,1975Me19,1976Sc20,1977To01, 1977Va10,1984Ba10,1986Ad11,1984Bh03,1968Ku05.

 ^{22}Ne Levels

$E(\text{level})^\dagger$	$J\pi^\S$	$T_{1/2}^\dagger$	Comments
0.0	0+		
1274.61	2+	3.67 ps 9	$T_{1/2}$: Weighted average of 6 ps 2 (1966Li07), 4.1 ps 4 (1972Sz05), 3.2 ps 4 (1969Jo10), 4.1 ps 8 (1972Sn01), 3.7 ps 3 (1973An01), 3.4 ps 5 (1977Og03), 3.90 ps 14 (1977Ra01), 3.58 ps 9 (1984Bh03).
3358.7 3	4+	236 fs 28	$T_{1/2}$: Other values: 277 fs 76 (1967Wa13), 187 fs 62 (1968Ku05), 250 fs 35 (1972Br17), 198 fs 35 (1974Fi16).
4456.2 9	2+	<30 fs	$T_{1/2}$: From 1976Fi02. Other value: 37 FS 6 (1993Ol05).
5146.0 9	2-	0.62 ps 28	$T_{1/2}$: Other value: 0.8 ps +4-3 (1976Fi02).
5334 2	1+	<3 fs	
5363.4 11	2+	69 fs 12	$J\pi$: From Adopted Levels.
5524.5 8	4+	26 fs 4	$T_{1/2}$: Other value: <20 fs (1976Fi02). $T_{1/2}$: Other value: <35 fs (1976Fi02).

Continued on next page (footnotes at end of table)

$^{19}\text{F}(\alpha, p\gamma)$ 1993O105, 1976Br06, 1976Fi02 (continued) ^{22}Ne Levels (continued)

E(level) [†]	J π [§]	T _{1/2} [‡]	Comments
5641.5 11	3+	<3 fs	T _{1/2} : Other value: <40 fs (1976Fi02). J π : From 1976Fi02.
5911 2	3-	33 fs 11	T _{1/2} : Other value: 35 fs 16 (1976Fi02).
6119.9 16	2+	24 fs 9	
6235 2	0+	236 fs 83	
6311.0 10	(6)+	48 fs 4	
6346.3 14	4+	13 fs 3	
6635.8 8	(3, 4)+	49 fs 21	J π : From Adopted Levels. T _{1/2} : Other value: 48 fs 14 (1976Fi02).
6689 11		243 fs 132	
6819.4 16	2+	<3 fs	
6853.6 16	1+	120 fs 60	
6900 2	0+	76 fs 8	
7051 3	1-	100 fs 30	
7341.1 11	0+	<3 fs	
7344.7 7	3+	35 fs 21	
7405.9 7	1-	32 fs 10	J π : (3)- in Adopted Levels considering γ feeding from 4+ state. 3,5 in 1976Br06. T _{1/2} : Other value: 63 fs +38-26 (1976Fi02). T _{1/2} : Other value: 47 fs 15 (1976Fi02).
7423.0 11	(5+)	<3 fs	
7469 2	1, 2	55 fs 21	
7489 5			
7643.1 13			
7663.7 9			
7722.0 11			
7921 2			
8076.9 14			
8134.3 4			
8162.2 13			
8375.9 16			
8489.6 12			
8552 4			
8596.0 9			
8741.0 14			
8855.3 15			
8900.3 16			
8976 3			
9045 3			
9097 3			E(level): From 1976Fi02. 1993O105 did not report this level due to unresolved transitions from this level.
9178.1 7			
9229 3			
9234 2			
9250 3			
9324 2			
9485 $\frac{5}{2}$ 20			
9609 $\frac{5}{2}$ 20	5 $\frac{5}{2}$		
9697 $\frac{5}{2}$ 20			
9838 $\frac{5}{2}$ 20			
10105 $\frac{5}{2}$ 20			
10183 $\frac{5}{2}$ 20			
10269 $\frac{5}{2}$ 20			
10405? $\frac{5}{2}$ 20	6, 8 $\frac{5}{2}$		
10634 $\frac{5}{2}$ 20	5 $\frac{5}{2}$		
10755 $\frac{5}{2}$ 20	5 $\frac{5}{2}$		
11000 $\frac{5}{2}$ 20	8 $\frac{5}{2}$		
11102 $\frac{5}{2}$ 20	6, 7, 8 $\frac{5}{2}$		
11482 $\frac{5}{2}$ 20	7 $\frac{5}{2}$ #		

[†] From 1993O105, except as noted.[‡] From 1976Br06.[§] From 1993O105, except as noted. J π values were inferred from multipolarities and mixing ratios determined by $\gamma(0)$ and Hauser-Feshbach calculations.

From angular correlations (1970Br28), analysis of cross sections, and comparison with shell model calculations.

$^{19}\text{F}(\alpha, \text{p}\gamma)$ 1993O105, 1976Br06, 1976Fi02 (continued) $\gamma(^{22}\text{Ne})$

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. [†]	$\delta^{\dagger}$	Comments
1274.61	1274.57	100	E2		Mult.: From 1976Fi02.
3358.7	2084.0	100	E2		Mult.: From 1976Fi02.
4456.2	3181.3	100.0 [‡] 21	M1+E2	+0.09 2	Mult.: From 1976Fi02.
	4455.7	3.1 [‡] 21			
5146.0	689.8	89 8	E1+M2	-0.29 2	
	3871.0	100 8	E1+M2	+0.96 18	
5334	4059	50 12	M1+E2	+2.0 6	δ : Alternate value: -0.8 4.
	5333	100 12			
5363.4	4088.4	100 4	M1+E2	-0.12 6	δ : Alternate value: -3.5 3. Other: -0.27 8 from 1976Fi02.
	5362.7	16 4			
5524.5	2165.7	100 1	M1+E2	-0.04 3	δ : Other value: 0.07 12 (1976Fi02).
	4249.5	4 1	E2		
5641.5	2282.7	50 6	M1+E2	-0.12 17	δ : From 1976Fi02. Alternate value 5 3. Other: 0.00 10 from 1976Br06.
	4366.4	100 6	M1+E2	+0.18 3	δ : From 1976Fi02. Other: +0.16 3 (1976Fi02), +0.19 4 (1967Bu01), +0.13 3 (1972Ho52 in (t,p γ)).
5911	1454.8	21 6	E1+M2	+0.19 10	
	2552.1	21 6			
	4635.9	100 6	E1+M2	+0.17 6	
6119.9	1663.6	17 4	M1+E2	+1.1 3	
	4844.7	100 4	M1+E2	+2.3 3	δ : Alternate value: -0.11 4.
	6119.0	4 3			
6235	901				
6311.0	2952.1	100			
6346.3	2987.4	100	M1+E2	+0.68 16	$E\gamma$: From 1976Fi02. Not reported by 1993O105.
6635.8	3276.8	89 6	M1+E2	-0.9 3	
	5360.5	100 6			
6689	5414	45 9			
	6688	100 9			
6819.4	1455.9	43 16			
	1673.3	57 16			
	2363.1	100 16	M1+E2	+2.5 4	δ : Alternate value: -0.14 8.
	5544.0	70 16	M1+E2	+0.10 10	δ : Alternate value: +2.4 4.
6853.6	5578.2	85 8	M1+E2	+1.3 5	$I\gamma$: Other value: 39 10 (1976Fi02). δ : Alternate value: -0.75 20.
	6852.5	100 8			
6900	5625	100	E2		
7051	5776	100 5			
	7050	16 5			
7341.1	2007.0	100 8			$I\gamma$: 100 4 in 1976Fi02.
	2884.7	75 8			$I\gamma$: 20 4 in 1976Fi02.
7344.7	1433.6	100 6			$I\gamma$: 30 13 in 1976Fi02.
	3985.6	96 6	M1+E2	-0.7 3	$I\gamma$: 100 13 in 1976Fi02.
7405.9	2259.8	100 3	M1+E2	+1.3 4	δ : Alternate value: -0.75 20.
	6130.4	56 3	E1		Mult.: From 1976Fi02.
7423.0	1898.4	100			
7469	1558	100			
7489	1369	10 6			
	2126	10 6			
	6213	23 6			
	7488	100 6			
7643.1	3186.7	42 5			
	6367.5	100 5			
	7641.7	12 5			
7663.7	1428.7	100			
7722.0	1602.0	19 16			
	2197.4	25 16			
	2575.8	22 16			
	3265.5	100 16			
	4362.8	78 16			
	6446.4	69 16			
7921	580	20 15			
	1102	29 15			

Continued on next page (footnotes at end of table)

$^{19}\text{F}(\alpha, p\gamma)$ 1993O105, 1976Br06, 1976Fi02 (continued) $\gamma(^{22}\text{Ne})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$
7921	2396	33 15	8552	1863	72 12	9045	5685	100 24
	6645	100 15		8550	100 12	9178.1	3266.8	64 11
8076.9	1765.8	50 22	8596.0	519.1	100 6		4721.4	25 11
	2713.3	36 22		3449.7	20 6		5818.6	100 11
	4717.7	100 22	8741.0	1396.3	19 12	9229	1565	79 9
	6801.2	92 22		1689.9	28 12		2178	100 8
8134.3	1314.9	8 3		4284.4	100 12	9250	1528	100 11
	6858.5	100 3		5381.6	28 12		3130	56 11
8162.2	1342.8	8 8	8855.3	1449.3	39 10	9324	1602	100
	4802.9	44 8		2544.1	100 10	9609	3298	45
	6886.4	100 8	8900.3	1477.2	54 33		6249	100
8375.9	712.2	8 7		1559.1	100 33	10405?	4094	100
	1476 [§]	8 7		2211.2	71 33	10634	4323	100
	5016.6	100 7		2589.1	79 33		7274	52
	7100.1	28 7		3258.5	54 33	10755	4444	100
8489.6	412.7	32 32		3536.6	58 33		7395	92
	1144.9	100 32	8976	1312	56 11	11000	4688	100
	2254.5	82 32		1925	100 11	11102	4790	100
	2847.9	71 32	9045	1402	71 24	11482	5170	100
	5130.3	71 32		1994	92 24			

[†] From 1993O105, except as noted. From level energy differences. Recoil energy subtracted.

[‡] From 1967Bu01.

[§] Placement should be considered with caution and not adopted: it would be a (3)- to (0,1)+ transition!.

$^{19}\text{F}(\alpha, \text{p}\gamma)$ 1993OI05, 1976Br06, 1976Fi02 (continued)

Level Scheme

Intensities: relative photon branching from each level

$^{19}\text{F}(\alpha, p\gamma)$ 1993OI05, 1976Br06, 1976Fi02 (continued)

Level Scheme (continued)

Intensities: relative photon branching from each level

$^{20}\text{Ne}(\text{t,p})$ 1994Ma37,1974F107,1961Si03 $J\pi(^{20}\text{Ne})=0+$.1994Ma37: $^{20}\text{Ne}(\text{t,p})$, $E=15$ MeV. Measured $\sigma(\text{Ep},\theta)$ DWBA analysis.1974F107: $^{20}\text{Ne}(\text{t,p})$, $E=15,20$ MeV. Measured $\sigma(\text{Ep},\theta)$.1961Si03: $^{20}\text{Ne}(\text{t,p})$, $E<2.6$ MeV. Magnetic spectrometer. ^{22}Ne Levels

E(level) [†]	L [†]	Comments
0.0	0	
1277 5	2	E(level): Unweighted average of 1279 5 (1994Ma37) and 1275 5 (1974F107).
3359 5	4	E(level): Same value both in 1994Ma37 and 1974F107. Other value: 3343 15 (1961Si03).
4457 5	2	E(level): Unweighted average of 4460 5 (1994Ma37) and 4453 5 (1974F107). Other value: 4473 15 (1961Si03).
5148 5	1, 3	E(level): Other value: 5139 15 (1961Si03).
5367 5	2	E(level): Other value: 5360 10 (1974F107).
5524 5	4	E(level): Other values: 5524 10 (1974F107), 5520 15 (1961Si03).
5641 5	2, 4	E(level): Other values: 5643 10 (1974F107), 5633 15 (1961Si03).
5911 5	3	E(level): Other values: 5911 10 (1974F107), 5917 15 (1961Si03).
6115 5	2	E(level): Other values: 6115 10 (1974F107), 6117 15 (1961Si03).
6236 5	0	E(level): Other values: 6238 10 (1974F107), 6242 15 (1961Si03).
6345 10	4	E(level): 6330 10 from 1994Ma37 may include contribution from 6311 level. Other value: 6349 15 (1961Si03).
6636 5	2	E(level): Other values: 6642 10 (1974F107), 6647 15 (1961Si03).
6686 10	1	E(level): Unweighted average of 6682 10 (1994Ma37) and 6691 10 (1974F107). Other value: 6696 15 (1961Si03).
6822 10	2	E(level): Unweighted average of 6820 10 (1994Ma37) and 6825 10 (1974F107). Other value: 6823 15 (1961Si03).
6856 10	0, 2	E(level): Other value: 6860 25 (1961Si03).
6905 10	0	E(level): Unweighted average of 6903 10 (1994Ma37) and 6908 10 (1974F107).
7050 10	1	E(level): Other value: 7047 15 (1961Si03).
7343 10	0	E(level): From 1974F107. Other value: 7343 10 (1994Ma37) may include contribution from 7341 level.
7405 10		E(level): From 1974F107. Other value: 7402 15 (1961Si03).
7414 15		E(level): From 1994Ma37, doublet 7406+7423.
7491 10	(1)	E(level): From 1974F107. Other values: 7486 10 (1994Ma37) doublet 7470?+7489, 7484 15 (1961Si03).
7641 10	2	E(level): Unweighted average of 7639 10 (1994Ma37) and 7643 10 (1974F107). Other value: 7633 15 (1961Si03).
7663 20		E(level): From 1961Si03.
7723 10	2	E(level): Unweighted average of 7720 10 (1994Ma37) and 7726 10 (1974F107). Other value: 7720 15 (1961Si03).
7925 10	2	E(level): Unweighted average of 7925 10 (1994Ma37) and 7924 10 (1974F107). Other value: 7913 15 (1961Si03).
8083 10	(4)	E(level): Unweighted average of 8081 10 (1994Ma37) and 8085 10 (1974F107). Other value: 8071 15 (1961Si03).
8127 10	2	E(level): Unweighted average of 8129 10 (1994Ma37) and 8125 10 (1974F107). Other value: 8122 15 (1961Si03).
8164 10	2, 3, 4	E(level): Unweighted average of 8164 10 (1994Ma37) and 8163 10 (1974F107).
8387 10	3	E(level): Unweighted average of 8387 10 (1994Ma37) and 8386 10 (1974F107). Other value: 8368 15 (1961Si03).
8500 10	2	E(level): Other values: 8504 15 (1974F107), 8488 15 (1961Si03).
8545 15	2	
8591 10	(2)	E(level): Unweighted average of 8590 10 (1994Ma37) and 8593 10 (1974F107). Other value: 8575 15 (1961Si03).
8741 10	3	E(level): Unweighted average of 8743 10 (1994Ma37) and 8738 10 (1974F107). Other value: 8724 15 (1961Si03).
8866 10		E(level): Unweighted average of 8865 10 (1994Ma37) and 8867 10 (1974F107). Other value: 8890 15 (1961Si03).
8980 10	2, 4	E(level): Unweighted average of 8980 10 (1994Ma37) and 8981 10 (1974F107). Other value: 8970 15 (1961Si03).
9050 15	4, 5	E(level): Other value: 9034 20 (1961Si03).
9094 10	(1)	E(level): Unweighted average of 9096 10 (1994Ma37) and 9092 10 (1974F107). Other value: 9069 15 (1961Si03).
9180 10	4	E(level): Unweighted average of 9181 10 (1994Ma37) and 9179 10 (1974F107). Other value: 9174 20 (1961Si03).
9227 10	2	E(level): Unweighted average of 9229 10 (1994Ma37) and 9225 10 (1974F107). Other value: 9215 20 (1961Si03).
9333 10		E(level): Unweighted average of 9337 10 (1994Ma37) and 9329 10 (1974F107). Other value: 9316 15 (1961Si03).
9508 10	(3)	E(level): Unweighted average of 9510 10 (1994Ma37) and 9505 10 (1974F107).
9541 10	2	E(level): Other value: 9540 15 (1974F107).
9654 10	4, 6	E(level): Other value: 9648 15 (1974F107).
9734 10		
9841 10		
10072 10		
10142 10	2	E(level): Other value: 10132 15 (1974F107).
10230 15		
10309 15	2, 3	E(level): Unweighted average of 10316 15 (1994Ma37) and 10302 15 (1974F107).
10384 15		
10466 10	3	E(level): Other value: 10474 15 (1974F107).
10504 10	2	
10551 15	2	
10635 14	(4)+5	E(level): Doublet 10654+10618.
10720 10		E(level): Other value: 10711 15 (1974F107).
10820 15		
10870 10	3	

Continued on next page (footnotes at end of table)

$^{20}\text{Ne}(\text{t},\text{p})$ 1994Ma37,1974F107,1961Si03 (continued) **^{22}Ne Levels (continued)**

E(level) [†]	L [†]	Comments
10933 10	1	
11064 10	2	E(level): Other value: 11063 15 (1974F107).
11173 10	3	E(level): Other value: 11161 15 (1974F107).
11284 15	3	E(level): Unweighted average of 11291 15 (1994Ma37) and 11276 15 (1974F107).
11451 15	(3)+1	E(level): Doublet 11433+11466.
11533 10	(7)	E(level): Other value: 11520 15 (1974F107).
11594 15		
11656 10	≥6	
11708 15	2	
11772 10	3	E(level): Other value: 11760 15 (1974F107).
11907 10	0, 1, 2	E(level): Other value: 11895 15 (1974F107).
12071 15		
12218 15		
12390 10	3	E(level): Other value: 12384 15 (1974F107).
12450 20	0, 1	
12643 15	0, 1, 2	
12862 15	(3)	
12910 15	2, 3	
13078 20		
13274 20		
13384 15		

[†] From 1994Ma37, except as noted. **$^{20}\text{Ne}(\text{t},\text{p}\gamma)$ 1972Ho52**

3.0 MeV tritons impinge upon a ^{20}Ne gas target of 99.9% isotopic and 97% elemental purity; protons were detected by a thick (500 μm) annular charged-particle detector, resolution ~70 keV; γ -rays were detected using NaI(Tl) detector, measured $E\gamma$, $I\gamma$, and proton-gamma angular correlations.

 ^{22}Ne Levels

E(level) [†]	J π [†]	Comments
0.0	0+	
1274.537 7	2+	
3357.2 5	4+	
4456.2 9	2+	
5146.0 9	2-	
5329.6 13	1+	
5363.4 11	2+	
5523.3 6	(4)+	
5641.2 7	3+	
5910.1 9	3-	
6119.9 16	2+	
6345.1 10	4+	
7051 3	1-	
7341.1 11	0+	J π : (1-) in 1972Ho52.
7489 5	1-	

[†] From Adopted Levels. **$\gamma(^{22}\text{Ne})$**

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$
1274.537	1274.537 7	100
3357.2	2082.6 5	100
4456.2	3181.4	100

Continued on next page (footnotes at end of table)

²⁰Ne(t,pγ) 1972Ho52 (continued) $\gamma(^{22}\text{Ne})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$
5146.0	689.8	47\$ 3	5641.2	4366.1 10	77\$ 3	7051	5776	91\$ 1
	3871.1	53\$ 3	5910.1	1453.8	10\$ 5		7050	9\$ 1
5329.6	4054.6	40\$ 10		2552.7	5\$ 5	7341.1	2011.4	90\$ 2
	5328.9	60\$ 10		4635.0	85\$ 5		2884.7	10\$ 2
5363.4	4088.4	>90	6119.9	1663.6	8\$ 1	7489	2125	22\$ 4
	5362.7	<10		4844.8	78\$ 3		7487	78\$ 4
5523.3	2166.1 5	100		6119.0	14\$ 2			
5641.2	2283.9 7	23\$ 3	6345.1	2987.7 9	100			

† From Adopted Gammas, except otherwise noted.

‡ 1972Ho52 quote from literature.

§ From 1972Ho52.

Level Scheme

Intensities: % photon branching from each level

$^{21}\text{Ne}(n,\gamma)$ E=thermal 1971Be34,1986Pr05

Based on the compilation of Reedy and Frankel (2002Re13). The data are probably incomplete.

Other references: 1977Ri14, 1970Se14, 1968Jo09.

1971Be34: $^{21}\text{Ne}(n,\gamma)$, E=thermal; measured E_γ , I_γ .

1986Pr05: 99.99% pure natural target of neon gas, E=thermal; measured E_γ , I_γ using. Pair spectrometer.

 ^{22}Ne Levels

E(level) [†]	Jπ [†]	Comments
0.0	0+	
1274.537 7	2+	
3357.2 5	4+	
4456.2 9	2+	
5523.3 6	(4)+	
5910.1 9	3-	
6345.1 10	4+	
(10364.26 4)	(2+)	E(level),Jπ: Level energy from S ₁ (²² Ne) in 2012Wa38 and Jπ from 2006MuZX.

† From Adopted Levels, except otherwise noted.

$^{21}\text{Ne}(\text{n},\gamma)$ E=thermal 1971Be34,1986Pr05 (continued) $\gamma(^{22}\text{Ne})$

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\# @}$
1274.537 7	1274.537	100 10
2082.6 5	3357.2	61 10
2166.1 5	5523.3	46 12
2987.7 9	6345.1	47 12
3181.4	4456.2	26 9
4018.8 §	(10364.26)	50 8
4635.0	5910.1	23 9
4840.4 §	(10364.26)	21 8
9087.79 ‡ 25	(10364.26)	16 8

† From Adopted Gammas, except otherwise noted.

‡ From 1986Pr05.

§ From level energy differences, recoil energy subtracted.

From 1971Be34, except otherwise noted. Uncertainty estimated by evaluator (2005Fi16).

@ Absolute intensity per 100 neutron captures.

Level Scheme

Intensities: relative I_{γ}

$^{21}\text{Ne}(\text{n},\gamma)$: Res 2014He25

95.4% enriched ^{21}Ne gas target in stainless steel cylinder at 150 atmospheric pressure. Neutrons were produced from $^7\text{Li}(\text{p},\text{n})^7\text{Be}$ reaction with a pulsed proton beam of 1.0 ns width and a variable repetition rate of 1 MHz and 250 MHz for the capture and transmission runs. E=5 to 800 keV. Neutrons were detected using two C_6D_6 liquid scintillation detectors, neutron energy resolution was 0.2 and 1.5 keV at 20 and 200 keV, respectively. Neutron capture events were detected using the C_6D_6 detectors in combination with the pulse height weighting technique. The resonances in the capture cross sections were identified and analyzed using the multilevel R-matrix code SAMMY.

 ^{22}Ne Levels

E(level) [†]	$J\pi^{\ddagger}$	$L^{\ddagger}$	Comments
10416.4 3	4	2	Resonance energy = 52.1 keV 3.
10462.5 5	4	2	Resonance energy = 98.2 keV 5.
10501.6 3	4	2	Resonance energy = 137.3 keV 3, $\Gamma_{\gamma}=1.56$ eV 21.
10544.9 4	2	0	Resonance energy = 180.6 keV 4, $\Gamma_{\gamma} < 0.24$ eV.

† Deduced by evaluator using $\text{Sn}(^{22}\text{Ne})=10364.26$ 4 (2012Wa38) and reported resonance energy in 2014He25.

‡ From capture cross section fittings using the multilevel R-matrix code SAMMY.

$^{21}\text{Ne}(\text{d,p})$ 1972Ne11 $J\pi(^{21}\text{Ne})=3/2+$. $^{21}\text{Ne}(\text{d,p})$, $E=12$ MeV, measured $\sigma(\text{Ep},\theta)$. Magnetic spectrometer.

Other references: 1969Ch21, 1970Ho19, 1972Ch15, 1972He24, 1975Ch26, 1976Qu01.

 ^{22}Ne Levels

E(level)	L	E(level)	L	E(level)	L
0.0	2	6644 10	2	8079 10	2
1275 10	2	6821 10	0	8141 10	2
3358 10	2	6858 10	0	8387 10	
4458 10	0+2	7055 10	1	8504 10	0
5152 10		7341 10	2	8548 10	2
5331 10	0+2	7402 10	1	8585 10	0+2
5359 10	0	7488 10	1	8736 10	1
5516 10	2	7630 10	0+2	8859 10	2
5638 10	2	7658 10	1	8903 10	1
6120 10		7722 10	1	9042 10	
6350 10		7927 10	0+2	9097 10	1

 $^{22}\text{Ne}(\gamma,\gamma')$ 1984Be26,1979Be101984Be26: $^{22}\text{Ne}(\gamma,\gamma)$, (pol γ,γ), $E=22$ MeV.1979Be10: $^{22}\text{Ne}(\gamma,\gamma)$, $E<18$ MeV. Enriched target, measured $E\gamma$, $\sigma(\gamma\gamma)$. **^{22}Ne Levels**

E(level) [†]	$J\pi$ [†]	$T_{1/2}$ [‡]	Comments
0.0			
1274.6			E(level): From Adopted Levels.
5326.2 13	1+	1.8 fs 7	$\Gamma_{\gamma 0}=0.25$ eV 10 (1984Be26). $T_{1/2}$: Other: 1.8 fs +12-6 (1979Be10).
6853.4 19	1+	0.38 fs 16	$\Gamma_{\gamma 0}=1.7$ eV 7 (1984Be26). $T_{1/2}$: Other: 0.21 fs +17-6 (1979Be10).
8561.4 19	(1,2)+	0.35 fs 13	$\Gamma_{\gamma 0}=1.3$ eV 5 (1984Be26). E(level), $T_{1/2}$: Other values: 8553 keV 3, 0.35 fs +24-10 (1979Be10).
9178 3	1+	84 as 3	$\Gamma_{\gamma 0}=5.4$ eV 2 (1984Be26). E(level), $T_{1/2}$: Other values: 9165 keV 3, 83 as +41-21 (1979Be10).
10203 4		41 as 14	$\Gamma_{\gamma 0}=9.4$ eV 33 (1979Be10). E(level): From 1979Be10. $T_{1/2}$: 1979Be10 report 41 as +23-11.

[†] From 1984Be26, except as noted. $J\pi$ assignments are from M1 strengths, determined using polarized and unpolarized bremsstrahlung beam.[‡] Deduced from $\Gamma_{\gamma 0}$ (1984Be26, 1979Be10) and Adopted γ -ray properties. **$\gamma(^{22}\text{Ne})$**

E(level)	$E\gamma$ [†]	$I\gamma$
5326.2	5325.5	100
6853.4	5578.1	27 8
	6852.3	100 8
8561.4	8559.6	100
9178	9176	100
10203	8926	19
	10200	100

[†] Calculated by evaluator from level energy differences, recoil energy subtracted.

