Title

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Nuclear Data Sheets for A=23*

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Abstract: Evaluated spectroscopic data and level schemes from radioactive decay and nuclear reaction studies are presented for ^{23}N, ^{23}O, ^{23}F, ^{23}Ne, ^{23}Na, ^{23}Mg, ^{23}Al, and ^{23}Si. This evaluation for A=23 supersedes the earlier one by R. B. Firestone (2007Fi02).

Highlights of this evaluation are the following:

The recommended absolute γ-ray emission probability (%Pγ) in the ^{23}Ne β- decay was reported with 3.0% systematic uncertainty in 1986BrZQ. In 2007Fi02, the Pγ for the most intense γ ray was recommended with 4% uncertainty. These uncertainties are comparable with the total excited state β feeding uncertainty of 33 *1*, resulting from 100 − 67 *1* (g.s. β feeding) in ^{23}Na (1963Ca06). In this evaluation, notes are added for relative and absolute γ-ray emission probabilities.

From new measurements 2020Kw01 constrain the spin of the 7788 keV level, the dominant resonance state for the ^{22}Na(p,γ)^{22}Mg reaction rate at stellar temperature, in ^{23}Mg to ($3/2^+$,$5/2^+$). Earlier assignment was $7/2^+$.

The ^{23}Al ε decay scheme appears to be incomplete. Some of the latest reported data on the ^{23}Al ε decay study in the literature need verification.

Cutoff Date: All data received by June 1, 2020 have been evaluated. During this evaluation, the NSR database (2014Pr09) was used extensively.

General Policies and Organization of Material: See the January issue of the *Nuclear Data Sheets* or http://www.nndc.bnl.gov/nds/NDSPolicies.pdf.

Acknowledgements: This evaluation benefits from earlier evaluations by R. B. Firestone (2007Fi02) and P. M. Endt (1998En04, 1990En08, 1978En02). Evaluators are thankful to the compilers of XUNDL datasets from references (compilers): 2017Ke01, 2016Ki03, 2015Su15, 2015Ma19, 2015De33, 2014Ts04, 2013Ji13, 2013Je04, 2012Bo09, 2011Sa15, 2011Sa12, 2011Ki26, 2011Ho05, 2011Ga18, 2011Ba27, 2010Sa26, 2010Lo05, 2009Ka14, 2009Ic06, 2008Ga17, 2008Ga10, 2008Fr10, 2007Su05, 2007Sc32, 2007He30, 2007El02, 2006Mi16, 2006Ia03 (B. Singh, J. Choquette, S. Geraedts, B. Karamy, J. Roediger, J. Chen, E. Thiagalingam, M. Birch, M. Mitchell, A. MacDonald (all from McMaster), F.G. Kondev (ANL), J.C. Batchelder (UC Berkeley), C. Smith and C.D. Nesaraja (ORNL)). The support of Ms. JoAnn Totans, NNDC, for providing secondary and other articles is deeply acknowledged. Finally, the evaluators are grateful to B. Singh for an in-depth review of the manuscript and for many useful comments and suggestions.

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Properties of A=23 Mirror States (T=1/2)