$^{22}\text{Ne}(\text{e},\text{e}')$ 1974Ma43,1979Ma13 (continued) $\gamma(^{22}\text{Ne})$

E(level)	$E\gamma^\dagger$	$I\gamma^\ddagger$	Mult.§	$\delta^\S$	Comments
1275	1275	100	E2		
4460	3185	100.0 2			
	4460	3.1 2	E2		
5310	4035	50 12	M1+E2	+1.9 5	
	5309	100 12	M1		
6140	1680	10.25 13	M1+E2	+1.1 3	
	4864	100 4	M1+E2	+2.3 3	
	6139	18 3	E2		Mult.: From B(E2).
6820	2360	100 16	M1+E2	+2.5 4	
	5544	70 16	M1		
7650	3190	42 5			
	6374	100 5	M1+E2	-0.08 5	
	7649	12 5	E2		

 † Calculated from level energy differences, recoil energy subtracted. ‡ Placement and branching from Adopted Gammas. § From Adopted Gammas, except otherwise noted.

Level Scheme

Intensities: relative photon branching
from each level **$^{22}\text{Ne}(\text{p},\text{p}')$ 1987Wi03** $^{22}\text{Ne}(\text{p},\text{p}')$ $E_p=201$ MeV.

Other references: 1969Hu02, 1972De18, 1974De46, 1976De12.

 ^{22}Ne Levels

E(level)	$J\pi^\ddagger$	$(d\sigma/d\Omega)_{\text{exp}} (\mu\text{b/sr})^\dagger$
0.0		
6860 10	1+	381 32
8890 10		197 20

Continued on next page (footnotes at end of table)

$^{22}\text{Ne}(\text{p},\text{p}')$ 1987Wi03 (continued) **^{22}Ne Levels (continued)**

E(level)	$J\pi^{\dagger}$	$(\text{d}\sigma/\text{d}\Omega)_{\text{exp}} (\mu\text{b}/\text{sr})^{\dagger}$
9180 10	1+	1860 120
10890 10	1+	266 26
11870 50	1+	101 19
12000 10	1+	224 27
13460 10		90 23
13890 20		77 20
14060 20		95 18
14450? 30		90 25
15580 40		185 36
16510 10		132 25

 † Measured at 4° . ‡ Deduced from $\sigma(\theta)$ and DWIA calculations.**Coulomb Excitation**1960An07: $^{22}\text{Ne}(^{14}\text{N}, ^{14}\text{N})$, $E=25.2$ MeV.1970Na07: $^{120}\text{Sn}, ^{130}\text{Te}, ^{148}\text{Sm}(^{22}\text{Ne}, ^{22}\text{Ne}')$ $E=50-75$ MeV.1974O101: $^{197}\text{Au}, \text{Pt}(^{22}\text{Ne}, ^{22}\text{Ne}')$ $E=80,91$ MeV.1977Sc36: $^{22}\text{Ne}(^{32}\text{S}, ^{32}\text{S}')$ $E=41.3-51$ MeV.2012Bo09: $^{208}\text{Pb}(^{22}\text{Ne}, ^{22}\text{Ne}\gamma)$ – Target= ^{208}Pb (thickness – $300 \mu\text{g}/\text{cm}^2$) sandwiched between two layers of 10 and 15 $\mu\text{g}/\text{cm}^2$ ^{12}C . Projectile: ^{22}Ne beam, $E=128$ MeV. γ -ray array CLARA consisting of 21 HPGe clover detectors. Measured $E\gamma$, (particle) γ -coin, deduced deformation parameters. **^{22}Ne Levels**

E(level)	$J\pi^{\dagger}$	$T_{1/2}$	Comments
0.0	0+		
1275	2+	3.75 ps 8	$T_{1/2}$: From $B(E2)\uparrow=0.0223$ 6 (1977Sc36). Other values: 2.0 ps 2 from $B(E2)\uparrow=0.042$ 4 (1960An07), 2.6 ps 5 from $B(E2)\uparrow=0.033$ 6 (1970Na07), and 3.4 ps 3 from $B(E2)\uparrow=0.025$ 2 (1974O101). $\beta_2=0.370$ deduced from $\sigma(\theta)$ of ^{22}Ne ions and analyzed by DWBA calculations (2012Bo09).

 † From Adopted Levels. **$^{23}\text{Na}(\text{d}, ^3\text{He})$ 1971Ar08** $^{23}\text{Na}(\text{d}, ^3\text{He})$ $E=80$ MeV.

Other: 1976Sa26.

 ^{22}Ne Levels

E(level)	L	C^2S
0.0	2	0.1
1320 50	2	1.4
3300 50	2	0.37
4470 70	0+2	0.2
5200 100	1	1.7
5750 100	1	0.8
6750 100	1	1.6

$^{23}\text{Na}(t,\alpha)$ 1990En08

From private communication from Hinds, Marchant, and Middleton (Aldermaston) listed in 1978En02. No details are available.

 ^{22}Ne Levels

E(level)	Comments
0.0	
1277? 20	E(level): Calibration energy.
3360 20	
4460 20	
5150 20	
5350 20	
5360 20	
5520 20	
5640 20	
5900 20	
6100 20	
6300 20	
6330 20	
6640 20	
6680 20	
6800 20	
6840 20	
6890 20	
7040 20	
7320 20	
7330 20	
7400 20	
7430 20	
7470 20	
7490 20	

 $^{26}\text{Mg}(d,^6\text{Li})$ 1981Ve05,1980Oe01

1981Ve05: $^{26}\text{Mg}(d,^6\text{Li})$ E=55 MeV. Magnetic spectrograph, enriched targets.
 Others: 1980Oe01: $^{26}\text{Mg}(d,^6\text{Li})$ E=80 MeV. Magnetic spectrograph, enriched targets, 1976Co15.

 ^{22}Ne Levels

E(level) [‡]	$J\pi^{\#}$	$S^{\dagger}$	E(level) [‡]	$J\pi^{\#}$	$S^{\dagger}$	E(level) [‡]	$J\pi^{\#}$	$S^{\dagger}$
0.0	0+	1.00	6233 §	0+	0.15	7700 200	3-	0.09
1273 §	2+	0.86	6340 7	4+	0.17	7920 10	(2)+	0.07
3365 7	4+	0.12	6620 200	(3,4)+		8134 10	2+	0.13
4460 §	2+	0.14	6676 7	1-	0.23	8370 200	(3)-	
5142 §	2-		6818 §	2+	0.13	8452 7		0.75
5359 7	2+	0.22	6886 10	0+		8573 10		
5520 §	(4)+	0.87	7080 200	1-	0.06	8724 10	(3)-	0.13
5629 10	3+		7320 200	0+		9042 7		
5908 §	3-	1.45	7397 7	(3)-	2.66	9229 10		
6113 10	2+	0.09	7623 10	2+	0.14	9490 200		

[†] Spectroscopic amplitude for the α -pickup reaction normalized to 1.0 for the ground state from 1981Ve05.

[‡] From 1981Ve05.

§ Used for energy calibration.

From Adopted Levels.

$^{26}\text{Mg}(^3\text{He}, ^7\text{Be})$ 1976St11 $^{26}\text{Mg}(^3\text{He}, ^7\text{Be})$ E=70 MeV. Magnetic spectrograph. ^{22}Ne Levels

<u>E(level)</u>	<u>E(level)</u>	<u>E(level)</u>
0 . 0	5570 160	8300 270
1270 30	6000 170	8750 350
3350 40	6420 170	9150 400
4470 50	7500 2000	9820 750

 $^{150}\text{Nd}(^{26}\text{Mg}, ^{22}\text{Ne}\gamma)$ 2005Ke08,2005Ke11

2005Ke08,2005Ke11: ^{26}Mg beam, E=160 MeV, bombarded onto a ^{150}Nd target of thickness 0.4 mg/cm², deep-inelastic and multi-nucleon transfer reaction; γ rays were detected using an array of 26 Ge clover detectors, 15 Ge cluster detectors, and a BGO array; measured $E\gamma$, $\gamma\gamma$ coin, deduced level scheme.

 ^{22}Ne Levels

<u>E(level)[†]</u>	<u>Jπ[‡]</u>
0 . 0	0+
1275 . 0 10	2+
3358 . 2 13	4+
4456 . 2 13	2+
5523 . 3 17	4+
6312 . 4 17	6+
7341 . 6 17	(3, 4)+
7423 . 4 20	(5+)
11033 . 9 20	(8+, 6+)

[†] From least-squares fit to γ -ray energies, assuming $\Delta E=1$ keV.[‡] From Adopted Levels. $\gamma(^{22}\text{Ne})$

<u>Eγ</u>	<u>E(level)</u>
1098	4456 . 2
1275	1275 . 0
1900	7423 . 4
2083	3358 . 2
2165	5523 . 3
2954	6312 . 4
3181	4456 . 2
3983	7341 . 6
4721	11033 . 9

$^{150}\text{Nd}(^{26}\text{Mg}, ^{22}\text{Ne}\gamma)$ 2005Ke08,2005Ke11 (continued)

Level Scheme

Adopted Levels, Gammas

Q(β⁻)=-4781.6 3; S(n)=11068.2 3; S(p)=6738.71 18; Q(α)=-8479.6 5 2012Wa38.

²²Na Levels

Cross Reference (XREF) Flags

A ²² Mg β ⁺ Decay	F ²⁰ Ne(³ He,p),(³ He,pγ)	K ²¹ Ne(³ He,d)
B ²³ Al β ⁺ p Decay	G ²⁰ Ne(α,d)	L ²² Ne(³ He,t)
C ¹⁰ B(¹⁶ O,α)	H ²⁰ Ne(⁶ Li,α)	M ²³ Na(³ He,α)
D ¹² C(¹⁴ N,α),(¹⁴ N,αγ)	I ²¹ Ne(p,γ)	N ²⁴ Mg(p, ³ He)
E ¹⁹ F(α,n),(α,nγ)	J ²¹ Ne(p,p),(p,p')	O ²⁴ Mg(d,α)

E(level) [†]	Jπ	XREF	T _{1/2} [#]	Comments
0.0	3+	ABCDEFGHI KLM O	2.6018 y 22	μ=+1.746 3; Q=+0.180 11; %ε+%β ⁺ =100. μ: From 2013StZZ, 2014StZZ – Adjusted by tabulator – β-NMR. Other: +0.185 11 – Atomic beam laser spectroscopy (1998Ga44, 2014StZZ). T _{1/2} : From 950.3 d 8: Weighted average of 957 d 7 (1961Wy01), 954 d 4 (1965An07), 950.7 d 4 (1965An07), 950 d 4 (1965An07), 950.34 d 13 (1980Ho17), 950.25 d 11 (1980RuZX, replaced by 1982RuZV), 950.30 d 25, (1982RuZV), 950.1 d 7 (Updated NIST value in 2014Un01 – earlier value 950.97 d 15 in 2002Un02). Other values: 946.3 d 11 (1965An07), 951.71 d 11 (1982HoZJ, replaced by 1992Un01). 2008Li02 and 2006Li34 report 0.46% 14 and 1.2% 14 shorter β+ half-lives measured in implanted Pd at 15K and 12K, respectively, compared with values measured at room temperatures. However, 2008Ru05 reports no difference at the 0.04% level, measured in implanted Al at 10K and room temperatures. A half-life value of 2.57 y 13 at room temperature is reported (2008Ru05). Jπ: Atomic beam measurement (1949Da14), L=2 in (³ He,α), Unnatural parity (pol d,α).
583.05 10	1+	ABCDEFGHI KLM O	243 ns 2	μ=+0.535 10. μ: From Time Dependent Perturbed Angular Distribution (1966Su07). +0.523 11 in 1989Ra17. Jπ: log ft=3.64 from 0+, L=0+(2) in (³ He,p), L=2 in (³ He,α), unnatural parity (pol d,α). T _{1/2} : From 1966Su07. Other value: 266 ns 10 (1958Te15). T=1.
657.00 14	0+	A DEF I KLM O	19.6 ps 7	Jπ: L=0 in (³ He,p), natural parity (pol d,α), L=2 in (³ He,α).
890.89 20	4+@	BCDEFGHI KLM O	10.0 ps 3	Jπ: L=2 in (³ He,α). Natural parity (pol d,α).
1528.1 3	5+@	DEFGHI KLM O	3.42 ps 24	Jπ: M1+E2 γ to 4+, unnatural parity (pol d,α).
1936.9 2	1+	A DEFGHI K MNO	13 fs 4	Jπ: log ft=3.46 from 0+, unnatural parity (pol d,α). T _{1/2} : From mean lifetime 19 fs 6: weighted average of 29 fs 5 (1967Wa13) and 16 fs 3 (1978Bi11). T=1.
1951.8 3	2+	C EF I K O	8 fs 2	Jπ: From isotopic-spin analog state in ²² Ne (1967Wa13). Natural parity (pol d,α).
1983.5 5	3+	CDEF HI K M O	1.47 ps 15	Jπ: L=2 in (³ He,α), L=4 in (³ He,p), E2 γ to 1+, γ to 4+. Unnatural parity (pol d,α).
2211.4 3	1-	DEF HI KLM O	14.9 ps 6	μ=0.36 7. μ: From 1976Be06. Jπ: L=1 in (³ He,α), L=(1) in (³ He,p). γ to 0+. Natural parity (pol d,α).
2571.5 3	2-	DEFGHI KLMNO	5.0 ps 6	Jπ: L=1 in (³ He,α), γ transition to 1+ and 3+, unnatural parity (pol d,α).
2968.6 6	3+	DEFGHI KLMNO	32 fs 4	Jπ: L=2 in (³ He,p), L=(2) in (³ He,α), M1+E2 γ to 2+, unnatural parity (pol d,α).
3059.4 6	2+	DEF HI K M O	23 fs 3	Jπ: L=0+2 in (³ He,d); M1+E2 γ to 1+; Natural parity (pol d,α).
3519.1 4	(3-)	DEF HI KLM O	465 fs 76	Jπ: L=(3) in (³ He,p); M1+E2 γ to 2-, γ to 4+. Natural parity (pol d,α).
3706.7 4	6+	CDEFGH KL O	59 fs 12	E(level),Jπ: From angular correlation, linear polarization measurements of 2815γ (α,n),(α,nγ) (1973Ma23, 1977Ha11). Natural parity (pol d,α).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{22}Na Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [#]	Comments
3941.9 9	1+	DEFGHI KLMNO	<0.7 fs	J π : L=0+2 in (^3He ,d), L=0 in (^3He , α), unnatural parity (pol d, α).
4071.4 6	4+ [@]	DEF I KLM O	<0.7 fs	T=1. J π : L=2 in (^3He , α) and (^3He ,d); γ to 3+, 5+; natural parity (pol d, α).
4296.2 4	(0-)	DEF I	3.5 ps +8-2	J π : γ 's to 2-, 1+, unnatural parity (pol d, α).
4319.0 5	1+	DEF HI K M O	17 fs 10	J π : L=0+(2) in (^3He ,p); Unnatural parity (pol d, α).
4360.0 4	2+	DEF HI K M O	5.0 fs 14	J π : L=0+(2) in (^3He ,p); Natural parity (pol d, α).
4468.7 4	(4-)	EFGH K M O	100 fs 38	J π : γ 's to 2-, 3+, and 5+; Unnatural parity (pol d, α).
4523.9 5	(5+)	CDEF H K M O	71 fs 33	J π : Weakly populated in one and two nucleon transfer (indication for high spin), strongly populated in (^{16}O , α) and consistent with Hauser-Feshbach prediction for spin-parity 7+ (discussion in 1975Sp02); 2995.8 γ to 5+; Unnatural parity in (pol d, α). T _{1/2} : From mean lifetime of 103 fs 48, weighted average of 55 fs 20 (1976Ma23), 115 fs 45 (1973Fr18), and 160 fs 23 (1977Ev02) using the Limitation of Relative Statistical Weight (LWM) averaging method (1985ZiZY).
4583 2	2-	DEF HI K M O	<69 ps	J π : L=1 in (^3He , α); unnatural parity (pol d, α); γ to 3+.
4622 2	1	DEF HI K M O	<69 ps	J π : Dipole transition to 0+.
4710.0 4	(5+)	CDEFGHI K M O	37 fs 14	J π : L=(4) in (^3He ,p); unnatural parity (pol d, α); γ to 3+, 4+.
4770 2	3+	D F HI K M O	5.9 ps 14	E(level): From (^3He ,p γ). J π : L=2 in (^3He ,d); 3+ from (pol d, $\alpha\gamma$) measurements in 1977Ku02.
5062.5 4	(2+)	DEF HI K MNO	<14 fs	J π : L=0+2 in (^3He , α); M1 γ 2+.
5100.4 13	4+	CDEFGH K M O	38 fs 12	J π : γ to 2+, 3+, 4+, 5+. Possible 3+ discarded based on linear polarization measurement of the 2041 γ (1976Ma23).
5130 7		EF K O	<69 ps	E(level): Weighted average of 5132 keV 10 (1964Hi05) and 5130 keV 10 (1971Ga04).
5174 $\frac{1}{2}$ 2	1+, 2+	D F I K M	<1 fs	T=1. J π : L=0+2 in (^3He , α), γ from 3+.
5318 5	(3+)	FGHI K M O	<0.7 fs	J π : L=2(+0) in (^3He ,d); Unnatural parity (pol d, α). E(level): Weighted average of 5317 15 (1964Hi05), 5317 7 (1971Ga04), and 5322 10 (1971Ga22).
5442 5		D F M O		E(level): Weighted average of 5440 7 (1971Ga04), 5436 10 (1971Ga22), 5446 10 (1964Hi05), 5448 10 (1978Ha29).
5603 $\frac{1}{2}$ 2	(1, 2)+	D FGHI K M O	<3 fs	J π : L=0+2 in (^3He , α).
5700 2		I		
5725 $\frac{1}{2}$ 2		I K M		
5739 $\frac{1}{2}$ 2	1+	D F HI K M O		J π : L=0+(2) in (^3He ,p), γ from 3+.
5832 6		F H M O		E(level): Weighted average of 5837 10 (1964Hi05), 5830 7 (1971Ga04), 5828 20 (1971Ga22).
5863 6	(1, 2)+	D F H M O		E(level): Weighted average of 5871 10 (1964Hi05), 5858 10 (1971Ga04), 5865 10 (1971Ga22), 5858 10 (1978Ha29).
5922 6		D F H NO		J π : L=0+2 in (^3He , α). E(level): Weighted average of 5938 15 (1964Hi05), 5918 7 (1971Ga04).
5959 $\frac{1}{2}$ 2	2-	F I M	2.9 fs 8	T=1. J π : L=1 in (^3He , α), γ 's to 1+, 3+.
5988 $\frac{1}{2}$ 2		I		
5995 $\frac{1}{2}$ 2	(1, 2)+	D F HI M O		T=(1). J π : L=0+2 in (^3He ,d); L=2 in (^3He , α), γ to 1+.
6090 5	(1, 2)+	D F H M O		T=(1). E(level): Weighted average of 6089 10 (1964Hi05), 6088 7 (1971Ga04), 6074 20 (1971Ga22), 6097 10 (1978Ha29).
6189 5	(0 to 4)+	D F H M O		J π : L=0+2 in (^3He , α). T=(1). E(level): Weighted average of 6190 15 (1964Hi05), 6185 7 (1971Ga04), 6183 10 (1971Ga22), 6196 10 (1978Ha29). Possible doublet.
6242 5		D FGH M O		J π : L=2 in (^3He ,d); (2) in (^3He , α). E(level): Weighted average of 6241 15 (1964Hi05), 6247 7 (1971Ga04), 6236 10 (1971Ga22), 6240 10 (1978Ha29).

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Adopted Levels, Gammas (continued) ^{22}Na Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [#]	Comments
6329 5	(0 to 3)-	D F MNO		T=(1). E(level): Weighted average of 6329 15 (1964Hi05), 6326 7 (1971Ga04), 6324 10 (1971Ga22), 6339 10 (1978Ha29). J π : L=1 in (^3He ,d).
6433 5		D F H M O		E(level): Weighted average of 6435 10 (1964Hi05), 6437 7 (1971Ga04), 6429 10 (1971Ga22), 6428 10 (1978Ha29).
6523 6		F M O		E(level): Weighted average of 6528 10 (1964Hi05), 6521 7 (1971Ga04).
6551 5	(1,2)+	D F H M O		T=1. E(level): Weighted average of 6556 15 (1964Hi05), 6557 7 (1971Ga04), 6543 10 (1971Ga22), 6445 10 (1978Ha29). J π : L=0+2 in (^3He ,d).
6580 6		D F M O		E(level): Weighted average of 6591 15 (1964Hi05), 6582 7 (1971Ga04), 6594 20 (1971Ga22), 6565 15 (1978Ha29).
6636 8		D FGH M O		E(level): Weighted average of 6640 10 (1964Hi05), 6641 20 (1971Ga22), 6625 15 (1978Ha29).
6668 5		D M		E(level): Weighted average of 6671 15 (1964Hi05), 6664 7 (1971Ga04), 6674 10 (1971Ga22), 6667 15 (1978Ha29).
6714 5		F H M O		E(level): Weighted average of 6713 15 (1964Hi05), 6715 7 (1971Ga04), 6711 10 (1971Ga22).
6756 6		D F H M O		E(level): Weighted average of 6752 15 (1964Hi05), 6750 7 (1971Ga04), 6770 20 (1971Ga22), 6780 15 (1978Ha29).
6834 7	(0+,1+)	F		T=(1). J π : L=0 in (^3He ,p).
6859.3 $\frac{1}{2}$ 6	1,2+	D F HI M O	<12 eV	J π : γ 's to 0+ and 2+. 1982Go11 proposed J π =1,2 or 3-. J π =3- is unlikely if γ ray feeding to 0+ is correct.
6957 6		F M O		T=(1). E(level): Weighted average of 6952 10 (1964Hi05), 6961 7 (1971Ga04), 6949 20 (1971Ga22).
6981 15		D		T=(1).
6997.1 $\frac{1}{2}$ 4		F HI MN	<5 eV	
6998.1 $\frac{1}{2}$ 4		I	<3 eV	
7016.4 $\frac{1}{2}$ 4		G I O	<11 eV	
7049 15		D		
7074.9 $\frac{1}{2}$ 4		F I M O	<0.1 keV	
7152 $\frac{1}{2}$ 4	3+,4+	D F I M O	<0.5 keV	J π : γ 's to 2+ and 5+.
7220 $\frac{1}{2}$ 2	1+,2,3+	D Fghi MNO	<0.4 keV	T=0. J π : γ 's to 1+ and 3+.
7240 $\frac{1}{2}$ 2	2+,3,4+	D F I O	<0.3 keV	J π : γ 's to 2+ and 4+.
7278 3	1,2+	I	<0.5 keV	T=(1). J π : γ 's to 0+ and 2+.
7279 $\frac{1}{2}$ 3		D F HI M	<1.5 keV	T=(1).
7360 $\frac{1}{2}$ 3	3+,4	F HI M O	<1.0 keV	J π : γ 's to 3+, 3-, and 5+.
7372 2	2	I	<0.5 keV	J π : γ 's to 1+, 1-, 3+, and 3-.
7378 $\frac{1}{2}$ 1	2+,3+	D I	<0.5 keV	J π : γ 's to 1+ and 4+.
7401 $\frac{1}{2}$ 2	1+,2+	HI M	<1.5 keV	J π : γ 's to 0+ and 3+.
7408.6 $\frac{1}{2}$ 5	1+	D F IJ O	3.5 keV 6	T=1. J π : L=0 in (p,p),(p,p'). J π =2+ excluded from non-interference with the E _p =768 keV (resonance state 7471 keV) (1983Go21).
7423 3	2	I	2.5 keV 5	J π : γ 's to 1-, 1+, and 3+.
7471.7 $\frac{1}{2}$ 12	(2+)	G IJ	3.5 keV 6	T=1. J π : L=0 in (p,p),(p,p'). M1+E2 γ 's to 1+ and 3+.
7515.2 $\frac{1}{2}$ 10	(3+)	F HI M O	<0.5 keV	T=0. J π : γ 's to 2+ and 4+.
7547.0 $\frac{1}{2}$ 10		F I O	<0.6 keV	T=1.
7573.5 $\frac{1}{2}$ 10	3+,4,5+	D F HI O	<0.5 keV	J π : γ 's to 3+ and 5+.
7599 $\frac{1}{2}$ 3	(2-)	D F IJ	1.9 keV 10	J π : L=1 in (p,p),(p,p'). γ 's to 1+ and 3+.
7605 $\frac{1}{2}$ 2	1+,2+	F I O	<0.6 keV	J π : γ 's to 0+ and 3+.
7636 3	2+,3,4+	I	<0.5 keV	T=0.
7683 $\frac{1}{2}$ 3	2+,3,4+	D F I O	<0.5 keV	J π : γ 's to (1+,2+) and 4+.