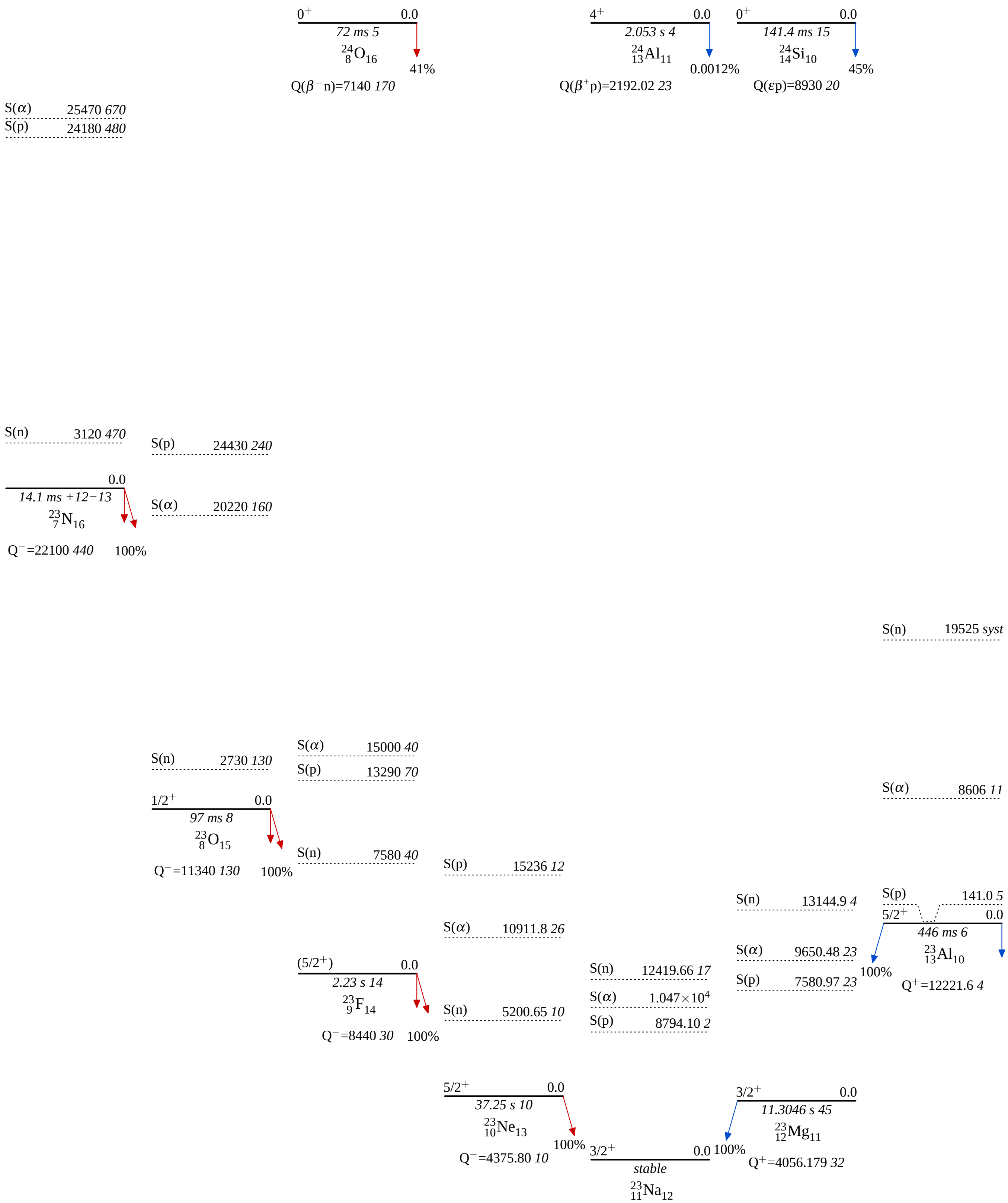
E(^{23}Na)	J^π	E(^{23}Mg)	J^π	ΔE_x
0.0	$3/2^+$	0.0	$3/2^+$	0
440.2 4	$5/2^+$	450.70 15	$5/2^+$	+10.5
2076.2 4	$7/2^+$	2051.6 4	$7/2^+$	-24.6
2390.9 3	$1/2^+$	2357.0 7	$1/2^+$	-33.9
2640.5 6	$1/2^-$	2771.2 7	$1/2^-$	+130.7
2703.8 5	$9/2^+$	2714.5 5	$9/2^+$	+10.7
2982.0 5	$3/2^+$	2905.2 7	$(3/2)^+$	-76.8
3677.9 5	$3/2^-$	3794.1 4	$3/2^-$	+116.2
3847.9 5	$5/2^-$	3971.7 6	$5/2^-$	+123.8
3914.6 4	$5/2^+$	3860.6 7	$3/2^+,5/2^+$	-54.1
4429.63 16	$1/2^+$	4356.4 20	$1/2^+$	-76.6
4775.2 5	$7/2^+$	4681.5 7	$(7/2)^+$	-93.7
5378.56 15	$5/2^+$	5287.5 8	$3/2^+,5/2^+$	-91.1
5534.2 6	$11/2^+$	5453.7 6	$(11/2)^+$	-80.5
5741.0 15	$5/2^+$	5658 4	$5/2^+$	-85
5965.9 9	$3/2^-$	5992.8 9	$1/2^-,3/2^-$	+26.9
6041.9 6	$7/2^-$	6129.3 7	$(7/2^-)$	+87.4