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Adopted Levels, Gammas (continued) ^{22}Na Levels (continued)

E(level) [†]	J π	XREF			T _{1/2} [#]	Comments
7778.2 $\frac{1}{2}$ 10	(1 to 3)-		IJ		2.8 keV 7	J π : L=1 in (p,p),(p,p'). T=(1).
7800.6 $\frac{1}{2}$ 10	(1,2)+	F	IJ		2.4 keV 7	T=0. J π : L=0 in (p,p),(p,p').
7821.1 $\frac{1}{2}$ 10	1+,2+	D	I	O	<0.5 keV	T=0. J π : γ 's to 0+ and 3+.
7883.7 $\frac{1}{2}$ 9		D	FG	I	<2.6 keV	T _{1/2} : No gammas observed.
7889.1 $\frac{1}{2}$ 11	4+		IJ		<0.5 keV	J π : L=2 in (p,p),(p,p'); M1+E2 to 3+ and 5+. T=(1).
7919 $\frac{3}{2}$ 2	2-		IJ		17 keV 4	T=1. J π : Assignment in 1977Ke04 (p, γ) based on γ feedings to 1-,2-,2+,3+. L=1 in (p,p),(p,p'). 1975Ch15 assigns J π =1- with a note for doublet.
7943 6		D	F			E(level): Weighted average of 7942 7 (1971Ga04), 7947 15 (1978Ha29).
7965 $\frac{3}{2}$ 2	0,1,2,3+	F	I		<0.5 keV	J π : γ to 1+. T=(1).
7977 $\frac{3}{2}$ 2	(1 to 3)-		IJ		10 keV 3	T=(1). J π : L=1 in (p,p),(p,p').
8018 $\frac{3}{2}$ 4	4+,5+	D	F	I	<1.0 keV	J π : γ 's to 3+ and 6+.
8041 2	2+,3,4+		I		<0.5 keV	J π : γ 's to 2+ and 4+.
8101 $\frac{1}{2}$ 4	1+,2+	F	IJ		3.8 keV 7	J π : L=0 in (p,p),(p,p'); γ 's to 0+ and 3+.
8108 2	3+,4		I		<1.5 keV	T=1. J π : γ 's to 3+, 3-, and 5+.
8114 $\frac{1}{2}$ 2	3-		G	IJ	3.5 keV 12	J π : L=1 (p,p),(p,p'); γ 's to 2+ and 4+.
8128 8		D	F			E(level): Weighted average of 8128 10 (1971Ga04), 8128 15 (1978Ha29).
8165 $\frac{3}{2}$ 2	3-	F	IJ		35 keV 10	T=1(+0). J π : L=1 (p,p),(p,p'); γ 's to 2+ and 4+.
8197 $\frac{3}{2}$ 4	2+,3+	F	I		<0.6 keV	J π : γ 's to 1+ and 4+.
8211 $\frac{1}{2}$ 2	1+,2+		IJ		10 keV 4	T=0. J π : L=0 in (p,p),(p,p'); γ 's to 2+ and 3+.
8221 4	4+,5,6+	D			<21 fs	J π : γ 's to 4+ and 6+. T _{1/2} : From ($^{14}\text{N},\alpha$),($^{14}\text{N},\alpha\gamma$).
8234 $\frac{1}{2}$ 2	1+,2+		IJ		13 keV 3	T=1. J π : L=0 in (p,p),(p,p'); γ 's to 1+ and 3+.
8288 $\frac{1}{2}$ 2	(1 to 3)-		IJ		4.5 keV 10	Γ_p =2 keV. J π : L=1 in (p,p),(p,p').
8328 $\frac{1}{2}$ 2	1-,2-	F	IJ		2.7 keV 8	Γ_p =5 keV. J π : Assignment in 1975Ch15, L=1 in (p,p),(p,p').
8371 $\frac{1}{2}$ 2		D	F	I		
8404 $\frac{1}{2}$ 5		D	F	I		
8436 $\frac{1}{2}$ 2	(1 to 3)-		IJ		5.4 keV 15	Γ_p =8 keV. J π : L=1 in (p,p),(p,p'); γ to 1- and 3-.
8496 $\frac{1}{2}$ 2	1+,2+	F	IJ		44 keV 4	Γ_p =29 keV. J π : L=0 in (p,p),(p,p'). T=1.
8538 2	(1 to 3)-	D	F	IJ	13.2 keV 15	Γ_p <8 keV. J π : L=1 in (p,p),(p,p').
8562 $\frac{1}{2}$ 2			I			
8567 $\frac{1}{2}$ 2	(0 to 4)+		IJ			J π : L=2 in (p,p),(p,p').
8572 3		D	F		<16 fs	E(level),T _{1/2} : From 1978Ha29 - ($^{14}\text{N},\alpha$),($^{14}\text{N},\alpha\gamma$).
8602 $\frac{1}{2}$ 2	(1 to 3)-	D	F	IJ	11.2 keV 20	Γ_p =2.1 keV. J π : L=1 in (p,p),(p,p').
8613 $\frac{1}{2}$ 2		CD	I		21 fs 14	T _{1/2} : From ($^{14}\text{N},\alpha$),($^{14}\text{N},\alpha\gamma$).
8636 $\frac{1}{2}$ 2	(1 to 3)-		IJ			Γ_p =5 keV. J π : L=1 in (p,p),(p,p').
8675 $\frac{1}{2}$ 2		D	FG	I	5.3 keV 15	T=1.
8724 4		D	F		<32 fs	E(level),T _{1/2} : From 1978Ha29 - ($^{14}\text{N},\alpha$),($^{14}\text{N},\alpha\gamma$).
8740 5			I			
8792 $\frac{1}{2}$ 5		F	I			
8845 $\frac{1}{2}$ 5		F	I			
8875 $\frac{1}{2}$ 5		D	F	I		

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Adopted Levels, Gammas (continued) ^{22}Na Levels (continued)

E(level) [†]	XREF	T _{1/2} [#]	Comments
8950 10	F		
9008§ 10	CD F		
9060 3	D F	<17 fs	E(level), T _{1/2} : From 1978Ha29 – ($^{14}\text{N}, \alpha$), ($^{14}\text{N}, \alpha\gamma$).
9122§ 10	D F		
9150 10	F		
9195 10	F		
9240 10	F		
9312§ 10	CD F		
9360§ 10	FG		XREF: F(9378).
9438§ 10	D F		
9527 10	F		
9582§ 10	D F		
9647§ 10	D F		
9682§ 10	D F		
9715 13		N	
9756 10	F		
9794 10	F		
9813 3	D		
9859§ 10	CD F		
9908§ 10	D F		
9957 10	F		
10009§ 10	FG		
10051 10	F		
10118§ 10	D F		
10167 10	F		
10220	G		
10990 40	G		
11540	G		E(level): Possible doublet.
11770	G		
12200	G		
12520	G		
12620	C G		XREF: G(12800).
13370	c G		
13750	c G		

[†] Upto 5130 keV from (α, n), ($\alpha, n\gamma$), except otherwise noted.

[‡] From (p, γ).

§ From ($^3\text{He}, p$), ($^3\text{He}, p\gamma$).

From (α, n), ($\alpha, n\gamma$) or (p, γ) or weighted average of data from these two data sets, except otherwise noted.

@ From ($\alpha, n\gamma$) angular correlation (transition characteristics – 1967Wa13, 1975Sp02, 1977Ha11) and polarization (1967Po14, 1976Ma23) measurements.

 $\gamma(^{22}\text{Na})$

E(level)	E γ [†]	I γ [†]	Mult.@	δ @&	α	Comments
583.05	583.04 10	100	E2			B(E2)(W.u.)=0.00944 8.
657.00	73.9 1	100	M1		0.00359	B(M1)(W.u.)=2.77 10.
890.89	890.87 20	100	M1+E2	+3.2 3		B(M1)(W.u.)=0.00028 5; B(E2)(W.u.)=25.1 9.
1528.1	637.50 20	4.7 13	M1+E2	+2.11 15		B(M1)(W.u.)=0.00020 7; B(E2)(W.u.)=16 5.
	1528.1 2	100.0 13	E2		1.05×10 ⁻⁴	B(E2)(W.u.)=5.2 4.
1936.9	1280.5 10	100.0 13	M1			B(M1)(W.u.)=0.80 25.
	1353.8	0.28 6				E γ , I γ : From ^{22}Mg β^+ decay.
	1936.8	0.59 6	[E2]			E γ , I γ : From ^{22}Mg β^+ decay.
						B(E2)(W.u.)=2.6 9.
1951.8	1294.8	0.29 5	[E2]			B(E2)(W.u.)=15 5.
	1368.7 3	100				
1983.5	1092.6	1.3 2				
	1400.4 5	100.0 3	E2			B(E2)(W.u.)=18.9 20.
						Mult.: Possible M3 admixture ruled out by large B(M3)(W.u.).
	1983.5	1.9 3				

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult.@	$\delta^{\text{a}}\&$	α	Comments
2211.4	1554.4 3	100.0 5	E1		3.14×10^{-4}	B(E1)(W.u.)= 1.52×10^{-5} 7. Mult.: From 1967Po14, 1973Ha55 (A,N),(A,NG). B(M2)(W.u.)=0.074 11.
	2211.3	1.5 2	[M2]			
2571.5	360.1	1.6 5				
	1914.4	2.6 7	[M2]		1.13×10^{-4}	B(M2)(W.u.)=0.60 18.
	1988.8 4	29 3	E1		6.38×10^{-4}	B(E1)(W.u.)= 4.8×10^{-6} 8.
	2571.5	100 3	E1		1.01×10^{-3}	B(E1)(W.u.)= 7.6×10^{-6} 10.
2968.6	1016.8 5	100	M1			B(M1)(W.u.)=0.65 9.
3059.4	1107.6 5	100 1	M1			B(M1)(W.u.)=0.68 9. Mult.: From ($^3\text{He},p\gamma$).
	2476.2 3	3 1	M1+E2	+0.13 7	4.46×10^{-4}	B(M1)(W.u.)=0.0018 7; B(E2)(W.u.)=0.03 2.
3519.1	948.0 2	11.4 8	M1+E2	+2.1 3		B(M1)(W.u.)=0.00059 18; B(E2)(W.u.)=20 4.
	1307.7	46 2	E2			Mult.: Possible M3 admixture ruled out by large B(M3)(W.u.). B(E2)(W.u.)=20 4.
	1566.8 2	100 6	E1		3.24×10^{-4}	B(E1)(W.u.)=0.00024 5.
	2628.0	14 4	[E1]			B(E1)(W.u.)= 7.2×10^{-6} 24.
	3518.8	28 6	E1+M2	-0.19 3	1.46×10^{-3} 2	B(E1)(W.u.)= 5.8×10^{-6} 16; B(M2)(W.u.)=0.08 4.
3706.7	2176.5 10	39 9	M1+E2	+6 3	4.01×10^{-4} 9	δ : From 1977Ha11 (α,n),($\alpha,n\gamma$). B(M1)(W.u.)=0.0003 2; B(E2)(W.u.)=15 5.
	2815.8 3	100 9	E2		7.05×10^{-4}	B(E2)(W.u.)=11 3.
3941.9	1990.0	7 1				
	3284.9 9	100 1	D			Mult.: From ($^3\text{He},p$),($^3\text{He},p\gamma$).
4071.4	2088.2 5	$100^{\pm} 2$	M1		2.83×10^{-4}	B(M1)(W.u.)>3.0.
	2543.3	$12.6^{\pm} 14$				
	4071	$3.7^{\pm} 6$				
4296.2	1724.7 2	$67^{\S} 17$	[E2]			B(E2)(W.u.)=1.2 +4-5.
	2359.3	$100^{\S} 17$	[E1]			B(E1)(W.u.)= 1.1×10^{-5} +3-4.
4319.0	3662.0	$100^{\S}$	M1		9.06×10^{-4}	B(M1)(W.u.)=0.026 16.
4360.0	2408.1 3	$100^{\S} 5$	M1		4.15×10^{-4}	B(M1)(W.u.)=0.24 7.
	3777.0	$8^{\S} 4$	M1 (+E2) $\S$	$\ddagger$		
	4360.0	$24^{\S} 4$				
4468.7	1897.2 3	100 6	(E2)		2.68×10^{-4}	B(E2)(W.u.)=41 17.
	2485.1	14 5	[E1]			B(E1)(W.u.)= $5. \times 10^{-5}$ 3.
	2940.4	21 5	[E1]			B(E1)(W.u.)= 4.7×10^{-5} 22.
	3577.5	17 5	[E1]			B(E1)(W.u.)= 2.1×10^{-5} 11.
4523.9	2995.8 4	100	M1 (+E2)		0.00072 7	
4583	2631	$100^{\S} 14$				
	4583.7	$43^{\S} 14$				
4622	2670	$100^{\S} 20$				
	3965	$67^{\S} 20$	D			Mult.: From ($^3\text{He},p$),($^3\text{He},p\gamma$).
4710.0	638.6	83 6	M1			B(M1)(W.u.)=1.0 4.
	1741.3	10 2	E2		1.96×10^{-4}	δ : Possible M3 admixture ruled out by large B(M3)(W.u.). B(E2)(W.u.)=14 6.
	2726.0 4	100 4	E2		6.64×10^{-4}	B(E2)(W.u.)=14 6. δ : Possible M3 admixture ruled out by large B(M3)(W.u.).
4770	2818	100	M1		5.85×10^{-4}	B(M1)(W.u.)=0.00017 4.
5062.5	3110.6 4	100	M1		7.01×10^{-4}	B(M1)(W.u.)>0.052. Mult.: From ($^3\text{He},p$),($^3\text{He},p\gamma$).
5100.4	1029.0	100 9	[M1]			B(M1)(W.u.)=0.20 7.
	2039.1	49 6	(E2)		3.37×10^{-4}	B(E2)(W.u.)=21 8.
	3573.3	32 6				
	4209.1	41 14	M1+E2	>1		Mult., δ : (α,n),($\alpha,n\gamma$). B(M1)(W.u.)<0.00086; B(E2)(W.u.)>0.12.
	5101.0	49 6	M1+E2	>+8		Mult., δ : (α,n),($\alpha,n\gamma$). B(M1)(W.u.)< 1.6×10^{-5} ; B(E2)(W.u.)>0.14.
5174	3191	$20^{\pm} 7$				
	4591	$100^{\pm} 7$				
5603	3651	100				
5700	3748	100				
5959	1599	10 2	[E1]			B(E1)(W.u.)=0.0043 15.

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult.@	$\delta^{\text{@@}}$	α	Comments
5959	2899	13 2	[E1]			B(E1)(W.u.)=0.0009 3.
	5376	47 6	[E1]			B(E1)(W.u.)=0.00053 17.
	5958	100 2	[E1]			B(E1)(W.u.)=0.00083 24.
5988	5404	100				
5995	5411	100				
6859.3	4907.0	100 11				
	6201.4	25 11				
6997.1	2287	$33^{\pm} 4$				
	5013.4	$100^{\pm} 6$				
	5468.7	$10^{\pm} 2$				
	6995.9	$61^{\pm} 4$				
6998.1	1824	$1.8^{\pm} 4$				
	4028.7	$8.4^{\pm} 18$				
	5014.4	$11.8^{\pm} 10$				
	5045.8	$58^{\pm} 4$				
	5060.5	$3.8^{\pm} 10$				
	6414.3	$3.6^{\pm} 8$				
	6996.9	$100^{\pm} 4$				
7016.4	1057.4	$13^{\pm} 1$				
	1842.3	$4.6^{\pm} 2$				
	2656.0	$0.4^{\pm} 2$				
	2944.9	$100^{\pm} 6$				
	4047.0	$1.4^{\pm} 2$				
	5032.7	$3.0^{\pm} 4$				
	5064.1	$45^{\pm} 2$				
	5488.0	$0.9^{\pm} 4$				
	6124.6	$13^{\pm} 1$				
	7015.2	$16^{\pm} 1$				
7074.9	1080	$13.1^{\pm} 13$				
	1116	$35^{\pm} 2$				
	1337	$2.2^{\pm} 6$				
	1350	$1.3^{\pm} 3$				
	1375	$53^{\pm} 6$				
	1901	$13.1^{\pm} 9$				
	2013	$1.9^{\pm} 6$				
	2453	$1.9^{\pm} 6$				
	2492	$2.2^{\pm} 6$				
	2716.2 12	$2.2^{\pm} 6$				
	2779	$2.5^{\pm} 6$				
	3132.0 10	$2.5^{\pm} 9$				
	3555	$4.7^{\pm} 6$				
	4016.3 10	$7.8^{\pm} 9$				
	5124.3 10	$21^{\pm} 5$				
	6418.6 10	$100^{\pm} 6$				
	6492.8 10	$94^{\pm} 6$				
	7075.4 10	$1.9^{\pm} 6$				
7152	3080	$34^{\pm} 5$				
	4092	$8^{\pm} 3$				
	5168	$47^{\pm} 8$				
	5624	$100^{\pm} 8$				
	6260	$24^{\pm} 5$				
	7151	$50^{\pm} 8$				
7220	2860	$61^{\pm} 6$				
	3275	$35^{\pm} 6$				
	4160	$39^{\pm} 6$				
	5267	$100^{\pm} 10$				
	5282	$32^{\pm} 10$				
	6636	$45^{\pm} 6$				
7240	7219	$10^{\pm} 3$				
	4180	$4.9^{\pm} 12$				
	5256	$100^{\pm} 7$				
	6348	$90^{\pm} 7$				
	7239	$49^{\pm} 7$				

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult.@	$\delta^{\text{@@}}$	α
7278	2104	$7.1^{\pm}_{-13}$			
	2216	$4.6^{\pm}_{-13}$			
	2656	$5.1^{\pm}_{-15}$			
	3333	$7.7^{\pm}_{-15}$			
	4218	$26^{\pm}_{-5}$			
	5326	$100^{\pm}_{-8}$			
	5340	$18^{\pm}_{-3}$			
	6620	$8.7^{\pm}_{-13}$			
	6694	$79^{\pm}_{-8}$			
	7279	$15^{\pm}_{-5}$			
7279	5750	$100^{\pm}_{-5}$			
	7360	$6.9^{\pm}_{-17}$			
7360	2650	$5.2^{\pm}_{-17}$			
	3840	$12.1^{\pm}_{-17}$			
7372	4391	$10.3^{\pm}_{-17}$			
	5831	$100^{\pm}_{-3}$			
7372	6468	$19^{\pm}_{-3}$			
	7359	$19^{\pm}_{-3}$			
	2198	$26^{\pm}_{-3}$			
	3852	$16^{\pm}_{-3}$			
	4801	$100^{\pm}_{-6}$			
	5160	$19^{\pm}_{-6}$			
	5388	$65^{\pm}_{-6}$			
	5420	$52^{\pm}_{-6}$			
	6788	$16^{\pm}_{-3}$			
	7371	$29^{\pm}_{-3}$			
7378	2204	$33^{\pm}_{-7}$			
	3306	$100^{\pm}_{-7}$			
7401	5394	$13^{\pm}_{-3}$			
	5426	$6.7^{\pm}_{-20}$			
	6794	$87^{\pm}_{-7}$			
	7377	$93^{\pm}_{-7}$			
	2779	$18^{\pm}_{-2}$			
	3041	$9^{\pm}_{-2}$			
	3456	$5.5^{\pm}_{-20}$			
	4341	$24^{\pm}_{-2}$			
	4830	$100^{\pm}_{-5}$			
	5417	$1.8^{\pm}_{-9}$			
7408.6	5449	$5.5^{\pm}_{-20}$			
	5463	$11^{\pm}_{-2}$			
	6743	$3.6^{\pm}_{-9}$			
	6817	$3.6^{\pm}_{-9}$			
	3048	$100^{\pm}_{-6}$	M1+E2§	$-0.4^{\pm}_{-1+4}$	$6.95 \times 10^{-4} \ 21$
	3464	$58^{\pm}_{-6}$	M1+E2§	$-1.3^{\pm}_{-9}$	$0.00093 \ 8$
	4348	$90^{\pm}_{-6}$	M1+E2§	$+0.3^{\pm}_{-3}$	$0.00115 \ 4$
	5471	$48^{\pm}_{-6}$	M1+E2§	$-0.29^{\pm}_{-11}$	$1.46 \times 10^{-3} \ 2$
	6825	$26^{\pm}_{-3}$	M1+E2§	$-0.19^{\pm}_{-10}$	
	7423	$2249 \ 3$			
7423	4852 3	$22^{\pm}_{-5}$			
	5211 3	$10^{\pm}_{-2}$			
7471.7	5439 3	$100^{\pm}_{-4}$			
	5485 3	$12^{\pm}_{-2}$			
7515.2	2698	$2.6^{\pm}_{-6}$			
	3151	$2.6^{\pm}_{-6}$			
	4411	$5.1^{\pm}_{-13}$			
	5488	$2.6^{\pm}_{-8}$			
	5534	$13^{\pm}_{-3}$	(M1+E2)§	$+0.2^{\pm}_{-2}$	$0.00147 \ 3$
	6888	$2.6^{\pm}_{-13}$			
	7470	$100^{\pm}_{-4}$	(M1+E2)§	$-0.2^{\pm}_{-2}$	
	2341	$6.4^{\pm}_{-11}$			
	3444	$100^{\pm}_{-6}$			
	5531	$8.5^{\pm}_{-21}$			
7515.2	5563	$6.4^{\pm}_{-21}$			

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Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult.@	$\delta^{\&}$	α
7515.2	6623	$60^{\pm} 4$			
	7514	$32^{\pm} 4$			
7547.0	3602	$64^{\pm} 4$			
	5609	$100^{\pm} 4$			
	6963	$18^{\pm} 4$			
7573.5	3502	$100^{\pm} 3$			
	6045	$11.5^{\pm} 13$			
	6682	$7.7^{\pm} 13$			
	7572	$9.0^{\pm} 13$			
7599	3239	$19^{\pm} 3$			
	3654	$25^{\pm} 3$			
	4539	$34^{\pm} 6$			
	5615	$72^{\pm} 9$			
	5647	$31^{\pm} 3$			
	7015	$31^{\pm} 6$			
	7598	$100^{\pm} 6$			
7605	2431	$15^{\pm} 3$			
	5392	$4.5^{\pm} 15$			
	5621	$8^{\pm} 3$			
	5653	$100^{\pm} 5$			
	6947	$20^{\pm} 3$			
	7021	$3.0^{\pm} 15$			
	7603	$1.5^{\pm} 7$			
7636	2462	$100^{\pm} 7$			
	6744	$45^{\pm} 5$			
	7635	$34^{\pm} 5$			
7683	2509	$34^{\pm} 4$			
	3611	$100^{\pm} 4$			
	4163	$12^{\pm} 2$			
	4623	$12^{\pm} 2$			
	6791	$32^{\pm} 4$			
7778.2	7682	$10^{\pm} 2$			
	4718	$27^{\pm} 3$			
	5566	$100^{\pm} 3$			
7800.6	5826	$42^{\pm} 3$			
	2626	$23^{\pm} 3$			
	5848	$100^{\pm} 4$	M1+E2 §	$-0.15^{\pm} 9$	$1.55 \times 10^{-3} 2$
	7799	$22^{\pm} 4$			
7821.1	2647	$78^{\pm} 4$			
	5869	$20^{\pm} 4$			
	7163	$100^{\pm} 4$			
	7820	$6^{\pm} 2$			
7889.1	4920	$4.2^{\pm} 12$			
	5905	$29^{\pm} 4$	M1+E2 §	$+0.08^{\pm} 3$	1.55×10^{-3}
	6360	$100^{\pm} 6$	M1+E2 §	$-0.03^{\pm} 2$	
	6997	$71^{\pm} 6$			
	7888	$4.2^{\pm} 12$			
7919	3558	$42^{\pm} 6$			
	5348	$16^{\pm} 6$			
	5706	$19^{\pm} 6$			
	5935	$61^{\pm} 6$			
	5981	$84^{\pm} 10$			
	7917	$100^{\pm} 10$			
	7965	$15^{\pm} 3$			
7965	4020	$30^{\pm} 3$			
	6027	$100^{\pm} 3$			
	7381	$20^{\pm} 3$			
	7977	$50^{\pm} 6$			
7977	5764	$68^{\pm} 6$			
	6024	$15^{\pm} 6$			
	6039	$15^{\pm} 6$			
	7319	$29^{\pm} 6$			
	7393	$100^{\pm} 6$			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$
7977	7975	$18^{\frac{3}{2}}_9$	8114	8112	$46^{\frac{3}{2}}_9$	8436	6223	$42^{\frac{3}{2}}_9$
8018	3946	$49^{\frac{3}{2}}_{12}$	8165	3804	$34^{\frac{3}{2}}_{11}$		6498	$3^{\frac{3}{2}}_9$
	4309	$42^{\frac{3}{2}}_{16}$		5104	$16^{\frac{3}{2}}_9$		7852	$100^{\frac{3}{2}}_{12}$
	7126	$100^{\frac{3}{2}}_{21}$		6212	$34^{\frac{3}{2}}_{11}$		8434	$45^{\frac{3}{2}}_{12}$
	8016	$42^{\frac{3}{2}}_{16}$		7273	$100^{\frac{3}{2}}_{11}$	8496	4135	$1^{\frac{3}{2}}_9$
8041	3267	$4.8^{\frac{3}{2}}_{12}$		8163	$43^{\frac{3}{2}}_{11}$		5435	$1^{\frac{3}{2}}_9$
	3680	$4.8^{\frac{3}{2}}_{12}$	8197	4125	$35^{\frac{3}{2}}_8$		8495	$100^{\frac{3}{2}}_{12}$
	4521	$6.0^{\frac{3}{2}}_{12}$		6244	$47^{\frac{3}{2}}_{12}$	8572	4048	$43^{\frac{3}{2}}_4$
	5071	$2.4^{\frac{3}{2}}_6$		6259	$14^{\frac{3}{2}}_{12}$		4865	$100^{\frac{3}{2}}_4$
	7149	$1.2^{\frac{3}{2}}_6$		8195	$100^{\frac{3}{2}}_{10}$	8613	1562	$100^{\frac{3}{2}}_{12}$
	8039	$100^{\frac{3}{2}}_4$	8211	3037	$73^{\frac{3}{2}}_8$		3904	$96^{\frac{3}{2}}_{12}$
8101	3740	$3.6^{\frac{3}{2}}_{11}$		6258	$100^{\frac{3}{2}}_8$	8675	4603	$9^{\frac{3}{2}}_9$
	5040	$7.1^{\frac{3}{2}}_{18}$		8209	$100^{\frac{3}{2}}_8$		5614	$2^{\frac{3}{2}}_9$
	6148	$57^{\frac{3}{2}}_5$	8221	4514 4	$31^{\frac{3}{2}}_{12}$		6462	$100^{\frac{3}{2}}_{12}$
	7443	$100^{\frac{3}{2}}_5$		6693 4	$65^{\frac{3}{2}}_{14}$		7783	$38^{\frac{3}{2}}_{12}$
	7517	$7.1^{\frac{3}{2}}_{18}$		7330 4	$100^{\frac{3}{2}}_{14}$		8091	$23^{\frac{3}{2}}_{12}$
	8099	$3.6^{\frac{3}{2}}_{11}$	8234	3651	$7.3^{\frac{3}{2}}_{18}$		8673	$19^{\frac{3}{2}}_{12}$
8108	2666	$59^{\frac{3}{2}}_5$		3873	$10.9^{\frac{3}{2}}_{18}$	8724	2892	$100^{\frac{3}{2}}_{12}$
	4587	$69^{\frac{3}{2}}_5$		5173	$18^{\frac{3}{2}}_4$	9060	2011	$10^{\frac{3}{2}}_4$
	6579	$100^{\frac{3}{2}}_5$		6281	$16^{\frac{3}{2}}_4$		3742	$40^{\frac{3}{2}}_6$
	7216	$5.1^{\frac{3}{2}}_{25}$		7650	$22^{\frac{3}{2}}_4$		5353	$100^{\frac{3}{2}}_{10}$
	8106	$23^{\frac{3}{2}}_3$		8232	$100^{\frac{3}{2}}_5$		7532	$50^{\frac{3}{2}}_{10}$
8114	5053	$100^{\frac{3}{2}}_{11}$	8436	4075	$11^{\frac{3}{2}}_9$	9813	5289	$100^{\frac{3}{2}}_{12}$
	6161	$15^{\frac{3}{2}}_9$		4915	$50^{\frac{3}{2}}_{12}$			
	7222	$57^{\frac{3}{2}}_{11}$		5375	$16^{\frac{3}{2}}_9$			

† γ -ray placement and intensity are from $(\alpha,n),(\alpha,n\gamma)$, except otherwise noted. γ rays depopulating 5174 keV and above levels are from (p,γ) , except otherwise noted. γ rays without uncertainty are from level energy difference, recoil energy subtracted.

$^{\frac{3}{2}}$ From (p,γ) .

$^{\frac{3}{2}}$ From $(^3\text{He},p\gamma)$.

$^{\#}$ From $(^{14}\text{N},\alpha)$.

$@$ From $(\alpha,n),(\alpha,n\gamma)$ and RUL, except otherwise noted.

$\&$ If no value given it was assumed $\delta=1.00$ for E2/M1, $\delta=1.00$ for E3/M2 and $\delta=0.10$ for the other multipolarities.

 ^{22}Mg β^+ Decay 2003Ha20,2010Ac01

Parent ^{22}Mg : $E=0$; $J\pi=0^+$; $T_{1/2}=3.8755$ s 12 ; $Q(\text{g.s.})=4781.6$ 3 ; $\% \beta^+$ decay=100.

Other references: 1972Ha58, 1975Ha21.