Isospin Quadruplet States (T=3/2) in A=23

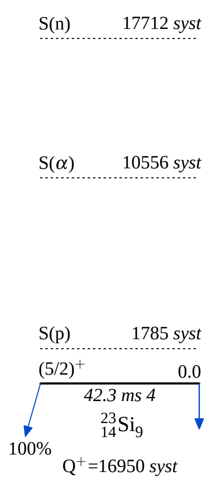
J^π	E(^{23}Ne)	E(^{23}Na)	E(^{23}Mg)	E(^{23}Al)
$5/2^+$	0.0	7891.2 3	7803.0 6	0.0
$1/2^+$	1016.93 2	8665.0 18		550 20

Index for A=23

Skeleton Scheme for A=23



Skeleton Scheme for A=23 (continued)



Ground-State and Isomeric-Level Properties

Nuclide	Level	Jπ	$T_{1/2}$	Decay Mode
^{23}N	0.0		14.1 ms *+12−13*	%β^-=100; %β^-n=42 *6*; %β^-2n=8 *4*...
^{23}O	0.0	$1/2^+$	97 ms *8*	%β^-=100; %β^-n=7 *2*
^{23}F	0.0	$(5/2^+)$	2.23 s *14*	%β^-=100; %β^-n<14
^{23}Ne	0.0	$5/2^+$	37.25 s *10*	%β^-=100
^{23}Na	0.0	$3/2^+$	stable	
^{23}Mg	0.0	$3/2^+$	11.3046 s *45*	%ε+%β^+=100
^{23}Al	0.0	$5/2^+$	446 ms *6*	%ε+%β^+=100; %εp=1.04 *3*
^{23}Si	0.0	$(5/2)^+$	42.3 ms *4*	%ε+%β^+=100; %εp≈88; %ε2p=3.6 *4*
^{24}O	0.0	0^+	72 ms *5*	%β^-n=41 *6*
^{24}Al	0.0	4^+	2.053 s *4*	%β^+p=0.0012 *3*
^{24}Si	0.0	0^+	141.4 ms *15*	%εp=45 *4*

Adopted Levels

Q(β^-)=22.10×10^3 *44*; S(n)=3.12×10^3 *47*; S(p)=24.18×10^3 *48*; Q(α)=−25.47×10^3 *67* 2017Wa10
Q(β^-n)=19.37×10^3 *42* (2017Wa10); Q(β^-2n)=12.5×10^3 and Q(β^-3n)=8.7×10^3 – deduced by evaluators using mass data in 2017Wa10.
S(2n)=4.7×10^3 *4*, S(2p)=55.2×10^3 *10 sys* (2017Wa10).
Particle stability established in tantalum + ^{40}Ar reactions (1985La03,1986Po13). Produced by ^{181}Ta(^{40}Ar,X) E=95 MeV/nucleon (1998Yo06).
Precise mass measurement: 2012Ga45, 2007Ju03.