2003Ha20: ^{22}Mg produced by $^1\text{H}(^{23}\text{Na},2n)$ reaction, $E=28$ MeV/nucleon. Mass separation, measured E_{γ} , I_{γ} , $\beta\gamma$ -coincidence, and $T_{1/2}$.

2010Ac01: ^{22}Mg produced by $^1\text{H}(^{23}\text{Na},2n)$ reaction, $E=32$ MeV/nucleon. The ^{22}Mg nuclei represented 65% of the secondary beam extracted. Detector system: two-element Si detector telescope, time-of-flight from detector signal and cyclotron rf. γ spectra measured by an HPGe detector. The number of 582-keV γ rays emitted relative to the number of decaying ^{22}Mg nuclei is reported.

 ^{22}Na Levels

E(level) †	$J\pi^{\dagger}$	$T_{1/2}^{\dagger}$
0.0	3^+	2.6018 y 22
583.05 10	1^+	
657.00 14	0^+	
1936.9 2	1^+	

† From Adopted Levels.

^{22}Mg β^+ Decay 2003Ha20,2010Ac01 (continued)

β^+, ϵ Data

E_{ε}	$E(\text{level})$	$I\beta^{+\dagger}$	I_{ε}	$\text{Log } ft$	$I(\varepsilon+\beta^{+})$
(2844.7 4)	1936.9	5.43 7	0.01843 24	3.46 1	5.45 7
(4124.6 4)	657.00	53.18 9	0.03669 6	3.487 1	53.22 9
(4198.6 4)	583.05	41.30 20	0.02657 13	3.64	41.33 20

[†] From γ -ray intensity balance by evaluator.

 $\gamma(^{22}\text{Na})$

I γ normalization: From $\Sigma I(\gamma+ce)(g.s.)=100$.

$E\gamma^\dagger$	E(level)	$I\gamma^{\S@}$	Mult.	α	Comments
73.9 1	657.00	58.36 6	(M1)	0.00358	
583.04 10	583.05	100.00 19	(E2)		I γ : measured absolute intensity=101.3% 23 (2010Ac01).
1280.5 10	1936.9	5.40 7			
1353.8 $\frac{3}{2}^+$	1936.9	0.015 3			
1936.8 $\frac{3}{2}^+$	1936.9	0.032 3			

[†] From Adopted Gammas, except otherwise noted.

[‡] From level energy difference, recoil energy subtracted.

§ From 2003Ha20.

[@] For absolute intensity per 100 decays, multiply by 0.9997 19.

Decay Scheme

²³Al β⁺p Decay 2011Sa15,2011Ki26,2000Pe28

Parent ^{23}Al : $E=0.0$; $J\pi=5/2^+$; $T_{1/2}=0.47$ s 3; $Q(\text{g.s.})=4640.6$ 4; $\%\beta^+\text{p decay}=1.25$ 5.

²³Al- β^+ p decay: From $\Sigma I(p)$. Note $\beta^+p=1.22$ 5 in 2011Sa15.

Other references: 1995Ti08, 2006Ia03.

Delayed proton emission.

2011Sa15: ^{23}Al produced from $^1\text{H}(^{24}\text{Mg}, ^{23}\text{Al})$ reaction, $E=48$ MeV/u, and implanted on detector stack. Target= H_2 cryogenic gas. Momentum achromat recoil separator (MARS) and a mass separator; Detectors: double-sided Si strip detector (DSSSD), a thick Si pad detector, HPGe detector; Measured $E\gamma$, $I\gamma$, delayed proton spectra, βp coin, $\beta\gamma$ coin. 2006Ia03 – from same research group.

2011Ki26: ^{23}Al beam produced from $^{24}\text{Mg}(p,2n)$ reaction, $E=40$ MeV, of natural 4.3 mg/cm^2 thick Mg target and implanted in a carbon foil; Detectors: four double-sided silicon strip detectors (DSSSD). Measured $E(\text{proton})$, $I(\text{proton})$. Deduced excitation energies for proton unbound states, and branching ratios. Comparisons with shell-model calculations.

2000Pe28: ^{23}Al produced from $^{24}\text{Mg}(p,2n)$, $E=40$ MeV, and mass-separated using the IGISOL facility in Jyvaskyla and implanted in a carbon foil; Detectors: HPGe, 1 mm thick plastic ΔE_{β} detector, a gas ΔE -Si E detector telescope. Measured E_{γ} , I_{γ} , delayed proton spectra.

1995T108: ^{23}Al produced from $^{24}\text{Mg}(p,2n)$, $E=40$ MeV, and collected on tape, first experiment with $\text{n}^{\text{at}}\text{Mg}$, and second one with 99.8% enriched ^{24}Mg targets. Observed four proton groups using Si $\Delta E+E$ telescope. Intensity calculated assuming measured relative proton branchings, $\log ft=3.3$ to 7795 IAS, 100 microbarn cross section for ^{23}Al production (calculated), and ~ 100 nanobarn cross section for the 223 proton group (measured).

^{23}Al $\beta^+\text{p}$ Decay 2011Sa15,2011Ki26,2000Pe28 (continued) ^{22}Na Levels

<u>E(level)[†]</u>	<u>Jπ[†]</u>	<u>T_{1/2}[†]</u>
0.0	3+	2.6018 y 22
583.1?	1+	
890.8?	4+	

[†] From Adopted Levels.Delayed protons

<u>E(p)[‡]</u>	<u>E(^{22}Na)</u>	<u>I(p)^{†#}</u>	<u>E(^{23}Mg)</u>	<u>Comments</u>
197 $\S$ 11	0.0	0.14 3	7787	E(p): Other values: 200 keV 20 (2000Pe28), 223 keV 20 (1995Ti08).
255 $\S$ 9	0.0	0.18 4	7848	E(p): Other values: 267 keV 9 (2000Pe28), 285 keV 20 (1995Ti08).
322 $\S$ 14	0.0	0.03 1	7917	
424 $\S$ 14	0.0	0.02 1	8024	E(p): Other value: 400 keV 20 (2000Pe28).
560 5	0.0	0.28 1	8166	E(p): From 1995Ti08. Other values: 554 keV 7 (2000Pe28), 554 keV 8 (2011Sa15), 558.2 keV 12 (2011Ki26).
				I(p): Other value: 0.190 6 (2011Ki26).
839 $\S$ 5	0.0	0.41 1	8458	E(p): From 1995Ti08. Other values: 839 keV 6 (2000Pe28), 828 keV 8 (2011Sa15), 828.8 keV 19 (2011Ki26).
954& 2	890.8?	0.0064@ 4	9422	
1148 3	0.0	0.02 1	8781	E(p): Other value: 1152 keV 8 (2011Sa15).
				I(p): Other value: 0.0130 7 (2011Ki26).
1204& 3	583.1?	0.0058@ 4	9468	
1266 3	0.0	0.02 1	8905	E(p): Other value: 1280 keV 9 (2011Sa15).
				I(p): Other value: 0.0168 8 (2011Ki26).
1379 4	0.0	0.02 1	9023	E(p): Other value: 1357 keV 10 (2011Sa15).
1454 5	0.0	0.0032@ 6	9102	
1495 4	0.0	0.03 1	9144	E(p): Other value: 1493 keV 9 (2011Sa15).
				I(p): Other value: 0.0174 9 (2011Ki26).
1664 4	0.0	0.02 1	9321	E(p): Other value: 1654 keV 24 (2011Sa15).
				I(p): Other value: 0.0059 4 (2011Ki26).
1760 4	0.0	0.05 1	9422	E(p): Other value: 1763 keV 9 (2011Sa15).
				I(p): Other value: 0.0214 9 (2011Ki26).
1805 5	0.0	0.0084@ 6	9469	
1935 5	0.0	0.0025@ 3	9604	E(p): Other value: 1931 keV 14 (2000Pe28). 2011Ki26 argue this line in 2000Pe28 is a background.
2009 7	0.0	0.0008@ 2	9682	

[†] Absolute intensity per 100 decays.[‡] From 2011Ki26, except otherwise noted. Proton energies are in laboratory frame of reference. $\S$ From 2011Sa15 (values converted to lab energy).[#] From 2011Sa15, except otherwise noted. All proton branches observed in 2011Ki26 are assumed to feed the ^{22}Na g.s., but as 2011Ki26 point out, 0.25% of the absolute proton intensity must feed the excited states in ^{22}Na , also stated in 2006Ia03. Proton intensity for two lowest-energy groups were low compared to values in 2011Sa15, 2000Pe28, and 1995Ti08. Considering total proton branch in the literature, evaluator list 2011Sa15 proton branch values in column. Other values are listed in comment section.

@ From 2011Ki26.

& Placement of transition in the decay scheme is uncertain.

 $^{10}\text{B}(^{16}\text{O},\alpha)$ 1973Go32

Other: 1974Go10.

1973Go32, 1974Go10: $^{10}\text{B}(^{16}\text{O},\alpha)$, E=46 MeV. Magnetic spectrograph $\sigma(E_{\alpha},\theta)$. ^{22}Na Levels

<u>E(level)</u>
0.0
580

Continued on next page

$^{10}\text{B}(^{16}\text{O},\alpha)$ 1973Go32 (continued)

 ^{22}Na Levels (continued)

E(level)	E(level)	E(level)
890	4720	9310
1530	5110	9860
1980	7410	12620
3710	8620	13580
4520	9030	

 $^{12}\text{C}(^{14}\text{N},\alpha),(^{14}\text{N},\alpha\gamma)$ 1989Ve01,1978Ha29

1989Ve01: $^{12}\text{C}(^{14}\text{N},\alpha\gamma)$, E=32,33 MeV. Magnetic spectrometer, Measured Γ/Γ , $\alpha\gamma$ coincidence, lifetime for excited states. Si and Ge(Li) detectors.

1978Ha29: $^{12}\text{C}(^{14}\text{N},\alpha)$, E=30.3,35.0,40.0,45.5 MeV and $^{14}\text{N}(^{12}\text{C},\alpha)$, E=39.3 MeV. Measured $\sigma(\theta,E)$.

 ^{22}Na Levels

E(level) [†]	$T_{1/2}^{\ddagger}$	Comments
0.0		
584 10		
644 10		
892 10		
1530 10		
1930 10		
1980 10		
2221 10		
2581 10		
2970 10		
3066 10		
3518 10		
3709 10		
3942 10		
4085 10		
4284 10		
4321 10		
4359 10		
4444 10		
4516 10		
4576 10		
4625 10		
4709 10		
4764 10		
5075 10		
5114 10		
5173 10		
5308 15		
5448 10		
5608 10		
5740 10		
5858 10		
5936 10		
6007 10		
6097 10		
6196 10		
6240 10		
6339 10		
6428 10		
6462 10		
6545 10		
6565 15		
6625 15		
6667 15		

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$^{12}\text{C}(^{14}\text{N},\alpha),(^{14}\text{N},\alpha\gamma)$ 1989Ve01,1978Ha29 (continued) ^{22}Na Levels (continued)

E(level) [†]	T _{1/2} [‡]	Comments
6780 15		
6865 15		
6981 15		
6992 15		
7049 15		
7153 15		
7190 15		
7255 15		
7281 15		
7380 15		
7418 15		
7574 15		
7595 15		
7694 15		
7832 15		
7887 15		
7947 15		
8013 15		
8128 15		
8221 4	<21 fs	$\Gamma_\gamma/\Gamma=0.42$ 5 (1989Ve01).
8349 15		
8416 15		
8526 15		
8572 3	<16 fs	$\Gamma_\gamma/\Gamma=0.50$ 8 (1989Ve01).
8610 3	21 fs 14	$\Gamma_\gamma/\Gamma=0.35$ 10 (1989Ve01).
8689 15		
8724 4	<32 fs	$\Gamma_\gamma/\Gamma=0.31$ 5 (1989Ve01).
8876 20		
9006 20		
9060 3	<17 fs	$\Gamma_\gamma/\Gamma=0.44$ 7 (1989Ve01).
9137 5		$\Gamma_\gamma/\Gamma=0.08$ 2, decay by proton emission (1989Ve01).
9297 20		
9378 5		$\Gamma_\gamma/\Gamma=0.03$ 1, decay by proton emission (1989Ve01).
9436 20		
9558 20		
9642 20		
9698 20		
9813 3	6 fs 3	$\Gamma_\gamma/\Gamma=0.7$ 1 (1989Ve01).
9852 20		
9901 20		
10148 20		
10217 20		
10346 20		
10422 20		
10563 20		
10640 20		
10834 20		
10977 20		
11152 20		
11254 20		
11361 20		
11460 20		
11493 20		
11570 30		
11625 20		
11768 30		
11823 20		
11927 25		
12054 20		
12118 30		
12252 25		
12296 25		
12363 20		

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$^{12}\text{C}(^{14}\text{N},\alpha),(^{14}\text{N},\alpha\gamma)$ 1989Ve01,1978Ha29 (continued) **^{22}Na Levels (continued)**

<u>E(level)[†]</u>	<u>E(level)[†]</u>	<u>E(level)[†]</u>
12408 20	13840 40	15980 50
12530 20	14070 40	16190 50
12564 25	14160 40	16325 50
12620 20	14330 40	16430 50
12713 20	14430 40	16560 50
12763 20	14535 40	16650 50
12798 30	14600 40	16770 50
12866 20	14720 40	16880 50
12967 20	14860 40	16950 50
13157 20	15000 40	17070 50
13292 20	15125 40	17180 50
13326 20	15170 40	17370 50
13364 25	15300 40	17510 50
13419 25	15393 40	17700 50
13474 25	15580 40	17860 50
13547 25	15650 40	
13705 40	15840 40	

[†] From 1978Ha29 if $\Delta E > 9$. Otherwise from 1989Ve01.

[‡] From 1989Ve01, measured by Doppler Shift Attenuation Method.

 $\gamma(^{22}\text{Na})$

<u>E(level)</u>	<u>$E\gamma^{\dagger}$</u>	<u>$I\gamma^{\ddagger}$</u>	<u>E(level)</u>	<u>$E\gamma^{\dagger}$</u>	<u>$I\gamma^{\ddagger}$</u>	<u>E(level)</u>	<u>$E\gamma^{\dagger}$</u>	<u>$I\gamma^{\ddagger}$</u>
8221	4512	31 12	8610	1561	100 12	9060	5350	100 10
	6690	65 14		3901	96 12		7529	50 10
	7328	100 14	8724	2984	100	9813	5296	100
8572	4056	43 4	9060	2011	10 4			
	4862	100 4		3752	40 6			

[†] From level energy differences, recoil energy subtracted. Placement in 1989Ve01 – $E\gamma$ not listed.

[‡] From 1989Ve01.

$^{12}\text{C}(^{14}\text{N},\alpha),(^{14}\text{N},\alpha\gamma)$ 1989Ve01,1978Ha29 (continued)

Level Scheme

Intensities: relative photon branching
from each level $^{22}_{11}\text{Na}_{11}$

$^{19}\text{F}(\alpha, n), (\alpha, n\gamma)$ 1967Wa13, 1976Ma23, 1982Ve05

Other references: 1966Su07, 1967KaZW, 1967Po14, 1968Bl03, 1968Pa11, 1969Jo10, 1969Wa17, 1971Go10, 1972Sn01, 1973An01, 1973Fr18, 1973Ha55, 1975Sp02, 1976Be06, 1976Fr19, 1977Ba77, 1977Ha11, 1977Og03, 1977Ra01, 1980Fi07, 1987Ne04, 2003Ge08.

1967Wa13: The ^{19}F targets were in the form of CaF_2 evaporated onto nickel backings. Projectile: α , E=4 to 7 MeV;

Detector: one Ge(Li) and two NaI(Tl) detectors. Measured: $E\gamma$, $I\gamma$, $\gamma\gamma$ coincidence, γ -ray angular distribution.

1976Ma23: Target ^6LiF (thickness =1 mg/cm²) evaporated onto 0.25 mm gold. Projectile: α , E=8.1- and 9.1-MeV.

Detectors: γ -ray angular distribution and linear polarization were measured by an escape-suppressed spectrometer positioned at five angles 0°, 30°, 45°, 60°, and 90° with respect to beam direction and a three-crystal Ge(Li) Compton polarimeter at 270°. Also measured $E\gamma$, $I\gamma$, deduced level energies, mixing ratios, mean lifetime, and excited level energies.

1982Ve05: CaF_2 target evaporated onto a 50 μm Ni foil. Projectile: α , E=5 MeV. Two Ge(Li) detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coincidence. Deduced isoscalar E2 strength.

 ^{22}Na Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0	3+		
583.05 10	1+	243 ns 2	$T_{1/2}$: From 1966Su07. Other value: 266 ns 10 (1958Te15).
657.00 14	0+	19.6 ps 7	$T_{1/2}$: Weighted average of 20.3 ps 7 (1987Ne04), 18.8 ps 8 (1980Fi07), Other value: 14 ps 2 (1967KaZW).
890.89 20	4+	10.0 ps 3	$T_{1/2}$: Weighted average of 11 ps 3 (1967KaZW), 7.5 ps 12 (1968Bl03), 8.5 ps 12 (1968Pa11), 11.2 ps 21 (1972Sn01), 10.2 ps 5 (1973Ha55), 11.4 ps 12 (1973Ha55), 9.6 ps 6 (1977Og03), 10.7 ps 4 (1977Ra01), 9.8 ps 3 (1980Fi07), 9.8 ps 4 (1977Ba77), and 10.0 ps 5 (1969Jo10).
1528.1 3	5+	3.42 ps 24	$T_{1/2}$: Weighted average of 3.3 ps 11 (1967KaZW), 2.6 ps 6 (1967Wa13), 2.4 ps 4 (1968Pa11), 3.5 ps 4 (1973Ha55), 3.1 ps 6 (1972Sn01), 3.26 ps 24 (1973An01), 4.0 ps 8 (1976Ma23), 4.1 ps 5 (1977Og03), 3.72 ps 19 (1977Ra01), 3.5 ps 5 (1969Jo10), 3.4 ps 2 (1977Ba77) and 3.0 ps 10 (1973Ha55).
1936.9 2	1+	20 fs 3	$T_{1/2}$: From 1967Wa13.
1951.8 3	2+ [§]		
1983.5 5	3+	1.47 ps 15	$T_{1/2}$: Weighted average of 1.2 ps 3 (1967Wa13), 1.21 ps 24 (1968Pa11), 1.66 ps 28 (1976Ma23), 1.66 ps 21 (1973An01), 1.73 ps 14 (1977Ra01), and 1.45 ps 28 (1973Ha55).
2211.4 3	1-	14.9 ps 6	$T_{1/2}$: Weighted average of 15.5 ps 10 (1973An01), 15.3 ps 7 (1973Ha55), 13.7 ps 12 (1977Og03), 14.1 ps 15 (1973Ha55), and 14.7 ps 6 (1977Ra01), 14.4 ps 7 (1969Jo10), 15.2 ps 6 (1976Be06). Other value: 8.3 ps 14 (1968Bl03).
2571.5 3	2- [§]	5.0 ps 6	$T_{1/2}$: Weighted average of 3.1 ps 7 (1968Bl03), 4.0 ps 6 (1968Pa11), 6.1 ps 6 (1973Ha55), and 5.6 ps 4 (1977Ra01).
2968.6 6	3+ [§]	42 fs 9	$T_{1/2}$: From 1968Pa11.
3059.4 6	2+ [§]	28 fs 7	$T_{1/2}$: From 1968Pa11.
3519.1	(3-) [§]	465 fs 76	$T_{1/2}$: Weighted average of 444 fs 110 (1973Ha55) and 485 fs 105 (1976Ma23). Other: >416 fs (1978Bi11).
3706.7 4	6+	59 fs 12	$T_{1/2}$: Weighted average of 36 fs 12 (1969Wa17), 53 fs 14 (1973Ha55), 90 fs 17 (1973An01), 55 fs 28 (1973Ha55) and 76 fs 14 (1976Ma23).
3941.9 9		<15 fs	$T_{1/2}$: From 1976Ma23.
4071.4 6	4+		E(level): From 1975Sp02.
4296.2 4		3.5 ps +8-2	$T_{1/2}$: From 1976Ma23.
4319.0 5		30 fs 8	$T_{1/2}$: From 1976Ma23.
4360.0 4	2+ [§]	<7 fs	$T_{1/2}$: From 1976Ma23.
4468.7 4	(4-)	100 fs 38	$T_{1/2}$: From 1972Sn01. Other value: 180 fs 42 (1976Ma23 - unreliable result).
4523.9 5	(7+, 5+) [§]	38 fs 14	$T_{1/2}$: From 1976Ma23. Other value: 80 fs 31 (1973Fr18).
4583 2		<69 ps	$T_{1/2}$: From 1968Pa11.
4622 2		<69 ps	$T_{1/2}$: From 1968Pa11.
4710.0 4	5+	37 fs 14	$T_{1/2}$: Weighted average of 35 fs 14 (1976Ma23) and 55 fs 40 (1972Sn01).
5062.5 4	2+	<14 fs	$T_{1/2}$: From 1976Ma23.
5100.4 13	4+	38 fs 12	$T_{1/2}$: From 1976Ma23.
5130 7		<69 fs	E(level), $T_{1/2}$: Level energy from adopted levels. Half life From 1968Pa11.

[†] Excited level energies up to 3059 keV are from 1967Wa13, energies above this level are from 1976Ma23, except otherwise noted.

[‡] From γ -ray placement and multipolarity, except otherwise noted.

[§] From Adopted Levels.

$^{19}\text{F}(\alpha, n), (\alpha, n\gamma)$ 1967Wa13, 1976Ma23, 1982Ve05 (continued)					
$\gamma(^{22}\text{Na})$					
E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [†]	$\delta^{\dagger}$	Comments
583.05	583.04 10				
657.00	73.9 1	100			
890.89	890.87 20	100	M1+E2	+3.2 3	δ : Weighted average of +3.1 3 (1968Wa04), +3.7 4 (1976Ma23), +3.2 7 (1970Ba47), and +2.6 5 (1967Po14).
1528.1	637.50 20	4.7 13	M1+E2	+2.11 15	δ : Weighted average of +2.00 15 (1968Wa04), +2.4 3 (1976Ma23) and +2.5 5 (1977Ha11); Other: +1.18 15 (1967Po14).
	1528.1@ 2	100.0 13	E2		
1936.9	1280.5 10	100	M1		
1951.8	1294.8&	0.29 $\frac{\ddagger}{\ddagger}$ 5			I_{γ} : From 1982Ve05.
	1368.7 3	100 $\frac{\ddagger}{\ddagger}$	M1 (+E2)	-0.04 6	δ : From 1968Wa04.
1983.5	1092.6	1.3 2			
	1400.4 5	100.0 $\S$ 3	E2 (+M3)	-0.02 2	δ : Average of -0.04 4 (1976Ma23) and -0.01 2 (1975Sp02).
	1983.5	1.9 $\S$ 3			
2211.4	1554.4 3	100.0 $\S$ 5	E1		Mult.: From 1967Po14, 1973Ha55.
	2211.3	1.5 2			I_{γ} : From 1976Fr19. Other value: 1.7 5 (1975Sp02).
2571.5	360.1	1.6 5			I_{γ} : Weighted average of 3.2 13 (1973Ha55) and 1.4 4 (1975Sp02).
	1914.4	2.6 7			I_{γ} : Weighted average of 2.4 7 (1973Ha55) and 3.4 14 (1975Sp02).
	1988.8 4	29 3	E1		I_{γ} : Weighted average of 28 3 (1973Ha55) and 32 4 (1975Sp02).
					δ : -0.05 6 in 1976Ma23, 0.00 10 in 1968Pa11.
	2571.4	100 3	E1		I_{γ} : From 1973Ha55.
					δ : -0.02 3 in 1968Pa11.
2968.6	1016.8 5	100	M1 (+E2)	-0.02 3	δ : From 1968Wa04.
3059.4	1107.6 5	100 1	M1 (+E2)	+0.01 5	δ : Weighted average of +0.05 15 (1968Wa04) and +0.01 5 (1976Ma23).
	2476.2	3 1	M1+E2	+0.13 7	δ : From 1976Ma23.
3519.1	948.0& 2	11.4 8	M1+E2	+2.1 3	δ : From 1976Ma23.
	1307.7	46 2	E2 (+M3)	-0.1 1	δ : From 1976Ma23.
	1566.8& 2	100 6	E1 (+M2)	-0.014 16	δ : From 1976Ma23.
	2628.0	14 4			
	3518.8	28 6	E1+M2	-0.19 3	δ : From 1976Ma23.
3706.7	2176.5 10	39 9	M1 (+E2)	+6 3	E_{γ}, δ : E_{γ} from 1975Sp02; A_2 =+0.65 15, A_4 =+0.92 21 (1975Sp02), mixing ratio from +5.7 +20-38 (1977Ha11); Other values: +3.7 +12-34 (1975Sp02), <+18 or >-15 (1976Ma23).
					I_{γ} : Weighted average of 54 15 (1969Wa17) and 33 9 (1973Fr18).
	2815.8 3	100& 9	E2 (+M3)	-0.0 1	E_{γ}, δ : From 1976Ma23.
3941.9	1990.0	7 1			
	3284.9& 9	100 1			
4071.4	2088.2 5	100	M1 (+E2)	0.00 7	E_{γ}, δ : From 1975Sp02, A_2 =-0.26 10, A_4 =+0.14 16 (1975Sp02).
4296.2	1724.7& 2	100			
4360.0	2408.1 3	100 5	M1 (+E2)	+0.02 9	E_{γ}, δ : From 1976Ma23.
4468.7	1897.2& 3	100# 6	(E2)		E_{γ} : Other: 1895.5 keV 6 (1975Sp02).
					Mult.: From 1975Sp02, A_2 =+0.56 26, A_4 =-0.11 31.
	2485.1	14# 5			
	2940.4	21# 5			
	3577.5	17# 5			
4523.9	2995.8 4		M1 (+E2)		Mult.: From 1975Sp02, A_2 =+0.40 8, A_4 =-0.17 10.
4710.0	638.6	83 6	M1 (+E2)	-0.04 4	δ : From 1976Ma23.
	1741.3	10 2	E2		δ : -0.04 10 in 1976Ma23.
	2726.0& 4	100 4	E2		δ : +0.06 6 in 1976Ma23.
5062.5	3110.6& 4	100	M1		δ : +0.04 8 in 1976Ma23.
5100.4	1029.0	100& 8	M1		δ : +0.00 9 in 1967Wa13.
	2039.1& 3	49& 5	E2		δ : +0.07 9 in 1967Wa13.
	3573.3& 4	32& 5			
	4209.1	40& 13	M1+E2	>1	
	5101.0& 6	49& 5	M1+E2	>+8	

[†] From 1967Wa13, except as noted. γ rays without uncertainty are from level energy difference (recoil energy subtracted). γ -ray multipolarity from angular distribution and linear polarization (at 90°) measurements.

$\frac{\ddagger}{\ddagger}$ From 1982Ve05.

$\S$ From 1975Sp02.

Branching in 1978En02.

@ Weighted average of data from 1967Wa13 and 1976Ma23.

& From 1976Ma23.

$^{19}\text{F}(\alpha, n), (\alpha, n\gamma)$ 1967Wa13, 1976Ma23, 1982Ve05 (continued)

Level Scheme

Intensities: relative photon branching from each level

$^{22}_{11}\text{Na}_{11}$ **$^{20}\text{Ne}(^3\text{He}, p), (^3\text{He}, p\gamma)$ 1970O103, 1971Ga04** $J^\pi(^{20}\text{Ne})=0^+$.