^{23}N Levels

Cross Reference (XREF) Flags

A ^{2}H(^{24}O,p)

E(level)	$T_{1/2}$	XREF	Comments
0.0	14.1 ms *+12−13*	A	%β^-=100; %β^-n=42 *6*; %β^-2n=8 *4*; %β^-3n<3.4 (2003Yo02) <r^2>$^{1/2}$(^{23}N)=3.41 fm *23* (matter radius) (2001Oz03). J$^\pi$: 1/2$^-$ from shell model calculations (2017Jo06). 2015Zh05 assumes ^{21}N core and two valence neutrons, where J$^\pi$(^{21}N) assigned as (1/2$^-$) in 2015Fi05. $T_{1/2}$: From β-n(t) coin 2003Yo02. Other: 14.5 ms *14* (1998Yo06 – same research group of 2003Yo02). Neutron Emission Probability %P_n ≈ 58 *10* (From Fig. 5b – %Pn=Σ i × %Pin (2003Yo02)). Other: 80 *21* (1998Yo06 – same research group of 2003Yo02).
≈3600		A	
≈5000		A	

$^{2}H(^{24}O,p)$ 2017Jo06

Target: Liquid deuterium (LD_2); Projectile: ^{24}O beam, E = 83.4 MeV/nucleon, was produced from fragmentation of primary beam of ^{48}Ca, E=140 MeV/nucleon, bombarding a ^{9}Be target at NSCL facility. A1900 fragment separator was used to select ^{24}O from reaction products. Remaining contaminants were removed by time-of-flight (TOF) in the off-line analysis. Finally, the ^{24}O beam was directed to bombard the liquid D_2 target. ^{23}N promptly decayed to ^{22}N. The resulting charged fragments were swept 43.3° by a 4-Tm superconducting sweeper magnet into a collection of position- and energy-sensitive charged particle detectors. Elemental identification was done by ΔE and TOF; Isotope identification was done through correlations in the TOF, dispersion position, dispersive angle following the sweeper magnet. Neutrons were detected by Modular Neutron Array (MoNA) and the Large-area multi-Institutional Scintillation Array (LISA), each consisted of 144 bars of plastic scintillator. Measured decay energy of the ^{22}N+n system, deduced excited energies above the $Sn(^{23}N)$. Shell model calculations.

^{23}N Levels

E(level)†	J^{π}‡	Comments
0.0	$1/2^-$	
≈3600	$3/2^-$	E(level): Decay Energy=1070 keV *100*. $Sn(^{23}N)$=2460 keV *380* (2012Ga45) gives an excitation energy of 3530 keV *400* (100 (stat)+400 (sys)) (Sn+Decay energy). In 2016-AME $Sn(^{23}N)$=3120 keV *470* (2017Wa10).
≈5000	$3/2^-$	E(level): Decay Energy=2500 keV *+500−700*. $Sn(^{23}N)$=2460 keV *380* (2012Ga45) gives an excitation energy of 4960 keV *+630−800* (Sn+Decay energy). In 2016-AME $Sn(^{23}N)$=3120 keV *470* (2017Wa10).

† Level energies were interpreted in 2017Jo06 within the context of shell-model predictions, as it was not possible to discern between any number of degeneracies or level orderings. 2017Jo06 deduce $Sn(^{23}N)$=2460 keV *380* using data in 2012Ga45. In 2017Wa10, $Sn(^{23}N)$=3120 keV *470*.

‡ From shell model calculations.

Adopted Levels

$Q(\beta^-)=11.34\times10^3$ *13*; $S(n)=2.73\times10^3$ *13*; $S(p)=2.443\times10^4$ *24*; $Q(\alpha)=-2.022\times10^4$ *16* 2017Wa10
$Q(\beta^-n)=3.76\times10^3$ *12* (2017Wa10).
$S(2n)=9.58\times10^3$ *12*, $S(2p)=45.6\times10^3$ *6 sys* (2017Wa10).
1970Ar09 – First production – ^{232}Th(^{22}Ne,X), E=174 MeV.
2000Oz01 – Measured production cross section 0.207 μb *64* for ^{23}O from fragmentation of ^{40}Ar on Be target, E ~1 GeV/nucleon.
2004St08: ^{9}Be(^{36}S,X),C(^{36}S,X) E=77.5 MeV/nucleon. Recoil mass spectrometer, BaF_2 coincidence array. Produced 7500 and 19620 ^{23}O nuclei using the Be and C targets, respectively. No gamma rays were observed in coincidence with ^{23}O recoils suggesting that the first excited state lies above the neutron separation energy or below the detector threshold of 100 keV.
Other measurements: 2020Ta11 – proton knockout reaction ^{1}H(^{25}F,^{23}O), E=277 MeV/nucleon, cross section measured to be 81 μb *26*.