Others: 1966Ma23, 1967Me15, 1967Po10, 1967Wa13, 1971Be19, 1971Me01.

1970O103: $^{20}\text{Ne}(^3\text{He}, p\gamma)$ $E=6.92$ MeV. Measured $\sigma(E)$; $E\gamma, \theta(\gamma)$, $\gamma\gamma$ coincidence, Doppler shift attenuation.1971Ga04: $^{20}\text{Ne}(^3\text{He}, p\gamma)$ $E=15$ MeV. Protons were registered with emulsions. Magnetic spectrograph, measured proton spectrum, $\sigma(\theta)$, deduced excited level energies, L.1971Be19: $^{20}\text{Ne}(^3\text{He}, p)$ $E=15-18$ MeV. Measured $\sigma(\theta)$, multi-angle spectrograph.1966Ma23: $^{20}\text{Ne}(^3\text{He}, p\gamma)$ $E=5.35$ MeV. Measured $E\gamma$, $\gamma\gamma$ - and $p\gamma$ -coincidence, $\sigma(E\gamma, \theta)$. Natural target. ^{22}Na Levels

E(level) [§]	J^π	L [§]	Comments
0.0	3+	(2)	
586 4	1+	0+(2)	
658 4	0+	0	T=1.
893 4	4+	(4)	
1529 4	5+	4	
1939 4	1+	0+2	
1952	2+		
1986 10	3+	4	
2214 4	1-	(1)	

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$^{20}\text{Ne}(^3\text{He,p}),(^3\text{He,p}\gamma)$ 1970O103,1971Ga04 (continued) **^{22}Na Levels (continued)**

E(level) [§]	J π [#]	L [§]	E(level) [§]	L [§]	E(level) [§]
2574 4	2-		6521 7		8417 10
2970 4	3+	2	6557 7		8497 10
3061 4	2+		6582 7		8525 10
3521 $\frac{1}{2}$ 2	(3-)	(3)	6664 7	(2)	8573 10
3708 $\frac{1}{2}$ 1			6715 7		8602 10
3944 $\frac{1}{2}$ 2	1+	0+2	6750 7		8674 10
4069 $\frac{1}{2}$ 2		(4)	6834 7	0	8726 $\frac{1}{2}$ 10
4294 $\frac{1}{2}$ 2			6862 7		8794 15
4319 $\frac{1}{2}$ 2	1+	0+(2)	6961 7		8841 15
4360 $\frac{1}{2}$ 2	2+		7008 7		8874 10
4468 4			7081? 7		8950 10
4526 4			7153 7		9008 10
4583 $\frac{1}{2}$ 2			7220 7		9051 10
4622 $\frac{1}{2}$ 2	1		7242? 7		9122 10
4708 $\frac{1}{2}$ 3		(4)	7278 7		9150 10
4770 $\frac{1}{2}$ 2			7367 7		9195 10
5061 $\frac{1}{2}$ 2	(2+)		7413 7		9240 10
5097 10			7512 7		9312 10
5130 10			7543 10		9360 10
5165 $\frac{1}{2}$ 4			7575 10		9438 10
5317 7		(2)	7595 10		9527 10
5440 7			7633 10		9582 $\frac{1}{2}$ 10
5605 7			7682 7		9647 10
5752 7		0(+2)	7806 10		9682 10
5830 7			7884 7		9756 10
5858 10			7942 7		9794 10
5918 7			7963 7		9859 10
5958 10			8026 10		9908 10
5995 10			8100 10		9957 $\frac{1}{2}$ 10
6088 7			8128 10		10009 $\frac{1}{2}$ 10
6185 7			8157 10		10051 $\frac{1}{2}$ 10
6247 7			8198 10		10118 10
6326 7			8323 10		10167 10
6437 7			8367 10		

† Possible doublet.

‡ From 1970O103.

§ From 1971Ga04, except as noted.

From Adopted Levels. Added by evaluator for γ -ray multiplicities, reported in references of this dataset. **$\gamma(^{22}\text{Na})$**

E(level)	E γ [†]	I γ [†]	Mult.	δ [‡]	Comments
586	586	100			
658	72	100			
893	893	100	M1+E2	1.7 9	Mult.: From 1966Ma23.
1529	1529	100			
1952	1366	100	M1		Mult.: A ₂ =-0.22 5, A ₄ =0.07 2, Pol(90)=-0.30 12 (1970O103).
2214	1556	100	E1		Mult.: A ₂ =-0.76 3, A ₄ =-0.26 6, Pol(90)=1.17 34 (1970O103).
2574	1916	18			
	2574	100	E1+M2	-0.08 5	Mult.: From 1966Ma23. δ: Or 4.7 10 (1966Ma23).
2970	1018	100	M1		Mult.: A ₂ =-0.37 11, A ₄ =0.26 6, Pol(90)=-1.01 34 (1970O103).
3061	1109	100	M1		Mult.: A ₂ =0.21 5, A ₄ =-0.16 5, Pol(90)=0.61 21 (1970O103).
3521	947 2	20 5			
	1307 2	55 8	E2(+M3)	-0.04 [§] 12	
	1569 2	100 13	E1(+M2)	-0.02 [§] 11	
	2628 2	20 5			
	3521 2	55 10			
3708	2179 1	54 15			
	2815 1	100 15			

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$^{20}\text{Ne}(^3\text{He,p}),(^3\text{He,p}\gamma)$ 1970O103,1971Ga04 (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult.	$\delta^{\ddagger}$	Comments
3944	1992 2	8 1			
	3286 2	100 1	D		Mult.: $A_2=-0.37$ 2, $A_4=0.00$ 2.
4069	2083 2	100			
4294	1720 2	67 17			
	2355 2	100 17			
4319	3661 2	100	M1		Mult.: $A_2=0.16$ 5, $A_4=0.00$ 5.
4360	2408	100 5	M1 (+E2)	+0.02 § 3	Mult.: $A_2=-0.35$ 5, $A_4=0.03$ 5.
	3774	8 4	M1 (+E2)		Mult.: $A_2=-0.46$ 4, $A_4=0.13$ 4.
	4360	24 4			
4583	2631 2	100 14			
	4582 2	43 14			
4622	2670 2	100 20			
	3964 2	67 20	D		Mult.: $A_2=-0.36$ 4, $A_4=0.01$ 3.
4708	639 3	67 17			
	2722 3	100 17			
4770	2818 2	100			
5061	3109 2	100	M1 (+E2)	+0.1 § 4	Mult.: $A_2=-0.45$ 1, $A_4=0.01$ 10.
5165	3179 4	100 18			
	4578 4	82 18			

† From 1970O103 and 1966Ma23. Intensity values averaged with those of 1967Wa13 by authors. γ -ray energies are calculated from level energy differences, recoil energy subtracted.

‡ From 1966Ma23, except otherwise noted.

§ From 1970O103.

$^{20}\text{Ne}(^3\text{He,p}),(^3\text{He,p}\gamma)$ 1970O103,1971Ga04 (continued)

Level Scheme

Intensities: relative photon branching from each level

$^{20}\text{Ne}(\alpha, d)$ 1969Lu07, 1986Ka36

$J\pi(^{20}\text{Ne})=0^{+}$.

1969Lu07: $^{20}\text{Ne}(\alpha, d)$ $E=40.1, 46.4, 45.4, 44.5$ MeV. Counter telescope, measured $\sigma(E_d, \theta)$.

1986Ka36: $^{20}\text{Ne}(\alpha, d)$ $E=64.4$ MeV. Magnetic spectrograph.

Others: 1964Ri03, 1975La11.

^{22}Na Levels

E(level) [†]	L [‡]	Comments
0.0	2	
580	2	
890	4	
1528 20	4	
1946 30	(0, 2)	
2558 40	(1)	
2976 20	2	
3690		
3940	2	
4488 30	(1)	
4733 20	(2)	
5110	1	
5339 30	4	
5620	2	
6274 20	(0)	
6617 30	4	
7042 30	(3)	
7200	(3, 4)	
7460 30	5	
7874 30	5	
8091 40	4	
8659 40	5	
9356 40	5	
9990 40	5	
10220		
10990 40	6	
11540	5	E(level): Possible doublet.
11770		
12200	(5)	
12520	(3, 4)	
12800	(2)	
13370		
13750		

[†] From 1969Lu07, if ΔE is given. Otherwise from 1986Ka36.

[‡] From 1986Ka36.

$^{20}\text{Ne}(^6\text{Li}, \alpha)$ 1971Ga04

Other: 1960Kr01.

$^{20}\text{Ne}(^6\text{Li}, \alpha)$, $E=18$ MeV. Enriched target. Measured $\sigma(E_p, \theta)$, multi-angle spectrograph.

^{22}Na Levels

E(level)	E(level)	E(level)
0.0	3064 10	4616 10
583 10	3521 10	4716 10
892 10	3711 10	4778 10
1529 10	3946 10	5071 10
1937 10	4324 10	5106 10
2004 15	4370 10	5313 10
2216 10	4473 10	5438 10
2573 10	4526 10	5605 10
2968 10	4583 10	5740 10

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$^{20}\text{Ne}({}^6\text{Li},\alpha)$ 1971Ga04 (continued) **^{22}Na Levels (continued)**

E(level)	E(level)	E(level)
5848 15	6443 10	7224 10
5881 15	6550 10	7281 15
5942 15	6647 10	7358 10
6004 10	6721 10	7403 15
6087 10	6771 10	7522 10
6203 10	6865 10	7586 15
6255 10	7006 10	

 $^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08

Other references: 1962Ar04, 1963Ar05, 1964Ar05, 1965Ta02, 1970An06, 1977Ke04, 1978He12, 1983Go21, 1992Be35, 1992Sc08, 1992Sc27.

Other reaction: $^{21}\text{Ne}(\text{p},\text{p}') - 1975\text{Ch15}$.

1982Go11: $^{21}\text{Ne}(\text{p},\gamma)$, $E=70-355$ keV. Measured $\sigma(E\gamma, E)$, $E\gamma$, $I\gamma(E, \theta)$.

1978Bi11: $^{21}\text{Ne}(\text{p},\gamma)$, $E=0.50, 0.70, 0.77, 0.81, 0.85, 1.09, 1.13, 1.28, 1.78$ MeV. Measured $E\gamma$, $I\gamma$, Doppler shift attenuation.

1977Be08: $^{21}\text{Ne}(\text{p},\gamma)$, $E=0.4-1.6$ MeV. Measured $\sigma(E\text{p})$, $E\text{p}$, $I\text{p}$, $E\gamma$, $I\gamma(\theta)$, excitation functions.

1970An06: $^{21}\text{Ne}(\text{p},\gamma)$, $E=0.3-1.0$ MeV. Measured $\sigma(E\gamma)$, Doppler shift attenuation.

1977Ke04: $^{21}\text{Ne}(\text{p},\gamma)$, $E=0.5-2.0$ MeV. Measured $\sigma(E)$.

1978He12: $^{21}\text{Ne}(\text{p},\gamma)$, $E=0.70-1.84$ MeV, Measured $I\gamma(E, \theta)$.

1992Be35: $^{21}\text{Ne}(\text{p},\gamma)$, $E=\text{resonance}$. Measured γ yield.

 ^{22}Na Levels

E(level) [†]	$J\pi$	$T_{1/2}$ [#]	$(2J+1)\Gamma_{\text{p}}\Gamma_{\gamma}/\Gamma$	Comments
0.0				
582.8 3				
657.0 1				
890.9 3				
1527.7 3				
1937.0 5		11 fs 2		$T_{1/2}$: Other value: 4 fs 3 from 1970An06 as reported in 1978Bi11.
1951.7 5		8 fs 2		$T_{1/2}$: Other value: 9 fs 4 from 1970An06 as reported in 1978Bi11.
1983.1 5				
2211.8 6				
2570.8 10				
2969.0 10		30 fs 4		
3059.9 7		22 fs 3		$T_{1/2}$: Other value: 28 fs 14 from 1970An06 as reported in 1978Bi11.
3520		>420 fs		
3706.7 4				E(level): From Adopted Levels.
3944.4 7		<0.7 fs		$T_{1/2}$: Other value: 9 fs 8 from 1970An06 as reported in 1978Bi11.
4071.3 10		<0.7 fs		$T_{1/2}$: Other value: <3 fs from 1970An06 as reported in 1978Bi11.
4296 $\frac{3}{2}$ 2				
4320		10 fs 6		
4360.2 12		5.0 fs 14		$T_{1/2}$: Other value: 19 fs 12 from 1970An06 as reported in 1978Bi11.
4583 $\frac{3}{2}$ 2				
4622 $\frac{3}{2}$ 2				
4710 2				
4773.5? 20		5.9 fs 14		
5062 $\frac{3}{2}$				
5174 $\frac{3}{2}$ 2		<1 fs		
5320		<0.7 fs		
5442 5				E(level): From Adopted Levels.
5603 $\frac{3}{2}$ 2		<3 fs		
5700 $\frac{3}{2}$ 2				
5725 $\frac{3}{2}$ 2				
5739 $\frac{3}{2}$ 2				
5959 $\frac{3}{2}$ 2		2.9 fs 8		
5988 $\frac{3}{2}$ 2				
5995 $\frac{3}{2}$ 2				

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$^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued) ^{22}Na Levels (continued)

E(level) [†]	J π	T _{1/2} [#]	(2J+1) $\Gamma_{\text{p}}\Gamma_{\gamma}/\Gamma$	Comments
6859.3 6		<12 eV	0.3×10 ⁻³ 6	Ep=126.3 6 (1982Go11). Other: Ep=126.69 4 (relative uncertainty) (1992Be35). Γ from 1992Be35.
6997.1 4		<5 eV	0.017 3	Ep=270.67 4 (relative uncertainty) (1992Be35). Other: Ep=271.7 4 (1982Go11). Γ from 1992Be35.
6998.1 4		<3 eV	0.66 10	Ep=271.56 4 (relative uncertainty) (1992Be35). Other: Ep=271.7 6 (1982Go11). From Ep=271.56 4 (1992Be35) and Sp. Γ from 1992Be35.
7016.4 4		<11 eV	0.016 3	Ep=290.0 4 (1982Go11). Other: Ep=290.50 4 (relative uncertainty) (1992Be35). Γ from 1992Be35.
7074.9 4		<0.1 keV	0.065 11	Ep=352.2 4 (1982Go11).
7152 4		<0.5 keV	0.15 3	Ep=433 4 (1977Be08).
7220 2		<0.4 keV	1.6 3	Ep=504.4 2 (1977Be08).
7240 2		<0.3 keV	6.1 12	Ep=524.7 15 (1977Be08).
7278 3		<0.5 keV	1.2 3	Ep=565 3 (1977Be08).
7279 3		<1.5 keV	0.28 7	Ep=566 3 (1977Be08).
7360 3		<1.0 keV	0.42 10	Ep=651 3 (1977Be08).
7372 2		<0.5 keV	0.42 10	Ep=663 2 (1977Be08).
7378 1		<0.5 keV	0.61 12	Ep=670 1 (1977Be08).
7401 2		<1.5 keV	1.5 3	Ep=694 2 (1977Be08).
7408.6 5	1+	3.5 keV 6	12 3	J π : M1+E2 γ's to 1+ and 2+. J π =2+ excluded from non-interference with the Ep=768 keV (resonance state 7471 keV) (1983Go21). Ep=701.8 5 (1977Be08).
7423 2		2.5 keV 5	0.21 5	Ep=717 2 (1977Be08).
7471.7 5	(2+) §	3.5 keV 6	51 15	Ep=767.9 5 (1977Be08).
7515.2 10		<0.5 keV	2.3 5	Ep=813.5 1 (1977Be08).
7547.0 10		<0.6 keV	2.7 5	Ep=846.8 1 (1977Be08).
7573.5 10		<0.5 keV	1.4 3	Ep=874.5 1 (1977Be08).
7599 3		1.9 keV 10	1.3 3	Ep=901 3 (1977Be08).
7605 2		<0.6 keV	0.81 16	Ep=907.5 20 (1977Be08).
7636 3		<0.5 keV	0.9 2	Ep=940 3 (1977Be08).
7683 3		<0.5 keV	0.24 5	Ep=989 3 (1977Be08).
7778.2 10	(1,2)−	2.8 keV 7	2.9 10	J π : From 1975Ch15 (p,p') and earlier studies. Ep=1089.0 10 (1977Be08).
7800.6 10	1+, 2+ §	2.4 keV 7	4.3 13	Ep=1112.5 1 (1977Be08).
7821.1 10		<0.5 keV	1.0 3	Ep=1133.9 1 (1977Be08).
7883.7 9		<2.6 keV		Ep=1199.5 9 (1977Be08). No depopulating gamma observed from this level.
7889.1 11	4+ §	<0.5 keV	8 2	Ep=1205.2 11 (1977Ke04).
7919 2	2−	17 keV 4	9 3	Ep=1237.0 21 (1977Ke04). J π : Assigned in 1977Ke04 on the basis of γ ray feeding.
7965 2		<0.5 keV	1.7 5	Ep=1284.3 21 (1977Ke04).
7977 2		10 keV 3	3.7 11	Ep=1296.9 21 (1977Ke04).
8018 4		<1.0 keV	1.0 3	Ep=1340 4 (1977Be08).
8041 2		<0.5 keV	3.3 10	Ep=1364.1 21 (1977Ke04).
8101 4		3.8 keV 7	2.1 8	Ep=1427 4 (1977Be08).
8108 2		<1.5 keV	1.7 5	Ep=1434.4 19 (1977Ke04).
8114 2		3.5 keV 12	1.6 5	Ep=1441.0 15 (1977Ke04).
8165 2		35 keV 10	21 7	Ep=1494.1 15 (1977Ke04).
8197 4		<0.6 keV	1.0 3	Ep=1528 4 (1977Be08).
8211 2		10 keV 4	7 2	Ep=1542.8 17 (1977Ke04).
8234 2		13 keV 3	26 8	Ep=1566.5 17 (1977Ke04).
8288 2		4.5 keV 10		Γ _p =5 keV. Ep=1623.2 15 (1977Ke04).
8328 2		2.7 keV 8		Γ _p =2 keV. Ep=1665.0 15 (1977Ke04).
8371 2				Ep=1710.0 13 (1977Ke04).
8404 5				Ep=1745 5 (1966St18).
8436 2		5.4 keV 15	3.5 7	Γ _p =8 keV. Ep=1778.5 16 (1977Ke04).

Continued on next page (footnotes at end of table)

$^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued) **^{22}Na Levels (continued)**

E(level) [†]	T _{1/2} [#]	(2J+1)Γ _p Γ _γ /Γ	Comments
8496 2	44 keV 4	25 5	Γ _p =29 keV. Ep=1840.8 15 (1977Ke04).
8538 2	13.2 keV 15		Γ _p <8 keV. Ep=1884.8 17 (1977Ke04).
8562 2		3.6 7	Ep=1910.4 19 (1977Ke04).
8567 2			Ep=1915.8 21 (1977Ke04).
8602 2	11.2 keV 20		Γ _p =2.1 keV. Ep=1952.3 15 (1977Ke04).
8613 2			Ep=1963.3 21 (1977Ke04).
8636 2	11.0 keV 20		Γ _p =5 keV. Ep=1987.5 19 (1977Ke04).
8675 2	5.3 keV 15	4.9 10	Ep=2028.9 20 (1977Ke04).
8741 5			Ep=2098 5 (1966St18).
8792 5			Ep=2152 5 (1966St18).
8845 5			Ep=2207 5 (1966St18).
8875 5			Ep=2239 5 (1966St18).

[†] Level energies up to 5995 keV from 1970An06, except otherwise noted. Above this level, energies have been deduced by evaluator using Ep and Sp(^{22}Na)=6738.71 keV 18 (2012Wa38).

[‡] From 1982Go11.

[§] From Adopted Levels, listed by evaluator for γ-ray multipolarities in this data set.

[#] From 1978Bi11 for E<6 MeV, 1992Be35 for E=6–7.1 MeV, 1977Be08 for E=7.1–8.3 MeV, and 1977Ke04 for E>8.3 MeV.

 $\gamma(^{22}\text{Na})$

E(level)	Eγ [†]	Iγ [†]	Mult. ^b	δ	Comments
1951.7	1294.7 5	0.30 7			
	1368.9 4	100.00 7			
4071.3	2088	100 [‡] 2			
	2543	12.6 [‡] 14			
	4071	3.7 [‡] 6			
5174	3191	20 7			
	4591	100 7			
5603	3651	100			
5700	3748	100			
5959	1599	10 [‡] 2			
	2899	13 [‡] 2			
	5376	47 6			
	5958	100 2			
5988	5404	100			
5995	5411	100			
6859.3	4907.0	100 11			
	6201.4	25 11			
6997.1	2287	33 [§] 4			
	5013.4	100 [§] 6			
	5468.7	10 [§] 2			
	6995.9	61 [§] 4			
6998.1	1824	1.8 [§] 4			
	4028.7	8.4 [§] 18			
	5014.4	11.8 [§] 10			
	5045.8	58 [§] 4			
	5060.5	3.8 [§] 10			
	6414.3	3.6 [§] 8			
	6996.9	100 [§] 4			
7016.4	1057.4	13 1			
	1842.3	4.6 2			
	2656.0	0.4 2			
	2944.9	100 6			
	4047.0	1.4 2			
	5032.7	3.0 4			
	5064.1	45 2			

Iγ: Weighted average of 56 5 (1982Go11) and 43 3 (1978Bi11).

Continued on next page (footnotes at end of table)

$^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. ^b	δ	Comments
7016.4	5488.0	0.9	4		
	6124.6	13	1		
	7015.2	16	1		
7074.9	1080	13.1	13		
	1116	35	2		
	1337	2.2	6		
	1350	1.3	3		
	1375	53	6		
	1901	13.1	9		
	2013	1.9	6		
	2453	1.9	6		
	2492	2.2	6		
	2716.2	2.2	6		
	2779	2.5	6		
	3132.0	2.5	9		
	3555	4.7	6		
	4016.3	7.8	9		
	5124.3	21	5		
	6418.6	100	6		
7152	6492.8	94	6		
	7075.4	1.9	6		
	3080	34@	5		
	4092	8@	3		
	5168	47@	8		
	5624	100@	8		
	6260	24@	5		
	7151	50@	8		
7220	2860	61@	6		
	3275	35@	6		
	4160	39@	6		
	5267	100@	10		
	5282	32@	10		
	6636	45@	6		
	7219	10@	3		
7240	4180	4.9@	12		
	5256	100@	7		
	6348	90@	7		
	7239	49@	7		
7278	2104	7.1@	13		
	2216	4.6@	13		
	2656	5.1@	15		
	3333	7.7@	15		
	4218	26@	5		
	5326	100@	8		
	5340	18@	3		
	6620	8.7@	13		
	6694	79@	8		
7279	3572	15@	5		
	5750	100@	5		
7360	2586	6.9@	17		
	2650	5.2@	17		
	3840	12.1@	17		
	4391	10.3@	17		
	5831	100@	3		
	6468	19@	3		
	7359	19@	3		
7372	2198	26@	3		
	3852	16@	3		
	4801	100@	6		
	5160	19@	6		
	5388	65@	6		
	5420	52@	6		
	6788	16@	3		

Continued on next page (footnotes at end of table)

$^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. ^b	δ	Comments
7372	7371	29@ 3			
7378	2204	33@ 7			
	3306	100@ 7			
	5394	13@ 3			
	5426	6.7@ 20			
	6794	87@ 7			
	7377	93@ 7			
7401	2779	18@ 2			
	3041	9@ 2			
	3456	5.5@ 20			
	4341	24@ 2			
	4830	100@ 5			
	5417	1.8@ 9			
	5449	5.5@ 20			
	5463	11@ 2			
	6743	3.6@ 9			
	6817	3.6@ 9			
7408.6	3048	100# 6	M1+E2	-0.4# -1+4	$A_2=+0.06$ 2, $A_4=-0.02$ 1 (1978He12).
	3464	58# 6	M1+E2	-1.3# 9	$A_2=+0.06$ 3, $A_4=+0.02$ 3 (1978He12).
	4348	90# 6	M1(+E2)	+0.3# 3	$A_2=+0.03$ 4, $A_4=-0.03$ 4 (1978He12).
	5471	48# 6	M1+E2	-0.29# 11	$A_2=+0.02$ 3, $A_4=-0.01$ 3 (1978He12).
	6825	26# 3	M1+E2	-0.19# 10	$A_2=+0.00$ 4, $A_4=+0.01$ 4 (1978He12).
7423	2249	28 ^a 4			
	4852	22 ^a 5			
	5211	10 ^a 2			
	5439	100 ^a 4			
	5485	12 ^a 2			
7471.7	2698	2.6@ 6			
	3151	2.6@ 6			
	4411	5.1@ 13			
	5488	2.6@ 8			
	5534	13# 3	(M1+E2)	+0.2# 2	$A_2=+0.02$ 2, $A_4=-0.01$ 2.
	6888	2.6@ 13			
	7470	100# 4	(M1+E2)	-0.2# 2	$A_2=+0.005$ 9, $A_4=-0.02$ 1.
7515.2	2341	6.4@ 11			
	3444	100@ 6			
	5531	8.5@ 21			
	5563	6.4@ 21			
	6623	60@ 4			
	7514	32@ 4			
7547.0	3602	64@ 4			
	5609	100@ 4			
	6963	18@ 4			
7573.5	3502	100@ 3			
	6045	11.5@ 13			
	6682	7.7@ 13			
	7572	9.0@ 13			
7599	3239	19@ 3			
	3654	25@ 3			
	4539	34@ 6			
	5615	72@ 9			
	5647	31@ 3			
	7015	31@ 6			
	7598	100@ 6			
7605	2431	15@ 3			
	5392	4.5@ 15			
	5621	8@ 3			
	5653	100@ 5			
	6947	20@ 3			
	7021	3.0@ 15			
	7603	1.5@ 7			
7636	2462	100@ 7			
	6744	45@ 5			

Continued on next page (footnotes at end of table)

$^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued) $\gamma(^{22}\text{Na})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. ^b	δ	Comments
7636	7635	34@ 5			
7683	2509	34@ 4			
	3611	100@ 4			
	4163	12@ 2			
	4623	12@ 2			
	6791	32@ 4			
	7682	10@ 2			
7778.2	4718	27@ 3			
	5566	100# @ 3	D(+Q) ^c	-0.1# 6	$A_2=-0.14$ 3, $A_4=-0.02$ 3. δ : If $J\pi=1-$, $\delta=-0.1$ 6. If $J\pi=2-$, $\delta=-0.03$ 3.
	5826	42# @ 3	D(+Q) ^c	-0.05# 10	$A_2=-0.12$ 4, $A_4=-0.05$ 4. δ : If $J\pi=1-$, $\delta=-0.05$ 10. If $J\pi=2-$, $\delta=+0.1$ 3.
7800.6	2626	23@ 3			
	5848	100# 4	D+Q ^c	-0.15# 9	$A_2=+0.03$ 3, $A_4=-0.04$ 3. δ : If $J\pi=2+$, $\delta=-0.15$ 9. If $J\pi=1+$, $\delta=+0.2$ 2.
	7799	22# 4	D+Q ^c		$A_2=+0.01$ 5, $A_4=-0.03$ 5. δ : If M1, $\delta<+0.35$.
7821.1	2647	78@ 4			
	5869	20@ 4			
	7163	100@ 4			
	7820	6@ 2			
7889.1	4920	4.2@ 12			
	5905	29# 4	D+Q ^c	+0.08# 3	$A_2=-0.14$ 5, $A_4=-0.07$ 5.
	6360	100# 6	D+Q ^c	-0.03# 2	$A_2=-0.09$ 3, $A_4=-0.01$ 3.
	6997	71# 6	D(+Q) ^c	+0.01# 2	$A_2=+0.40$ 2, $A_4=-0.01$ 2.
	7888	4.2@ 10			
7919	3558	42@ 6			
	5348	16@ 6			
	5706	19@ 6			
	5935	61@ 6			
	5981	84@ 10			
	7917	100@ 10			
7965	3645	15@ 3			
	4020	30@ 3			
	6027	100@ 3			
	7381	20@ 3			
7977	5405	50@ 6			
	5764	68@ 6			
	6024	15@ 6			
	6039	15@ 6			
	7319	29@ 6			
	7393	100@ 6			
	7975	18@ 9			
8018	3946	49@ 12			
	4311	42@ 16			
	7126	100@ 21			
	8016	42@ 16			
8041	3267	4.8@ 12			
	3680	4.8@ 12			
	4521	6.0@ 12			
	5071	2.4@ 6			
	7149	1.2@ 6			
	8039	100@ 4			
8101	3740	3.6@ 11			
	5040	7.1@ 18			
	6148	57@ 5			
	7443	100@ 5			
	7517	7.1@ 18			
	8099	3.6@ 11			
8108	2666	59@ 5			
	4587	69@ 5			
	6579	100@ 5			
	7216	5.1@ 25			

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$^{21}\text{Ne}(\text{p},\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued) **$\gamma(^{22}\text{Na})$ (continued)**

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Comments
8108	8106	23@ 3	
8114	5053	100@ 11	
	6161	15@ 9	
	7222	57@ 11	
	8112	46@ 9	
8165	3804	34@ 11	
	5104	16@ 9	
	6212	34@ 11	
	7273	100@ 11	
	8163	43@ 11	
8197	4125	35@ 8	
	6244	47@ 12	
	6259	14@ 12	
	8195	100@ 10	
8211	3037	73@ 8	
	6258	100@ 8	
	8209	100@ 8	
8234	3651	7.3@ 18	
	3873	10.9@ 18	
	5173	18@ 4	
	6281	16@ 4	
	7650	22# 4	$A_2=+0.02$ 5, $A_4=+0.03$ 5.
	8232	100# 5	$A_2=0.00$ 4, $A_4=0.00$ 4.
8436	4075	11&	
	4915	50&	
	5375	16&	
	6223	42&	
	6498	3&	
	7852	100&	
	8434	45&	
8496	4135	1&	
	5435	1&	
	8494	100#	$A_2=+0.04$ 3, $A_4=+0.04$ 3.
8675	4603	9&	
	5614	2&	
	6462	100&	
	7783	38&	
	8091	23&	
	8673	19&	

† From 1982Go11, except as noted. γ -ray energies without uncertainty were calculated from level energy difference, recoil energy subtracted.

‡ From 1978Bi11.

§ From 1992Be35.

$^{\#}$ From 1978He12.

$^{\textcircled{a}}$ From 1977Be08.

$^{\&}$ From 1977Ke04.

$^{\text{a}}$ From 1983Go21.

$^{\text{b}}$ From Adopted Gammas, except otherwise noted.

$^{\text{c}}$ From angular distribution coefficients.

$^{21}\text{Ne}(p,\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued)

Level Scheme

Intensities: relative photon branching from each level

$^{22}_{11}\text{Na}_{11}$

$^{21}\text{Ne}(p,\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued)

Level Scheme (continued)

Intensities: relative photon branching from each level

$^{22}_{11}\text{Na}_{11}$

$^{21}\text{Ne}(p,\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued)

Level Scheme (continued)

Intensities: relative photon branching from each level

$^{21}\text{Ne}(p,\gamma)$ 1982Go11,1978Bi11,1977Be08 (continued)

Level Scheme (continued)

Intensities: relative photon branching from each level

$^{21}\text{Ne}(\text{p,p}),(\text{p,p}') \quad 1975\text{Ch15}$ $J\pi(^{21}\text{Ne})=3/2+$.

Target: Enriched (91%) ^{21}Ne target with 3.3% ^{20}Ne and 5.7% ^{22}Ne isotopes; Projectile: p, $E=0.6-2.0$ MeV; The reaction particles were detected simultaneously by eight surface barrier detectors placed at angles between 40° and 160° in the laboratory system. Measured proton spectrum, deduced resonance energies, L, Γ_p .

 ^{22}Na Levels

E(level) [†]	$J\pi^\ddagger$	L	$\Gamma_p^\S$	Comments
7408.6 5	(1,2)+	0	<2 [#]	
7471.7 12	(1,2)+	0	2	
7599 3	(1 to 3)-	1	2.5	
7778.2 10	(1 to 3)-	1	<2 [#]	
7800.6 10	(1,2)+	0	1.8	
7889.1 11	(0 to 4)+	2	<0.5 [@]	
7919 2	1-	1	23	E(level): Possible doublet (1975Ch15).
7977 2	(1 to 3)-	1	2	
8101 4	(1,2)+	0	<4 [#]	
8114 2	2-, 3-	1	0.6	
8165 2	3-	1	15	
8211 2	2+	0	4.5	
8234 2	2+	0	4.4	
8288 2	(1 to 3)-	1	5	
8328 2	1-, 2-	1	2	
8436 2	(1 to 3)-	1	8	
8496 2	2+	0	29	
8538 2	(1 to 3)-	1	<8 [#]	
8567 2	(0 to 4)+	2	<4.5 [#]	
8602 2	(1 to 3)-	1	2.1	
8636 2	3-	1	5	

[†] Resonance energies from Adopted Levels.[‡] Assignment in 1975Ch15.[§] In units of keV.[#] The upper limit corresponds to the proposed upper spin value.[@] For weak widths only an upper limit is given. **$^{21}\text{Ne}(^3\text{He,d}) \quad 1971\text{Ga14}$** $J\pi(^{21}\text{Ne})=3/2+$.

$^{21}\text{Ne}(^3\text{He,d})$ $E=18$ MeV. Enriched target, $J\pi=3/2+$. Measured $\sigma(E_p, \theta)$, multi-angle spectrograph. DWBA calculation.

 ^{22}Na Levels

E(level) [†]	L	S	Comments
0.0	2	0.47	
583	2(+0)	0.65	
657	2	<0.4	
891	2	0.80	
1528			
1936	0+2		L: unresolved from 1952 keV level.
1952	0+2		L: unresolved from 1936 keV level.
1983	2	0.27	
2212	1		
2572	1		
2969	2		
3060	0+2	0.12, 0.5 6	
3520	(1)		
3707			
3944	0+2	0.33	
4072	2	0.04	
4320	(2)		
4361	0		

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$^{21}\text{Ne}(^3\text{He},\text{d})$ 1971Ga14 (continued) **^{22}Na Levels (continued)**

E(level) [†]	L	S	E(level) [†]	L	S	E(level) [†]	L	S
4468			5174	0+2	0.12, 0.28	5995	0+2	
4524			5318	2(+0)		6090	2(+0)	
4583	(0)		5442	1		6189	2	
4622			5603	0+2		6242		
4771	2	0.13	5725			6329	1	0.37
5063			5739			6433		
5101			5832			6551	0+2	
5131			5863					

[†] From Adopted Levels. **$^{22}\text{Ne}(^3\text{He},\text{t})$ 1970Du08** $J\pi(^{22}\text{Ne})=0+$. $^{22}\text{Ne}(^3\text{He},\text{t})$ E=16,30 MeV. **^{22}Na Levels**

E(level)	L	E(level)	L	E(level)	L
0.0	2+4	2211	0	3710	4
583	2	2572	1+3	3950	2,3
657	0	2969	3	4080	4
891	4	3059	2		
1528	4+6	3530	4		

 $^{23}\text{Na}(^3\text{He},\alpha)$ 1971Ga22,1964Hi05 $J\pi(^{23}\text{Na})=3/2+$.Other: 1975Sp02: $^{23}\text{Na}(^3\text{He},\alpha)$, E=8.46 MeV. Measures $\alpha\gamma$ coincidences.1971Ga22: $^{23}\text{Na}(^3\text{He},\alpha)$, E=18 MeV. Measured $\sigma(E\gamma,0)$, multi-angle spectrograph. DWBA calculations.1964Hi05: $^{23}\text{Na}(^3\text{He},\alpha)$, E=6, 13.02 MeV. Magnetic spectrograph. **^{22}Na Levels**

E(level) [‡]	L	NC ² S [†]	Comments
0.0	2	27, 40	
583 5	2	11.1, 16.2	
660 5	2	3.24	NC ² S: For $j_n=3/2$.
890 5	2	25.5	NC ² S: For $j_n=5/2$.
1528 5			
1945 7	2	25.8, 40.8	E(level): Doublet.
1980 7	2	12.9, 19.6	
2212 7	1	9.52, 12.0	
2567 7	1	7.8, 9.6	
2978 20	(2)	<0.9, 1.4	
3062 7	2	1.68, 2.56	
3526 10		<0.16	NC ² S: For $j_n=3/2$.
3704.4 10			
3951 10	0	1.4	NC ² S: For $j_n=1/2$.
4071.4 6	2	7.8	NC ² S: For $j_n=5/2$.
4317 10			
4362 10	0+2		
4467.0 7			
4523.4 7			
4583 10	1	12.0, 15.3	

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$^{23}\text{Na}(^3\text{He},\alpha)$ 1971Ga22,1964Hi05 (continued) **^{22}Na Levels (continued)**

E(level) [‡]	L	NC ² S [†]	Comments
4640 20			
4732 § 10	(0)		
4769 10	(2)	4.56, 7.20	
5063 10	0+2	0.86, 0.26	
5115 10			
5167 10	0+2		
5322 10			
5436 10	1	3.72, 4.90	
5600 10	0+2		
5728 § 15	(0)		
5738 10			
5828 20			
5865 10	0+2		
5958 10	1	19.6, 26.4	
6004 20	2	5.64, 8.96	
6074 20	0+2		
6183 10	(2)	1.95, 3.28	
6236 10			
6324 10	(1)	6.48, 8.60	
6429 10			
6528 § 10	(0)		
6543 10			
6594 20			
6641 20			
6674 10	(0+2)		
6711 10	(1)	2.68, 3.64	
6770 20			
6866 20			
6949 20			
7000 10	2	4.56, 7.00	
7075 20			
7158 20			
7225 20			
7285 10	2	6.94, 8.60	
7356 20			
7403 10			
7512 10	0	0.169	NC ² S: For $j_n=1/2$.

[†] For $j_n=l_n+1/2$, $j_n=l_n-1/2$, respectively. From 1971Ga22.[‡] From 1964Hi05 if $\Delta E < 10$, otherwise from 1971Ga22, except as noted.

§ From 1964Hi05.

 $^{24}\text{Mg}(p,^3\text{He})$ 2010Ch46 $J\pi(^{24}\text{Mg})=0+$.

Enriched (99.9%) ^{24}Mg target, thickness 500 $\mu\text{g}/\text{cm}^2$, proton beam, $E=41-$ and $51.5-\text{MeV}$. Recoiling ^3He detected in a large area annular silicon detector array (SIDAR), each detector segmented into 16 radial strips and configured with a 100- μm detector backed by a 1000- μm detector. Measured $\sigma(E_\alpha, \theta)$. Deduced levels, J , π , L for 10 levels from DWBA analysis.

 ^{22}Na Levels

E(level)	$J\pi^{\dagger}$	$L^{\dagger}$	Comments
1936 [†]	1+	0	Relative $d\sigma/d\Omega=0.440$ 6 at 28° .
2572 [†]	2-, 3-, 4-	3	Relative $d\sigma/d\Omega=0.064$ 3 at 27° .
2969 [†]	1+, 2+, 3+	2	Relative $d\sigma/d\Omega=0.125$ 4 at 18° .
3944 [†]	1+	0	Relative $d\sigma/d\Omega=0.077$ 1 at 28° .
5061 3	1+, 2+, 3+	0+2	E(level): unresolved level.
5914 4	(2-, 3-, 4-)	(3)	Relative $d\sigma/d\Omega=0.010$ 1 at 28° .

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$^{24}\text{Mg}(\text{p}, ^3\text{He})$ 2010Ch46 (continued) **^{22}Na Levels (continued)**

E(level)	$J\pi^{\ddagger}$	$L^{\ddagger}$	Comments
6329 7	1+, 2+, 3+	2	Relative $d\sigma/d\Omega=0.039$ 2 at 18° .
6996 11	1+, 2+, 3+	2	Relative $d\sigma/d\Omega=0.007$ 2 at 18° .
7215 10	0-, 1-, 2-	1	Relative $d\sigma/d\Omega=0.024$ 3 at 15° .
9715 13	(1+, 2+, 3+)	(2)	Relative $d\sigma/d\Omega=0.011$ 1 at 50° .

$\dagger$ Used for ^3He spectrum calibration.

$\ddagger$ From comparison of experimental differential cross section with DWBA predictions.

 $^{24}\text{Mg}(\text{d}, \alpha)$ 1964Hi05, 1976Sc06

$J\pi(^{24}\text{Mg})=0+$.

Others: 1966Ja05.

1964Hi05: $^{23}\text{Na}(\text{d}, \alpha)$, E=6, 13.02 MeV. Magnetic spectrograph.

1976Sc06: $^{23}\text{Na}(\text{d}, \alpha)$, E=17-26 MeV. Multigap spectrometer, enriched targets.

 ^{22}Na Levels

E(level)	$J\pi^{\dagger}$	$L^{\ddagger}$	$S^{\S}$	Comments
0.0	-	2(+4)	1.3	
585 5	-	0(+2)	0.34	
655 5	+			
888 5	+	4	4.7	
1527 5	-	4	1.0	
1933 7	-	0+2	0.72	
1946 7	+			
1980 7	-	2+4	1.3	
2210 7	+	1		
2566 7	-	1+3		
2965 7	-	2(+4)	0.57	
3055 7	+	2	1.0	
3521 10	+	3		
3710 10	+			
3943 10	-	0(+2)	0.48	
4082 10	+			
4300	-			$J\pi$: Probably 0-.
4329 10	-			
4365 10	+			
4474 10	3+	3		$J\pi$: From (pol d, $\alpha\gamma$) (1977Ku02). Unnatural parity.
4532 10	-			
4593 10	-			
4631 10				
4721 10	-	4	1.4	
4786 10				
5076 10				
5111 15	+			
5139 10				
5330 15	-			
5446 10				
5615 15				
5741 15				
5752 15				
5842 10				
5876 10				
5938 15				
6001 15				
6092 10				
6200 15				
6251 15				
6338 15				

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 $^{24}\text{Mg}(\text{d},\alpha)$ 1964Hi05,1976Sc06 (continued)

 ^{22}Na Levels (continued)

<u>E(level)</u>	<u>E(level)</u>	<u>E(level)</u>
6434 10	6863 10	7409 20
6450? 15	6955 10	7513 20
6533 10	7017 20	7548 20
6563 15	7094? 20	7573 20
6591 15	7155 20	7628 20
6643 10	7212 20	7677 20
6727 15	7276 20	7822 20
6752 15	7364 20	7882 20

[†] From $^{24}\text{Mg}(\text{pol d},\alpha)$, Boerma, Jahresbericht ETH Zurich (1976), summarized in 1978En02.

[‡] From 1976Sc06.

[§] (d, α) normalization divided by the average (d, α) normalization for eight states (1976Sc06).

Adopted Levels, Gammas

$Q(\beta^-) = -18601$ SY; $S(n) = 19385$ 16; $S(p) = 5504.3$ 4; $Q(\alpha) = -8142.5$ 5 2012Wa38.

$\Delta Q(\beta^-) = 401$ (syst) 2012Wa38.

 ^{22}Mg Levels

Cross Reference (XREF) Flags

A ^{22}Al β^+ Decay
 B ^{23}Si ϵp Decay
 C $^1\text{H}(^{21}\text{Na}, \gamma)$
 D $^1\text{H}(^{21}\text{Na}, p)$: Res
 E $^{12}\text{C}(^{12}\text{C}, 2n\gamma)$

F $^{12}\text{C}(^{16}\text{O}, ^6\text{He})$
 G $^{12}\text{C}(^{22}\text{Mg}, ^{22}\text{Mg}')$
 H $^{12}\text{C}(^{23}\text{Al}, ^{22}\text{Mg}\gamma)$
 I $^{18}\text{Ne}(\alpha, p)$
 J $^{20}\text{Ne}(^3\text{He}, n), (^3\text{He}, n\gamma)$

K $^{24}\text{Mg}(p, t)$
 L $^{24}\text{Mg}(\alpha, ^6\text{He})$
 M $^{25}\text{Mg}(^3\text{He}, ^6\text{He})$

E(level) [†]	J π	XREF	T _{1/2} [@]	Comments
0.0	0+	ABC EF HIJK M	3.8755 s 12	% ϵ +% β^+ =100. $\delta\langle r^2 \rangle(^{26}\text{Mg}, ^{22}\text{Mg}) = +0.214$ fm ² 5 (stat) 51 (syst) (2012Yo01). $\langle r^2 \rangle^{1/2} = 3.0691$ fm 7 (stat) 86 (syst) (2012Yo01). J π : L=0 in (p,t). T _{1/2} : From 2003Ha20. Other value: 3.857 s 9 (1972Ha58, 1975Ha21). 2015Ha07 Weighted average of data in 2003Ha20 and 1975Ha21 is 3.8752 s 24 at 2 σ (2015Ha07).
1247.02 3	2+	ABC EF H JK M	2.0 ps 8	J π : L=2 in (p,t); E2 γ to 0+. T _{1/2} : From weighted average of 2.9 ps 10 (1975Gr04) and 1.3 ps 9 (symmetric value of 0.7 ps +15-3 (1972Ro20)) in ($^3\text{He}, n$), ($^3\text{He}, n\gamma$).
3308.22 6	4+	A C EF H JK M	200 fs 45	J π : E2 γ to 2+, member of isobaric triplet.
4402.0 3	2+	C EF JK M	<21 fs	J π : L=(2) and natural parity in (p,t). (M1) to 2+, γ 's to 0+ and 4+.
5035.4 5	2+	EF JK M	<0.07 ns	E(level): From ($^{12}\text{C}, 2n\gamma$).
5089.3 8	(1+)	E K M		J π : L=2 in ($^3\text{He}, n$) and L=(2) and natural parity in (p,t). J π : Assigned in 2005Se02 ($^{12}\text{C}, 2n\gamma$) based on γ ray feeding and transition characteristics.
5293.11 16	(4+)	A E H JK	44 fs 15	J π : (M1+E2) γ to 4+. 2005Se02 ($^{12}\text{C}, 2n\gamma$) assigned 4+ comparing with a 4+ state at 5146.0 keV in ^{22}Ne mirror. Natural parity in (p,t).
5296.0 4	(2-)	E J		J π : Dipole γ to 2+. 2005Se02 ($^{12}\text{C}, 2n\gamma$) assigned 2- comparing with a 2- state at 5146.0 keV in ^{22}Ne mirror.
5318 4	(4+)	J	<17 ns	J π : L=(4) in $^{20}\text{Ne}(^3\text{He}, n)$.
5452.4 4	(3+)	A E JK	<0.07 ns	XREF: J(5464). J π : Dipole γ to 2+. 2005Se02 ($^{12}\text{C}, 2n\gamma$) assigned 3+ in analogy with a 3+ state at 5641.2 keV in ^{22}Ne mirror. Natural parity in 2001Ba17 (p,t) probably doubtful - 2005Se02 note the strength is noticeably suppressed.
5711.4 7	2+	C EF JK M	28 fs 10	J π : L=2 in and natural parity in (p,t); L=2 in ($^3\text{He}, n$). $\Gamma_p/\Gamma < 0.20$ (2003Da36).
5838 5	2+, 3, 4+	C J	<17 ns	J π : γ 's to 2+ and 4+.
5953.8 8	0+	C JK		XREF: J(5980). $\Gamma_p/\Gamma = 0.98$ 1 (2003Da36). E(level): From (p,t). J π : L=0 in ($^3\text{He}, n$) and (p,t).
6043 3	(0+)	C F KLM		E(level): From 6036.2 8 (p,t), 6042 13 ($^{21}\text{Na}, \gamma$), 6051 4 ($^3\text{He}, ^6\text{He}$), 6041 11 ($^{16}\text{O}, ^6\text{He}$), 6059 9 ($\alpha, ^6\text{He}$) using The Limitation of Relative Statistical Weight method (1985ZiZY). J π : Natural parity in 2001Ba17 (p,t), L=0 in (p,t). However, 2003Da36 assign 1-.
6226.1 10	(4+)	A C F K M		$\Gamma_p/\Gamma = 0.97$ 3 (2003Da36). E(level): From (p,t). J π : L=4 in ($^3\text{He}, n$); Analogue state of 6345.1 (J π =4+) in ^{22}Ne . (2009Ma68).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) **^{22}Mg Levels (continued)**

E(level) [†]	J π	XREF			T _{1/2} [@]	Comments
6242.7? 11		C	F	M		XREF: F(6255). E(level): From ($^{21}\text{Na},\gamma$). Evaluator lists this level as doubtful based on observations in 2009Ma68 (p,t). It is noted that 2001Ba17 (p,t) measured a peak at 6241.1 keV 51 (width 26 keV 6) and suggested as a doublet. 2005Se02 ($^{12}\text{C},2n\gamma$) resolved the doublet by measuring a 6+ state at 6254 keV. 2009Ma68 measured only one level at 6226.1 keV 10 (width 13 keV). Evaluator's note: Average of 6254.23 and 6226.1 is 6240.1.
6254.23 $\frac{+}{-}$ 21	6+	E	JKL			XREF: K(6226). E(level): From ($^{12}\text{C},2n\gamma$). J π : L=6 in (p,t) – see comments for level at 6226.1), Q γ to 4+.
6313 5	4+	A	JK		<17 ns	E(level): Weighted average of 6307 8 (^{22}Al β^+ decay) and 6317 6 (p,t). J π : L=4 in (p,t) and ($^3\text{He},n$). E(level): From ($^{21}\text{Na},\gamma$). J π : Analogue state of 6853.5 (J π =(1+)) in ^{22}Ne . Γ : Other value – 16 keV 3 ($^{21}\text{Na},\gamma$ – 2004Da17).
6325.6 10	(1+) $\frac{\$}{\$}$	CD	K M		13.6 keV 14	E(level): From (p,t). J π : From differential cross section fittings (2005Ru01). Γ_p =11.9 keV 14 and Γ_p =0.94 keV 11 ($^{21}\text{Na},p$) – 2005Ru01).
6476 8		A				E(level): Weighted average of 6611 11 ($^{21}\text{Na},p$), 6606 7 (p,t), 6605.4 25 ($^{21}\text{Na},\gamma$), 6616 4 ($^3\text{He},^6\text{He}$), 6606 11 ($^{16}\text{O},^6\text{He}$), 6606 9 ($\alpha,^6\text{He}$). J π : L=0 and natural parity in ($^{21}\text{Na},p$), analogue state of 6819.4 (J π =2+) in ^{22}Ne . Γ : Other values: – 30 keV 7 ($^{21}\text{Na},\gamma$ – 2004Da17). Γ_p =17.6 keV 15 and Γ_p =0.3 keV 1 ($^{21}\text{Na},\gamma$ – 2005Ru01); Γ_p =23 keV 7 ($^{21}\text{Na},p$ – 2009He12).
6578 7	(1-) $\frac{\$}{\$}$	D	JK		12.8 keV 15	E(level): From (p,t). J π : From differential cross section fittings (2005Ru01). Γ_p =11.9 keV 14 and Γ_p =0.94 keV 11 ($^{21}\text{Na},p$) – 2005Ru01).
6608 2	(2+) $\frac{\$}{\$}$	CD F	KLM		17.9 keV 16	E(level): Weighted average of 6611 11 ($^{21}\text{Na},p$), 6606 7 (p,t), 6605.4 25 ($^{21}\text{Na},\gamma$), 6616 4 ($^3\text{He},^6\text{He}$), 6606 11 ($^{16}\text{O},^6\text{He}$), 6606 9 ($\alpha,^6\text{He}$). J π : L=0 and natural parity in ($^{21}\text{Na},p$), analogue state of 6819.4 (J π =2+) in ^{22}Ne . Γ : Other values: – 30 keV 7 ($^{21}\text{Na},\gamma$ – 2004Da17). Γ_p =17.6 keV 15 and Γ_p =0.3 keV 1 ($^{21}\text{Na},\gamma$ – 2005Ru01); Γ_p =23 keV 7 ($^{21}\text{Na},p$ – 2009He12).
6724 8		A				E(level): Weighted average of 6611 11 ($^{21}\text{Na},p$), 6606 7 (p,t), 6605.4 25 ($^{21}\text{Na},\gamma$), 6616 4 ($^3\text{He},^6\text{He}$), 6606 11 ($^{16}\text{O},^6\text{He}$), 6606 9 ($\alpha,^6\text{He}$). J π : L=0 and natural parity in ($^{21}\text{Na},p$), analogue state of 6819.4 (J π =2+) in ^{22}Ne . Γ : Other values: – 30 keV 7 ($^{21}\text{Na},\gamma$ – 2004Da17). Γ_p =17.6 keV 15 and Γ_p =0.3 keV 1 ($^{21}\text{Na},\gamma$ – 2005Ru01); Γ_p =23 keV 7 ($^{21}\text{Na},p$ – 2009He12).
6766 12	(3-) $\frac{\$}{\$}$	D F	JKLM		105 keV 33	E(level): Weighted average of 6792 17 ($^{21}\text{Na},p$), 6770 20 ($^3\text{He},n$), ($^3\text{He},n\gamma$), 6768.8 12 (p,t), 6771 5 ($^3\text{He},^6\text{He}$), 6767 20 ($^{16}\text{O},^6\text{He}$), and 6766 12 ($\alpha,^6\text{He}$). Also Γ_p =94 keV 32 and Γ_p =11.1 keV 8 (2005Ru01); Γ_p =64 keV 20 (2009He12). J π : From ^{22}Al β^+ decay, log ft=5.6 from (4)+.
6865 8	(3+) $\frac{\$}{\$}$	A				E(level): From (p,t). J π : L=3 in ($^3\text{He},n$). J π : L=3 in ($^3\text{He},n$).
6876.0 12	(1-) $\frac{\$}{\$}$	D F	K M			E(level): From (p,t). J π : L=3 in ($^3\text{He},n$).
6983 9	(3-)		J			
7027 9	[3+] $\frac{\#}{\#}$		K			
7048 5	[4+] $\frac{\#}{\#}$	A	K			E(level): Weighted average of 7052 8 (^{22}Al β^+ decay) and 7045 7 (p,t).
7060 7			K			
7079 8	[1-] $\frac{\#}{\#}$		K			
7132 8	(5+)	A				J π : From ^{22}Al β^+ decay, log ft=4.75 from (4)+.
7218.3 10	0+		JKLM			E(level): From (p,t). J π : L=0 in ($^3\text{He},n$). XREF: D(7270).
7254 8	(1-) $\frac{\$}{\$}$	A D				E(level): From (p,t). XREF: D(7270).
7338 13	(2+) $\frac{\$}{\$}$	D	K			E(level): From (p,t). XREF: M(7757).
7384 8	(3-) $\frac{\$}{\$}$	D F	K M			E(level): Weighted average of 7402 13 ($^{16}\text{O},^6\text{He}$), 7389 12 (p,t), and 7373 9 ($^3\text{He},^6\text{He}$). XREF: D(7585). E(level): From (p,t). Γ_p =23 keV 7 ($^{21}\text{Na},p$) – 2009He12).
7573 8		A				XREF: D(7585). E(level): From (p,t). Γ_p =23 keV 7 ($^{21}\text{Na},p$) – 2009He12).
7599.5 29	(2+) $\frac{\$}{\$}$	D	KLM			XREF: D(7585). E(level): From (p,t). Γ_p =23 keV 7 ($^{21}\text{Na},p$) – 2009He12).
7674 18	(1-) $\frac{\$}{\$}$	D F				XREF: D(7654). XREF: M(7757).
7741.1 2			K M			E(level): From (p,t). XREF: D(7802).
7810 40	(2-) $\frac{\$}{\$}$	D	J			J π : Unnatural parity ($^{21}\text{Na},p$).

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Adopted Levels, Gammas (continued) **^{22}Mg Levels (continued)**

E(level) [†]	J π	XREF		Comments
7928 3	[2+] [#]	D F	JKLM	XREF: D(7920). E(level): Weighted average of 7920.6 15 (p,t), 7931 5 ($^3\text{He}, ^6\text{He}$), 7964 16 ($^{16}\text{O}, ^6\text{He}$), 7938 9 ($\alpha, ^6\text{He}$).
8007.0 14	[3-] [#]	A D	KL	E(level): from (p,t). J π : Natural parity ($^{21}\text{Na}, \text{p}$).
8062 16		F		
8180.3 17	[2+] [#]	D F	KLM	XREF: F(8203)L(8197)M(8229). E(level): From (p,t).
8290 40		A	J	XREF: A(8339).
8398 8	[2+] [#]	A D F	KLM	XREF: D(8353). E(level): Weighted average of 8416 8 (^{22}Al β^+ decay), 8394 21 ($^3\text{He}, ^6\text{He}$), 8396 15 ($^{16}\text{O}, ^6\text{He}$), 8380 10 ($\alpha, ^6\text{He}$), 8383 13 (p,t).
8519.3 21	(3-) [§]	D F	JKLM	XREF: F(8547)J(8550)M(8487). E(level): From (p,t). $\Gamma_p=60$ keV 20 ($^{21}\text{Na}, \text{p}$) – 2009He12).
8579 6		A D	K M	E(level): Weighted average of 8589 8 (^{22}Al β^+ decay), 8598 20 ($^3\text{He}, ^6\text{He}$), and 8572 6 (p,t).
8657.5 17		D F	KL	XREF: D(8677)F(8613)L(8644). E(level): From (p,t).
8727	(2+) [§]	D		
8743 14	[4+] [#]		K	
8784.5 23	[1-] [#]	F	KLM	XREF: F(8754). E(level): From (p,t).
8827	(1-) [§]	D		
8933.1 29	[2+] [#]	D F	KL	E(level): Weighted average of 8925 19 ($^{16}\text{O}, ^6\text{He}$) and 8921 9 ($\alpha, ^6\text{He}$).
8991 7	(1-) [§]	A D	L	XREF: D(9050). E(level): Weighted average of 8985 8 (^{22}Al β^+ decay) and 9029 20 ($\alpha, ^6\text{He}$).
9080 7		F	KL	XREF: L(9029). E(level): Weighted average of 9082 7 (p,t) and 9066 18 ($^{16}\text{O}, ^6\text{He}$).
9157 4	(4+) [§]	D F	KL	XREF: F(9172). E(level): From (p,t).
9248? 20		F		
9318 12		F	K	E(level): Weighted average of 9329 26 ($^{16}\text{O}, ^6\text{He}$), 9315 14 (p,t).
9378? 22			L	E(level): Weighted average of 9378 22 ($^{16}\text{O}, ^6\text{He}$), 9315 14 (p,t).
9452? 21		F		
9481 18	[3-] [#]	F	K	E(level): Weighted average of 9452 21 ($^{16}\text{O}, ^6\text{He}$) and 9492 13 (p,t).
9529 7		A F	KL	XREF: A(9518). E(level): Weighted average of 9518 8 (^{22}Al β^+ decay), 9533 24 ($^{16}\text{O}, ^6\text{He}$), 9542 12 ($\alpha, ^6\text{He}$), and 9546 15 (p,t). J π : [2+] in 2009Ma68 (p,t) and (1-) in 2009Ch28 (p,t).
9640 9		F	L	E(level): Weighted average of 9638 21 ($^{16}\text{O}, ^6\text{He}$) and 9640 10 ($\alpha, ^6\text{He}$).
9712 21	[0+] [#]	a F	K	E(level): From ($^{16}\text{O}, ^6\text{He}$).
9751.6 27	(2+, 1+) [#]	a	KL	E(level), J π : From (p,t). 2009Ma68 (p,t) propose [2+] from mirror analogy with 10137 keV level in ^{22}Ne .
9859 5	[0+] [#]	F	KL	E(level): Weighted average of 9827 44 ($^{16}\text{O}, ^6\text{He}$), 9853 11 ($\alpha, ^6\text{He}$), and 9861 6 (p,t).
9960 7		A F	L	XREF: A(9965). E(level): Weighted average of 9965 8 (^{22}Al β^+ decay), 9924 28 ($^{16}\text{O}, ^6\text{He}$), and 9953 13 ($\alpha, ^6\text{He}$).
10084 13	[2+] [#]	F	KL	XREF: L(10128). E(level): Weighted average of 10087 15 (p,t) and 10078 24 ($^{16}\text{O}, ^6\text{He}$).
10168 9	[3+] [#]	F	K	E(level): From (p,t).
10271.7 17	[2+] [#]	F	KL	XREF: F(10297). E(level): Weighted average of 10297 25 ($^{16}\text{O}, ^6\text{He}$) and 10260 10 ($\alpha, ^6\text{He}$).
10418 8	[4+] [#]	A F	KL	XREF: L(10389). E(level): Weighted average of 10413 10 (^{22}Al β^+ decay), 10429 26 ($^{16}\text{O}, ^6\text{He}$), and 10430 19 (p,t). J π : From (p,t). 2009Ch28, also in (p,t), propose (1-). Considering the presence of this level in ^{22}Al β^+ decay, evaluator lists [4+].
10572 22		F	I	E(level): Weighted average of 10580 50 (α, p) and 10570 25 ($\alpha, ^6\text{He}$).
10665 11	[3-] [#]	A F	KL	E(level): Weighted average of 10678 12 (^{22}Al β^+ decay), 10660 28 ($^{16}\text{O}, ^6\text{He}$), 10627 20 ($\alpha, ^6\text{He}$), and 10667 19 (p,t).
10768 13	[2+] [#]	F	i KL	E(level): Weighted average of 10750 31 ($^{16}\text{O}, ^6\text{He}$), 10776 20 ($\alpha, ^6\text{He}$), and 10768 21 (p,t).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{22}Mg Levels (continued)

E(level) [†]	J π	XREF	Comments
10876 14	[4+] [#]	F i K	E(level): Weighted average of 10881 15 (p,t) and 10844 38 ($^{16}\text{O},^6\text{He}$).
10901 17		F I L	E(level): Weighted average of 10910 50 (α ,p), 10844 38 ($^{16}\text{O},^6\text{He}$), and 10915 20 ($\alpha,^6\text{He}$).
11001 11	[0+] [#]	F I KL	E(level): Weighted average of 10990 50 (α ,p), 10980 31 ($^{16}\text{O},^6\text{He}$), 11015 20 ($\alpha,^6\text{He}$), and 10999 15 (p,t).
11122 17		F I L	E(level): Weighted average of 11130 50 (α ,p), 11135 40 ($^{16}\text{O},^6\text{He}$), and 11118 20 ($\alpha,^6\text{He}$).
11231? 20		L	
11314 16	[4+] [#]	A KL	E(level): From 11313 20 ($\alpha,^6\text{He}$) and 11317 27 (p,t).
11410 8		A	
11499 17	[2+] [#]	K	
11594 12		KL	E(level): Weighted average of 11581 20 ($\alpha,^6\text{He}$) and 11603 16 (p,t). J π : (3-,4+) in 2009Ch28 and [1-] in 2009Ma68 both in (p,t).
11748 17	[0+] [#]	KL	E(level): Weighted average of 11742 20 ($\alpha,^6\text{He}$) and 11760 30 (p,t).
11914 13		KL	E(level): Weighted average of 11881 20 ($\alpha,^6\text{He}$) and 11937 17 (p,t). J π : (1-,2+) in 2009Ch28 and [0+] in 2009Ma68 both in (p,t).
12003? 20		L	
12185 17	[3-] [#]	KL	E(level): Weighted average of 12169 20 ($\alpha,^6\text{He}$) and 12220 30 (p,t).
12474 26	[2+] [#]	K	
12665 17	[3-] [#]	K	
13014 37		A K	E(level): Weighted average of 13018 56 (^{22}Al β^+ decay) and 13010 50 (p,t). J π : [0+] in (p,t) not consistent, considering population of this level in ^{22}Al β^+ decay from (4)+.
14012 3		A G	E(level): IAS of ^{22}Al g.s., J π =4+. Other value: 14044 keV 15 (1982Ca16).

[†] From least squares fit to γ -ray energies for excited levels up to 5838 keV.[‡] From ($^{12}\text{C},2n\gamma$).[§] From R-matrix analysis in 2014Zh05 ($^{21}\text{Na},p$).[#] Based on mirror analogy with ^{22}Ne nucleus in 2009Ma68 (p,t).[@] From ($^3\text{He},n$), ($^3\text{He},n\gamma$), except otherwise noted. Γ_{tot} from ($^{21}\text{Na},p$) – additional data listed in the comments section. $\gamma(^{22}\text{Mg})$

E(level)	E γ	I γ	Mult. [§]	δ	Comments
1247.02	1246.98 [†] 3	100	E2		B(E2)(W.u.)=26 11.
3308.22	2061.09 [†] 5	100	E2		B(E2)(W.u.)=21 5.
4402.0	1090 [‡] 50	6 [‡] 5			
	3154.7 [‡] 3	100 [‡] 5	(M1)		B(M1)(W.u.)>0.029.
	4400 [‡] 50	9 [‡] 5	[E2]		B(E2)(W.u.)>0.33.
5035.4	3788.0 [‡] 5	100 [‡] 5	(M1)		B(M1)(W.u.)>5.1 $\times 10^{-6}$.
	5037 [‡] 6	14 [‡] 5	[E2]		B(E2)(W.u.)>8.3 $\times 10^{-5}$.
5089.3	3841.0 [†] 10	55 [†] 9			
	5089.9 [†] 12	100 [†] 10			
5293.11	1984.80 [†] 14	100	(M1+E2)		
5296.0	893.98 [†] 9	100	D		E γ : Placement from ($^{12}\text{C},2n\gamma$).
5318	4070 [‡] 5	100 [‡] 21			
	5317 [‡] 6	43 [‡] 21			
5452.4	2143.5 [†] 6	29 [†] 5			
	4205.4 [†] 5	100 [†] 7	D		
5711.4	4463.5 [‡] 10	100 [‡] 3	M1+E2	-0.17 10	B(M1)(W.u.)=0.007 3; B(E2)(W.u.)=0.08 5.
	5711 [‡] 1	15 [‡] 3	[E2]		B(E2)(W.u.)=0.12 5.
5838	2530 [‡] 45	25 [‡] 19			
	4590 [‡] 5	100 [‡] 19			
6242.7?	2934.3 [@]				E γ : From ($^{21}\text{Na},\gamma$). Evaluator lists this γ -ray as doubtful based on the existence of the level at 6242.7 keV 11. Please see comments for the depopulating level.
6254.23	2945.8 [†] 2	100	Q		
6325.6	5077.9 [#]				
	6324.6 [#]				
6608	2205.9 [#]				
	5360.3 [#]				

Footnotes continued on next page

Adopted Levels, Gammas (continued) $\gamma(^{22}\text{Mg})$ (continued)† From ($^{12}\text{C}, 2n\gamma$).‡ From ($^3\text{He}, n$), ($^3\text{He}, n\gamma$).§ From γ -ray angular distribution measurements in ($^{12}\text{C}, 2n\gamma$), ($^3\text{He}, n$), ($^3\text{He}, n\gamma$) and RUL.# Placement from ($^{21}\text{Na}, \gamma$), calculated by evaluator from level energy difference, recoil energy subtracted.

@ Placement of transition in the level scheme is uncertain.

 ^{22}Al β^+ Decay 2006Ac04Parent ^{22}Al : $E=0$; $J\pi=(4)^+$; $T_{1/2}=91.1$ ms 5; $Q(\text{g.s.})=18601$ syst; $\%\beta^+$ decay=100.Other references: 1997Cz02, 1997Bl03, 1982Ca16. β -delayed two-proton emission measurements: 1984Ca29, 1985Ja07, 1988Zh15, 1989Re02.2006Ac04: ^{22}Al isotope produced by fragmentation of 95 MeV/nucleon ^{36}Ar beam on a carbon target. Reaction products separated by LISE3 zero-degree achromatic recoil spectrometer at GANIL. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, β , $\beta\gamma$ coin, (delayed particles) γ coin, isotopic half-life. Detection system: two Si detectors, a Si(Li) detector and an EXOGAM Ge clover detector. Comparisons with shell-model calculations.1997Bl03, 1997Cz02: ^{22}Al produced by $^{58}\text{Ni}(^{36}\text{Ar}, x)$, $E(^{36}\text{Ar})=95$ MeV/A. Reaction products separated by LISE3 zero-degree achromatic recoil spectrometer at GANIL. Measured $T_{1/2}$, β -delayed proton emission, 2-proton emission from IAS branch and $\beta\alpha$ emission branch.1982Ca16: ^{22}Al isotope produced from the $^{24}\text{Mg}(^3\text{He}, p4n)$ reaction, $E=110$ MeV; measured β -delayed protons.

The experimental work of 2006Ac04, 1997Bl03, and 1997Cz02 were carried out at GANIL. Some coauthors are common.

Listed data are from 2006Ac04.

 ^{22}Mg Levels

$E(\text{level})^\dagger$	$J\pi^\S$	$T_{1/2}$	Comments
0.0	0+	3.8755 s 12	
1247.02 3	2+		
3308.21 6	4+		
5293.11 16	(4+)		
5451.8 6	(3+)		
6221 ‡ 8	(4+)		
6307 8	4+		
6476 8			
6724 8			
6865 8	(3+)		
7052 8			
7132 8	(5+)		
7254 8			
7573 8			
8004 9			
8339 ‡ 9			
8416 8			
8589 ‡ 8			
8985 ‡ 8			
9518 ‡ 8			
9725 10			
9965 ‡ 8			
10413 10			
10678 12			
11309 49			
11410 8			
13018 56			
14012 3			

E(level): IAS of ^{22}Al g.s., 4+. Other value: 14044 keV 15 (1982Ca16).† Level energies up to 5451.8 keV deduced by evaluator from γ -ray energies. Above energies are from 2006Ac04, except otherwise noted. These excitation energies were determined from the delayed charged particles and γ rays in coincidence when observed.‡ Level supposed to emit protons to the ^{21}Na g.s.

§ From Adopted Levels.

^{22}Al β^+ Decay 2006Ac04 (continued) β^+, ϵ Data

E_ϵ	E(level)	$I\beta^\dagger$	$I\epsilon^\S$	Log ft	$I(\epsilon+\beta^\dagger)^{\dagger\S}$
(4589)	14012	1.90 20	0.00116 15	3.56 7	1.90 20
(5583)	13018	0.33 7		4.81 11	0.33 7
(7191)	11410	0.2 6		>5.0	0.2 6
(7292)	11309	0.2 6		>5.1	0.2 6
(7923)	10678	0.29 11		5.70 17	0.29 11
(8188)	10413	0.3 3		>5.5	0.3 3
(8636)	9965	2.52 14		4.96 4	2.52 14
(8876)	9725	0.84 11		5.51 7	0.84 11
(9083)	9518	1.0 3		5.48 14	1.0 3
(9616)	8985	2.18 15		5.28 4	2.18 15
(10010)	8589	1.89 7		5.43 3	1.89 7
(10190)	8416	4.89 24		5.06 3	4.89 24
(10260)	8339	2.11 9		5.44 3	2.11 9
(10600)	8004	0.64 13		6.03 9	0.64 13
(11030)	7573	0.48 7		6.25 7	0.48 7
(11350)	7254	0.45 8		6.34 8	0.45 8
(11470)	7132	18.5 17		4.75 5	18.5 17
(11550)	7052	0.81 16		6.13 9	0.81 16
(11740)	6865	3.0 3		5.60 5	3.0 3
(11880)	6724	0.75 10		6.23 6	0.75 10
(12130)	6476	0.25 5		6.75 9	0.25 5
(12290)	6307	4.7 6		5.51 6	4.7 6
(12380)	6221	7.4 10		5.33 7	7.4 10
(13150)	5451.8	5.9 24		5.56 18	5.9 ‡ 24
(13310)	5293.11	31 5		4.87 8	31 ‡ 5

 † From 2006Ac04. ‡ Deduced value in 2006Ac04 using relative γ -ray intensities in the literature. § Absolute intensity per 100 decays. $\gamma(^{22}\text{Mg})$

$E_\gamma^\dagger$	E(level)	$I_\gamma^\ddagger$	Comments
1246.98 3	1247.02	38 7	E_γ : 1248.5 keV 20 in 2006Ac04.
1984.80 14	5293.11	31 5	E_γ : 1985.6 keV 13 in 2006Ac04.
2061.09 5	3308.21	34 6	E_γ : 2062.3 keV 15 in 2006Ac04.
2143.5 6	5451.8	1.7 7	E_γ : 1245 keV 5 in 2006Ac04.

 † From Adopted Gammas. γ ray energies of 2006Ac04 listed as comments. ‡ From 2006Ac04. § Absolute intensity per 100 decays.

^{23}Si ep Decay 1997B104 (continued)Delayed protons (continued)

$E(p)^{\dagger}$	$E(^{22}\text{Mg})$	$E(^{23}\text{Al})$
11620 100	0.0	11780

† Corrected for recoil by evaluator (2005Fi16).

‡ Absolute intensity per 100 decays.

 $^1\text{H}(^{21}\text{Na},\gamma)$ 2004Da17,2005Tr11

Others: 2003Bi03, 2005Ch30, 2007Gr11.

2004Da17: $p(^{21}\text{Na},\gamma)$ $E=200-1103$ keV. TRIUMF-ISAC RFQ linear accelerator. Recoil separator, measured $E\gamma$, $I\gamma$, particle- γ coincidence.

2005Tr11: $p(^{21}\text{Na},\gamma)$, ^{21}Na beam energy not listed; measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin. deduced resonance levels, spin and parity.

 ^{22}Mg Levels

$E(\text{level})^{\dagger}$	$J\pi^{\S}$	$\Gamma^{\#}$	Comments
0.0			
1247.02 ‡ 3			
3308.22 ‡ 6			
4402.0 ‡ 3			
5710.0 6			Resonance energy 205.7 5 (2003Bi03).
5833.3 4			Resonance energy 329 (2004Da17).
5958 5			Resonance energy 454 5 (2004Da17).
6042 13			Resonance energy 538 13 (2004Da17).
6242.7 11	4+		Resonance energy 738.4 10 (2004Da17).
6325.6 10	1+	16 keV 3	Resonance energy 821.3 9 (2004Da17).
6605.4 25	2+	30 keV 7	Resonance energy 1101.1 25 (2004Da17).

† Level energies 5710 keV and above are deduced by evaluator using $\text{Sp}(^{22}\text{Mg})=5504.3$ 4 (2012Wa38) and resonance energy listed in comments.

‡ From Adopted Levels.

§ Assigned in 2005Tr11, based on γ -ray feeding and analogue states in ^{22}Ne .

$^{\#}$ From 2004Da17.

 $\gamma(^{22}\text{Mg})$

$E(\text{level})$	$E\gamma^{\dagger}$	$I\gamma^{\@}$	$E(\text{level})$	$E\gamma^{\dagger}$	$I\gamma^{\@}$	$E(\text{level})$	$E\gamma^{\dagger}$
1247.02	1246.98 § 3		5710.0	5709.2 ‡	15	6325.6	6324.6 $^{\#}$
3308.22	2061.09 § 5		5833.3	2524.9 ‡	25	6605.4	2203.3 $^{\#}$
4402.0	3154.7 § 3			4585.8 ‡	100		5357.7 $^{\#}$
	4401.5 $^{\#}$		6242.7	2934.3 $^{\#}$			
5710.0	4462.5 ‡	100	6325.6	5077.9 $^{\#}$			

† From level energy difference, recoil energy subtracted, except otherwise noted.

‡ Measured - γ -ray energy not listed in 2004Da17.

§ From Adopted Gammas. γ -ray energy not listed in 2005Tr11.

$^{\#}$ Placement from 2005Tr11.

$^{\@}$ From 2004Da17.

$^1\text{H}(^{21}\text{Na},\gamma)$ 2004Da17,2005Tr11 (continued)

Level Scheme

Intensities: relative photon
branching from each level

$^1\text{H}(^{21}\text{Na},p)$: Res 2014Zh05,2005Ru01

Other references: 2013He16, 2009He12, 2008He04, 2005Ru15, 2002Ru03.

$J\pi(^{21}\text{Na})=3/2+$.

2014Zh05: ^{21}Na secondary beam, $E=89.4$ MeV, bombarded a $(\text{CH}_2)_n$ target of thickness 8.8 mg/cm². Secondary beam of ^{21}Na was produced from $^2\text{H}(^{20}\text{Ne},n)^{21}\text{Na}$ reaction, $E=8.2$ MeV/nucleon. Recoiled protons were detected using three sets of ΔE -E Si telescopes. Measured proton spectra, angular distributions. FWHM=30 keV. R-matrix analysis. Deduced resonances, J , π , L , thermonuclear reaction rates for $^{18}\text{Ne}(\alpha,p)^{21}\text{Na}$.

2005Ru01,2005Ru15: ^{21}Na secondary beam, $E=0.58$ – 1.4 MeV. TRIUMF-ISAC, measured recoil proton spectra using silicon detector array, deduced resonance energy, Γ_{tot} , Γ_p . Also 2002Ru03 data were revised through a superior analysis (2005Ru01).

2014Zh05, 2013He16, 2009He12, and 2008He04 – all from the same research group. Results in 2014Zh05 supersede those in 2013He16 and represent better statistics compared with those in 2009He12 and 2008He04.

 ^{22}Mg Levels

E(level) [†]	$J\pi^{\S}$	$\Gamma_{\text{tot}}^{\&}$	L^a	Comments
6329.1 [‡] 24	1+	13.6 keV 14	0	E(level): Other value: 6333 (2014Zh05). Resonance energy 824.8 keV 24 (2005Ru01). $\Gamma_p=13.6$ keV 14 (2005Ru01).
6587 [‡] 10	1-	12.8 keV 15	1	E(level): Other value: 6591 (2014Zh05). Resonance energy 1083 keV 10 (2005Ru01). $\Gamma_p=11.9$ keV 14 and $\Gamma_p=0.94$ keV 11 (2005Ru01).
6611 [‡] 11	2+ [#]	17.9 keV 16	0	E(level): Other value: 6615 (2014Zh05). Resonance energy 1107 keV 11 (2005Ru01). $\Gamma_p=17.6$ keV 15 and $\Gamma_p=0.3$ keV 1 (2005Ru01); $\Gamma_p=23$ keV 7 (2009He12).
6792 [‡] 17	2-	105 keV 33	1	E(level): Other value: 6796 (2014Zh05). From resonance energy 1288 keV 17 (2005Ru01). $\Gamma_p=94$ keV 32 and $\Gamma_p=11.1$ keV 8 (2005Ru01); $\Gamma_p=64$ keV 20 (2009He12).
6885	(1-)		3	
7270	(1-)		1	$\Gamma_p=17$ keV 7 (2009He12).
7339	(2+)		2	
7369	(3-)		3	
7585	(2+)		0	E(level): From Table II (2014Zh05). Appears to be average of 7580 (2008He04) and 7590 (2009He12). In Fig. 7 (2014Zh05) 7580 is presented. $\Gamma_p=23$ keV 7 (2009He12).
7654	(1-)		1	
7802	(2-) [@]		1	E(level): 7782 in Fig. 7 (2014Zh05), source unknown. $\Gamma_p=27$ keV (roughly estimated in 2009He12).
7920	(2+)		0	$J\pi$: 3- in Table II (2014Zh05) probably a typo.
8005	(3-) [#]		3	$\Gamma_p=20$ keV (roughly estimated in 2009He12).
8190	(2+)		2	$\Gamma_p=33$ keV (roughly estimated in 2009He12).

Continued on next page (footnotes at end of table)

$^1\text{H}(^{21}\text{Na},\text{p})$: Res 2014Zh05,2005Ru01 (continued) **^{22}Mg Levels (continued)**

E(level) [†]	J π [‡]	L ^a	Comments
8353	(1+)	2	
8527	(3-)	1	$\Gamma_p=60$ keV 20 (2009He12).
8578	(4+)	2	
8677	(2+)	2	
8727	(2+)	0	
8827	(1-)	1	
8922	(2+)	2	
9050	(1-)	1	
9158	(4+)	2	

[†] From 2014Zh05, except otherwise noted. Uncertainty not given in 2014Zh05, probably ≈ 10 keV.

[‡] Deduced by evaluator using $\text{Sp}(^{22}\text{Mg})=5504.3$ 4 (2012Wa38) and resonance energy listed in comments.

[§] From R-matrix analysis in 2014Zh05.

Natural parity (2009He12).

@ Unnatural parity (2009He12).

& From 2005Ru01. Γ_p , Γ_p are listed in the comment section. These data were estimated from R-matrix fits.

a From 2014Zh05, used in the R-matrix analysis.

 $^{12}\text{C}(^{12}\text{C},2\text{n}\gamma)$ 2005Se02

Other reference: 2007Je03.

2005Se02: $^{12}\text{C}(^{12}\text{C},2\text{n}\gamma)$, E=52 MeV; GAMMASPHERE array of Ge detectors, Argonne fragment mass analyzer; Measured E_γ , I_γ , $\gamma\gamma$, (^{22}Mg residues)(γ) coin, $\gamma(\theta)$ in coincidence with A=22. ^{22}Mg , ^{22}Na , ^{21}Ne ions were resolved using $\Delta E-E$ information from an ionization chamber. No evidence was found for a 5006 keV state decaying by a 604.6 γ , proposed earlier.

2007Je03: $^{12}\text{C}(^{12}\text{C},2\text{n}\gamma)$, E=50 MeV; Measured E_γ using three clover detectors surrounded by BGO shields for Compton suppression. Reported E_γ 's, listed as comments, are 1 to 3 keV lower compared to those in 2005Se02.

 ^{22}Mg Levels

E(level) [†]	J π [‡]	E(level) [†]	J π [‡]	E(level) [†]	J π [‡]
0.0 [§]	0+	5035.4 5	2+	5452.4 4	3+
1247.02 [§] 3	2+	5089.3 8	1+	5711.4 7	2+
3308.22 [§] 6	4+	5293.11 16	4+	6254.23 21	6+
4402.0 3	2+	5296.0 4	2-		

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

[‡] Assigned in 2005Se02 based on γ ray feeding and transition characteristics.

[§] (A): g.s. band.

 $\gamma(^{22}\text{Mg})$

E_γ	E(level)	I_γ	Mult. [†]	Comments
893.98 9	5296.0	5.4 3	D	$A_2=0.15$ 6, $A_4=0.09$ 7 (2005Se02).
1246.98 3	1247.02	100.0 8	Q	$A_2=0.17$ 3, $A_4=-0.07$ 3 (2005Se02). E_γ : Other: 1246 keV 1 (2007Je03).
1984.80 14	5293.11	8.3 3	D+Q	$A_2=0.33$ 10, $A_4=0.13$ 12 (2005Se02). E_γ : Other: 1982.8 keV 10 (1282.8 in 2007Je03, probably a typo).
2061.09 5	3308.22	54.7 7	Q	$A_2=0.34$ 4, $A_4=-0.15$ 5 (2005Se02). E_γ : Other: 2059.9 keV 10 (2007Je03).
2143.5 6	5452.4	1.2 2		
2945.8 2	6254.23	22.1 5	Q	$A_2=0.30$ 7, $A_4=-0.07$ 8 (2005Se02). E_γ : Other: 2945 keV 1 (2007Je03).
3154.7 3	4402.0	10.0 4		E_γ : Other: 3153.8 keV 10 (2007Je03).
3788.0 5	5035.4	3.9 3		E_γ : Other: 3788 keV 3 (2007Je03).
3841.0 10	5089.3	0.94 15		E_γ : Other: 3842 keV 3 (2007Je03).

Continued on next page (footnotes at end of table)

$^{12}\text{C}(^{12}\text{C}, 2n\gamma)$ 2005Se02 (continued)

 $\gamma(^{22}\text{Mg})$ (continued)

E_γ	$E(\text{level})$	I_γ	Mult. [†]	Comments
4205.4 5	5452.4	4.2 3	D	$A_3 = -0.31$ 18, $A_4 = -0.06$ 23 (2005Se02). E γ : Other: 4203.6 keV 30 (2007Je03).
4463.5 10	5711.4	3.1 4		E γ : Other: 4463.3 keV 30 (2007Je03).
5089.9 12	5089.3	1.70 17		E γ : Other: 5093.4 keV 30 (2007Je03).
5711 1	5711.4	0.49 12		

[†] From angular distribution coefficients.

Level Scheme

Intensities: relative I_γ

 $^{12}\text{C}(^{16}\text{O}, ^6\text{He})$ 2001Ch35

$^{12}\text{C}(^{16}\text{O}, ^6\text{He})$ E=90 MeV. Enge split-pole spectrometer. Measured particle spectra, $\sigma(\theta)$. Deduced excited level and resonance energies.

Other reference: 2001Ch43.

 ^{22}Mg Levels

$E(\text{level})$	$E(\text{level})$	$E(\text{level})$
0.0 [†]	7964 16	9712 21
1246.3 [†]	8062 16	9827 44
3308.2 [†]	8203 23	9924 28
4408 12	8396 15	10078 24
5029 12	8547 18	10190 29
5272 9	8613 20	10297 25
5711 13	8754 15	10429 26
6041 11	8925 19	10570 25
6255 10	9066 18	10660 28
6606 11	9172? 23	10750 31
6767 20	9248? 20	10844 38
6889 10	9329 26	10980 31
7169 11	9452? 21	11135 40
7402 13	9533 24	
7674 18	9638 21	

[†] Calibration energy.

$^{12}\text{C}(^{22}\text{Mg}, ^{22}\text{Mg}') \quad 2015\text{Ma19}$

^{22}Mg beam, $E=53.5$ MeV/nucleon, was produced from fragmentation of ^{28}Si beam, $E=135$ MeV/nucleon, on a ^9Be target. Particle identification of ^{22}Mg was done by means of Bp- ΔE -tof method using RIPS beamline at RIBF-RIKEN facility. Detectors: Around ^{12}C secondary target, a γ detector array of 160 NaI(Tl) detectors, after which there were five layers of Si-strip detectors for detection of heavy fragments and protons. Analyzed excitation energy distribution from invariant mass of two-protons emissions in $^{20}\text{Ne}+p+p$ channel, momentum distributions of two protons in the excitation energy window of 12.5–18 MeV, and opening angle distribution of two protons. The calculations compared the three-body ($^{20}\text{Ne}+p+p$) emission with 2-body ($^{20}\text{Ne}+^2\text{He}$) emission. The momentum distribution as shown in figure 3a of 2015Ma19 is and angular distribution in figure 3b show a peak structure, ascribed to diproton (^2He) emission. This gives evidence for component of diproton (^2He) emission from high lying level in ^{22}Mg .

 ^{22}Mg Levels

E(level)	$J\pi$	Comments
15.3×10^3	2	7
E(level): excitation energy window=12.5 to 18 MeV. Analysis shows evidence of diproton emission component based on peak structures in observed momentum and angle distributions.		

 $^{12}\text{C}(^{23}\text{Al}, ^{22}\text{Mg}\gamma) \quad 2011\text{Ba27}$

^{23}Al secondary beam, $E=57$ MeV/nucleon, produced from fragmentation of ^{32}S primary beam, $E=95$ MeV/nucleon, on a thick carbon target. Ions were identified at the focal plane of SPEG spectrometer using the energy loss in a ionization chamber and time-of-flight between a thick plastic stopping detector and the cyclotron radio frequency. The secondary beam bombarded a secondary target of carbon, thickness 175 mg/cm². 8 EXOGAM Germanium clover detectors for detecting γ -rays. Measured $E\gamma$, γ -yields; momentum distributions using the SPEG (FWHM= 5×10^{-3}). Deduced levels, J , π , spectroscopic factors and asymptotic normalization coefficients (ANCs) for ^{22}Mg .

 ^{22}Mg Levels

E(level)	$J\pi^\dagger$	$S^\ddagger$	Comments
0.0	0+	0.45 7	$\sigma_{-1p}=18.5$ mb 12, ANC=3896 fm ⁻¹ 113.
1247	2+	1.15 18	S: Other: <0.09 for removal of $\pi 2s_{1/2}$ proton. $\sigma_{-1p}=39.3$ mb 12, ANC=10.4 fm ⁻¹ 10.
3308	4+	0.34 6	$\sigma_{-1p}=9.5$ mb 9, ANC=5.4 fm ⁻¹ 8.
5293	(4+)	0.50 9	$\sigma_{-1p}=10.9$ mb 9, ANC=13.8 fm ⁻¹ 22. $J\pi$: $4+_{2}$ in 2011Ba27.

[†] From Adopted Levels.

[‡] For one proton ($1d_{5/2}$) removal from ^{23}Al ground state.

 $\gamma(^{22}\text{Mg})$

$E\gamma$	E(level)
1247	1247
1985	5293
2061	3308

Level Scheme

$^{18}\text{Ne}(\alpha, p)$ 1999Br18

1999Br18: $^{18}\text{Ne}(\alpha, p)$ E=2–3 MeV. Measured proton spectra, $\sigma(\theta)$. Deduced excited level energies.

 ^{22}Mg Levels

E(level)	Comments
0.0	
10580? 50	
10820? 60	
10910 50	
10990 50	
11050? 50	E(level): Not referred in the Adopted Levels. Larger uncertainty overlaps with 11003 and 11122 keV Adopted Levels.
11130 50	

 $^{20}\text{Ne}(^3\text{He}, n), (^3\text{He}, n\gamma)$ 1972Ro20, 1986Al15, 1975Gr04

$J\pi(^{20}\text{Ne})=0+$.

1972Ro20: $^{20}\text{Ne}(^3\text{He}, n\gamma)$, E=4.3–11.5 MeV. Enriched target, $n\gamma$ coincidence, Ge(Li), NaI(Tl), NE213 neutron detector.

Measured E_γ , I_γ , $\gamma(\theta)$.

1986Al15: $^{20}\text{Ne}(^3\text{He}, n)$, E=25.4 MeV. Measured n TOF, $\sigma(E, \theta)$. DWBA analysis. Deduced excited level energies, L values.

1975Gr04: $^{20}\text{Ne}(^3\text{He}, n\gamma)$, E=10 MeV. Measured mean lifetime by Doppler Shift Attenuation Method. 1970Mc06: $^{20}\text{Ne}(^3\text{He}, n)$, E=3.4–9.4 MeV. Enriched target.

Other references: 1964Br13, 1970Mc06, 1972Be68, 1974Bo06, 1975Pe11.

 ^{22}Mg Levels

E(level) [†]	$T_{1/2}$ [†]	$L^\ddagger$	Comments
0.0		0	
1247.0 4	2.0 ps 8	(2)	$T_{1/2}$: Weighted average 2.9 ps 10 (1975Gr04) and 1.3 ps 9 (symmetric value of 0.7 ps +15–3 (1972Ro20) is considered by evaluator).
3308.2 9	200 fs 45	(4)	
4401.9 15	<21 fs		
5006 2	<17 ns		E(level): 2005Se02 ($^{12}\text{C}, 2n\gamma$) and 2001Ba17 (p,t) conclude this level does not exists. See comments for 604.4 γ . Level not adopted.
5037.0 14	<0.07 ns	2	
5290 2	44 fs 15		
5317 5	<17 ns	(4)	
5464 5	<0.07 ns		
5714.4 15	28 fs 10	2	
5837 5	<17 ns		
5980 ‡ 30		0	
6298 50	<17 ns	4	E(level): From 1972Ro20. Other value: 6263 20 (1970Mc06).
6573 20			E(level): From 1970Mc06.
6770 ‡ 20		3	E(level): From 1970Mc06. Other value: 6760 90 (1972Ro20).
6980 ‡ 80		3	
7201 ‡ 20		0	E(level): From 1970Mc06. Other value: 7230 100 (1972Ro20).
7840 ‡ 90			
7890 ‡ 100			
8290 ‡ 40			
8550 ‡ 90			

[†] From 1972Ro20, except as noted.

[‡] From 1986Al15.

 $\gamma(^{22}\text{Mg})$

E(level)	E_γ [†]	I_γ [†]	Mult. [‡]	δ	Comments
1247.0	1247.0 4	100	Q		$A_2=+0.48$ 10, $A_4=-0.60$ 15 (1972Ro20).
3308.2	2061.2 8	100	Q		$A_2=+0.59$ 9, $A_4=-0.47$ 15 (1972Ro20).
4401.9	1090 50	6 5			
	3154.9 14	100 5	D+Q	+0.8 7	$A_2=+0.46$ 14, $A_4=+0.56$ 27 (1972Ro20).

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$^{20}\text{Ne}(^3\text{He},\text{n}),(^3\text{He},\text{n}\gamma)$ 1972Ro20,1986Al15,1975Gr04 (continued) $\gamma(^{22}\text{Mg})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. ‡	δ	Comments
4401.9	4400 50	9 5			
5006	604.6 18	100			E_{γ} : not observed in other reaction studies.
5037.0	3790.0 13	100 5	D+Q	+0.08 15	$A_2=+0.56$ 8, $A_4=-0.06$ 14 (1972Ro20).
	5037 6	14 5			
5290	890.5 10	67 17			E_{γ} : In Adopted Gammas – placement from a different level (5296 keV).
	1980 2	100 17			
5317	4070 5	100 21			
	5317 6	43 21			
5464	2160 4	43 14			
	4214 4	100 14			
5714.4	4466.4 13	100 3	D+Q	-0.17 10	$A_2=+0.15$ 11, $A_4=-0.09$ 15 (1972Ro20).
	5717 4	15 3			$A_2=+0.2$ 3, $A_4=+0.4$ 4 (1972Ro20).
5837	2530 45	25 19			
	4590 5	100 19			

 † From 1972Ro20. ‡ From angular distribution coefficients.

Level Scheme

Intensities: relative photon branching
from each level

$^{24}\text{Mg}(\text{p},\text{t})$ 2009Ma68,2009Ch28,2001Ba17

Other references: 2002Mi31,2003Mi21,2003Da36,1972Pa02.

 $J\pi(^{24}\text{Mg})=0^{+}$.

2009Ma68: 99.8% enriched self-supporting ^{24}Mg target, thickness 0.82 mg/cm². Projectile: proton, E=98.7 MeV. Grand Raiden magnetic spectrometer, detection system consisted of two multi-wire drift chambers followed by three scintillation detectors. Measured: triton spectra, FWHM=13 keV, at -0.3°, 8° and 17°. Deduced ^{22}Mg resonance levels. DWBA analysis of $\sigma(\theta)$ data.

2009Ch28: Proton beams of E=41- and 41.5-MeV impinged a target of 99.9% enriched ^{24}Mg (thickness - 500 $\mu\text{g}/\text{cm}^2$), tritons were measured using a large area annular silicon detector array (SIDAR), consisting of ΔE and E detectors and arranged in a lampshade configuration. Measured tritons, angular distributions. DWBA analysis. Deduced ^{22}Mg resonance levels.

2001Ba17: $^{24}\text{Mg}(\text{p},\text{t})$ E=37.925 MeV. QDD spectrometer, measured $\sigma(\theta)$. Deduced excitation energies.

Continued on next page (footnotes at end of table)

$^{24}\text{Mg}(\text{p},\text{t})$ 2009Ma68,2009Ch28,2001Ba17 (continued)2002Mi31,2003Mi21: $^{24}\text{Mg}(\text{p},\text{t})$ E=34.68 MeV. Magnetic spectrograph, $\sigma(\text{E},\theta)$.2003Da36: $^1\text{H}(^{24}\text{Mg},\text{t})$ E=55 MeV/nucleon, in inverse kinematics. Magnetic spectrometer, measured proton decay branch, resonance strength.1972Pa02: $^{24}\text{Mg}(\text{p},\text{t})$ E=40–45 MeV. ^{22}Mg Levels

E(level) [†]	J π @	L [§]	Comments
0.0		0	
1247.02 $\frac{3}{2}$ 3		2	E(level): 1247.18 3 (2005Se02) for calibration in 2009Ma68.
3308.22 $\frac{3}{2}$ 6			E(level): 3308.21 6 (2005Se02) for calibration in 2009Ma68.
4402.0 $\frac{3}{2}$ 3	+b	(2)	
5035.4 $\frac{3}{2}$ 5	+b	(2)	
5088.7 [#] 17			E(level): Other value: 5092 5 (2009Ma68).
5293.7 [#] 16	+b		E(level): Other value: 5294.7 23 (2009Ma68).
5451.9 [#] 16	+b		
5711.4 $\frac{3}{2}$ 7	+b	2	E(level): 5711.0 10 (2005Se02) for calibration in 2009Ma68.
5953.8 8	+b	0	$\Gamma_p/\Gamma < 0.20$ (2003Da36).
6036.2 8	+b	0	$\Gamma_p/\Gamma = 0.98$ 1 (2003Da36).
			E(level): 6041.3 30 (Revised value of 2001Ba17 in 2009Ma68).
			J π : 1972Pa02 and 2002Mi31 assign J π =0+, 2003Da36 assign (1–), [3–] from mirror analogy with ^{22}Ne nucleus in 2009Ma68.
			$\Gamma_p/\Gamma = 0.97$ 3 (2003Da36).
6226.1 10			E(level): 6241 5 (Revised value of 2001Ba17 in 2009Ma68 – a doublet).
			L: 2009Ma68 propose L=6 in (2002Mi31,2003Mi21) reported for a doublet at 6242 keV, corresponds to 6254 keV level.
6317 [#] 6		4	
6578 7			
6606 [#] 7			E(level): Possible doublet (2001Ba17).
6768.8 12			E(level): Other values: 6830 11 (2003Mi21), 6780 14 (Revised value of 2001Ba17 in 2009Ma68).
6876.0 12			
7027 9	[3+]		
7045 7	[4+]		
7060 7			
7079 8	[1–]		
7218.3 10			E(level): Other value: 7260 40 (1972Pa02).
7338 13	[2+]		
7389 12			
7599.5 29			
7741.1 20			
7920.6 15	2+&		E(level): Other values: 7960 50 (1972Pa02), 7967 3 (2009Ch28).
8007.0 14	[3–]		
8180.3 17	[2+]		
8383 13	[2+]		
8519.3 21	[3–]&		E(level),J π : Other value: 8495 4 (2009Ch28), spin parity from 2009Ma68. Earlier assignment 2+ in 2009Ch28 noted as doubtful in 2014Zh05 ($^{21}\text{Na},\text{p}$).
8572 6	[4+] ^a		
8657.5 17	[0+] ^a		
8743 14	[4+]		
8784.5 23	[1–]		
8933.1 29	[2+]		
9082 7	[1–]		J π : negative parity from mirror analogy, J=1 is assumed in 2009Ma68.
9157 4	[4+] ^a		
9315 14	[2+] ^a		
9492 13	[3–]		
9546 15	[2+]		E(level),J π : Others: 9544 5 (2009Ch28). J π =1– in 2009Ch28.
9700? 50	[0+]		
9751.6 27	(1 to 2+)&		E(level): Other value: 9773 5 (2009Ch28).
			J π : [2+] from mirror analogy in 2009Ma68.
9861 6	[0+]		
10087 15	[2+]		
10168? 9	[3+]		
10271.7 17	[2+]		
10430 19	[4+]		E(level),J π : Others: 10414 9, spin and parity (1–) From $\sigma(\theta)$ measurements and DWBA analysis (2009Ch28).
10667 19	[3–]		

Continued on next page (footnotes at end of table)

$^{24}\text{Mg}(\text{p,t})$ 2009Ma68,2009Ch28,2001Ba17 (continued) **^{22}Mg Levels (continued)**

E(level) [†]	J π [@]	Comments
10768 21	[2+]	
10881 15	[4+] ^a	
10999 15	[0+]	
11317 27	[4+] ^a	
11499 17	[2+]	
11603 16	(3-, 4+)&	E(level),J π : Others: 11611 9 (2009Ch28). J π =1- in (2009Ma68).
11760 30	[0+]	
11937 17	(1-, 2+)&	E(level),J π : Others: 11950 8 (2009Ch28). J π =0+ in (2009Ma68).
12220 30	[3-]	
12474 26	[2+]	
12665 17	[3-]	
13010? 50	[0+]	

[†] From 2009Ma68, except otherwise noted. 2001Ba17 used calibration energies of 5037.0 14 and 5713.9 keV 12. Present adopted energies for these levels are 5035.4 and 5711.4 keV. Revised level energies are noted in 2009Ma68. In 2009Ch28, the reported excitation energy and uncertainties are average data from the 16 strips of detector. These data are listed as comments.

[‡] From Adopted levels, 2009Ma68 used for calibration, except noted otherwise.

[§] From 2002Mi31, 2003Mi21.

[#] From 2001Ba17, revised value with new calibration data (2009Ma68).

[@] Assignments assumed in 2009Ma68, except otherwise noted, based on mirror analogy with ^{22}Ne nucleus (Fig. 8).

& From $\sigma(\theta)$ measurements and DWBA analysis in 2009Ch28.

^a Based on theoretical considerations (2009Ma68).

^b From 2001Ba17.

 $^{24}\text{Mg}(\alpha, ^6\text{He})$ 2003Be50,2005ShZY

2003Be50: Enriched ^{24}Mg target, thickness 0.7 mg/cm², E=206 MeV. Magnetic Spectrometer, FWHM $\approx$ 75 keV. Measured particle spectra, deduced excited level energies.

2005ShZY: ^{24}Mg target, thickness 0.7 mg/cm², E=205 MeV. Magnetic Spectrometer, FWHM=56 to 80 keV. Measured particle spectra, deduced excited level energies.

 ^{22}Mg Levels

E(level) [†]	Comments
6059 9	E(level): Other: 6046 4 (2005ShZY).
6244 9	E(level): Other: 6246 7 (2005ShZY).
6606 9	E(level): Other: 6005 3 (2005ShZY).
6766 12	E(level): Other: 6774 2 (2005ShZY).
6876 [‡] 6	
7070 [‡] 8	
7216 9	E(level): Other: 7224 2 (2005ShZY).
7614 9	E(level): Other: 7604 7 (2005ShZY).
7938 9	E(level): Other: 7931 5 (2005ShZY).
8006 [‡] 8	
8197 10	E(level): Other: 8191 8 (2005ShZY).
8380 10	E(level): Other: 8384 8 (2005ShZY).
8512 10	E(level): Other: 8521 5 (2005ShZY).
8644? 18	E(level): Other: 8685 6 (2005ShZY).
8771 9	E(level): Other: 8791 5 (2005ShZY).
8921 9	E(level): Other: 8947 4 (2005ShZY).
9029? 20	
9154 10	E(level): Other: 9154 3 (2005ShZY).
9378? 22	
9542 12	E(level): Other: 9526 10 (2005ShZY).
9640 10	
9746 10	E(level): Other: 9748 6 (2005ShZY).
9853 11	E(level): Other: 9861 6 (2005ShZY).
9953 13	E(level): Other: 9972 6 (2005ShZY).
10128? 20	E(level): Other: 10165 4 (2005ShZY).

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$^{24}\text{Mg}(\alpha, ^6\text{He})$ 2003Be50, 2005ShZY (continued) **^{22}Mg Levels (continued)**

E(level) [†]	Comments
10260 10	E(level): Other: 10162 3 (2005ShZY).
10389? 20	E(level): Other: 10404 7 (2005ShZY).
10627 20	E(level): Other: 10609 5 (2005ShZY).
10776 20	E(level): Other: 10711 4 (2005ShZY).
10915? 20	E(level): Other: 10872 4 (2005ShZY).
11015? 20	E(level): Other: 11003 5 (2005ShZY).
11118? 20	E(level): Other: 11125 5 (2005ShZY).
11231? 20	E(level): Other: 11236 5 (2005ShZY).
11313 20	E(level): Other: 11347 5 (2005ShZY).
11581 20	E(level): Other: 11540 5 (2005ShZY).
12003? 20	
12169? 20	

[†] From 2003Be50, except otherwise noted. Comparable level energies are listed as comments from 2005ShZY. Reported uncertainties in 2005ShZY are resulted from peak fitting of ^{22}Mg spectra.

[‡] From 2005ShZY, no comparable level energy is reported in 2003Be50.

 $^{25}\text{Mg}(^3\text{He}, ^6\text{He})$ 2002Ca36

2002Ca36: $^{25}\text{Mg}(^3\text{He}, ^6\text{He})$, E=51.0 MeV, Enge split-pole spectrometer. Measured particle spectra, deduced excited level energies.

 ^{22}Mg Levels

E(level)	E(level)	E(level)
0.0 [†]	6051 4	7757 11
1246.3 [†]	6246 4	7916 16
3308.2 [†]	6329 6	7986 16
4400.9 [†]	6616 4	8229 20
5033 7	6771 5	8394 21
5094 6	6878 9	8487 36
5301 4	7206 6	8598 20
5451 5	7373 9	8789 20
5713.9 [†]	7606 11	

[†] Calibration energy.

Adopted Levels

$Q(\beta^-) = -15137$ SY; $S(n) = 16860$ SY; $S(p) = 1.0$ SY; $Q(\alpha) = -9260$ SY 2012Wa38.
 $\Delta Q(\beta^-) = 643(\text{syst})$, $\Delta S(n) = 566(\text{syst})$, $\Delta S(p) = 401(\text{syst})$, $\Delta Q(\alpha) = 416(\text{syst})$ 2012Wa38.

 ^{22}Al Levels

Cross Reference (XREF) Flags

A ^{22}Si β^+ Decay

E(level)	J π	XREF	T $_{1/2}$	Comments
0.0	(4)+	A	91.1 ms 5	T $_{1/2}$: From 2006Ac04 based on three different analyses procedures. The most reliable value is from decay time spectra in coin with delayed protons. Other values: 59 ms 3 (1997B103 – probably suffered from shorter beam off cycle of only 100 ms – noted in 2006Ac04); 70 ms +50–35 (1982Ca16). J π : Spin assignment based on T=2 isospin multiplet (1982Ca16) and from comparison of measured γ -ray intensity, summed Gamow–Teller strength and delayed proton branching ratio with calculations (2006Ac04). % ϵ +% β^+ =100; % β^+p =55 3; % $\beta+2p$ =1.1 1; % $\beta^+\alpha$ =0.038 17 (2006Ac04). % β^+p and % $\beta+2p$ values are deduced by evaluator from data in Table 1 (2006Ac04). In Fig. 9 an uncertainty of =7 for summed % β^+p is shown. Other values: % β^+p =60; % $\beta+2p$ =0.9 5; % $\beta^+\alpha$ =0.31 9 (1997B103). % p =? J π : log ft <4.3 from 0+. % p =? J π : log ft <4.8 from 0+.
1850	1+	A		
2210	1+	A		

 ^{22}Si β^+ Decay 1996B111

Parent ^{22}Si : E=0.0; J π =0+; T $_{1/2}$ =29 ms 2; Q(g.s.)=15137 syst; % β^+ decay=100.
 Produced by $^{58}\text{Ni}(^{36}\text{Ar},x)$ E(^{36}Ar)=95 MeV/A. Measured half-life, β^+ -delayed proton emission.

 ^{22}Al Levels

E(level) [†]	J π [†]
0.0	(4)+
1850	1+
2210	1+

[†] From Adopted Levels.

 β^+, ϵ Data

E ϵ	E(level)	I β^+ [†]	Log ft	I($\epsilon+\beta^+$) [†]
(12930)	2210	≥6	<4.8	≥6
(13290)	1850	≥22	<4.3	≥22

[†] Absolute intensity per 100 decays.

Adopted Levels

S(p)=941 SY 2012Wa38.
ΔS(p)=643(syst) 2012Wa38.
Produced by ⁵⁸Ni(³⁶Ar,x) E(³⁶Ar)=95 MeV/a. Shown to be particle stable in 1987Sa24.

²²Si Levels

E(level)	Jπ	T _{1/2}	Comments
0 . 0	0 +	29 ms 2	<p>%ε+%β⁺=100; %β⁺p=32 4.</p> <p>T_{1/2}: From decay-time characteristics of proton groups between 1.8 MeV and 2.4 MeV of ²²Si (1996B111).</p> <p>%β⁺p from 1997Cz02, deduced by evaluator based on four proton group intensities of 6 2%, 20 2%, 4 2% and 2 1%.</p>

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