^{23}O Levels

Cross Reference (XREF) Flags

A	^{1}H(^{24}O,^{23}O)	E	^{9}Be(^{26}Ne,2pnX)
B	^{2}H(^{22}O,p^{23}O)	F	C(^{24}O,n^{23}O)
C	^{9}Be(^{24}O,^{23}O)	G	C(^{23}O,^{22}O),Pb(^{23}O,^{22}O)
D	^{9}Be(^{26}F,2n^{22}O)	H	^{12}C(^{24}F,p^{23}O)

E(level)	J$^\pi$	T or Γ	XREF	Comments
0.0	1/2$^+$	97 ms *8*	ABCDEFGH	%β^-=100; %β^-n=7 *2* <r^2>$^{1/2}$(^{23}N)=2.95 fm *23* (matter radius) (2011Ka36) using Fermi density and 2.97 fm *11* using harmonic oscillator density; deduced using Glauber model (2011Ka36). Also 3.20 fm *4* and 3.24 fm *27* in 2001Oz03. J$^\pi$: L=0 from analysis of single neutron removal cross sections in (^{23}O,^{22}O). Configuration: $\nu s_{1/2}$ (2007El02 – ^{2}H(^{22}O,P)). T or Γ: From 2007Su05. Others: 82 ms *+45−28* (1990Mu06), 89 ms *76* (2008ReZZ, 1995ReZZ). %β^-n: From 2007Su05. Others: 31 *7* (1990Mu06), 28 *30* (2008ReZZ, 1995ReZZ), and <29 (1991Re02).
2.78×10^3† *13*	(5/2)$^+$	<5 keV	A DE	%n≈100 E(level): From ^{1}H(^{24}O,^{23}O). J$^\pi$: L=2 (longitudinal momentum distribution – ^{1}H(^{24}O,^{23}O)). Configuration: $\nu(0d_{5/2})^{-1}$ (^{26}Ne,2pnX) – (2007Sc32,2008Fr10). Γ: From (^{26}Ne,2pnX) – 2008Ch07. Other: Γ=100 keV (2007Sc32 – (^{26}Ne,2pnx)) and (2011Ho05 – (^{26}F,2n^{22}O)) – value should be considered as upper limit – see comments in (^{26}Ne,2pnx). Same research group – 2007Sc32 and 2011Ho05.
4000† *20*	(3/2)$^+$		B	Possible configuration: $\nu d_{3/2}$ (2007El02 – ^{2}H(^{22}O,p^{23}O)).
5300† *40*			B	It is a state in fp shell. Possible configuration: $\nu p_{3/2}$ with S ≈ 1.0. Also a smaller probability for $\nu f_{7/2}$ with S ≈ 0.02. (2007El02 – ^{2}H(^{22}O,p^{23}O)).

† Unbound state.

$^{1}H(^{24}O,^{23}O)$ **2014Ts04**

Other: 2015Jo14 – $^{2}H(^{24}O,2n^{22}O)$, E=83.4 MeV/nucleon – sequential neutron decay through intermediate state of ^{23}O.
Based on XUNDL: Compiled by B. Singh (McMaster), Oct 28, 2014.
Target: Liquid hydrogen H_2; ^{24}O beam, E=62 MeV/nucleon, was produced by fragmentation of ^{40}Ar primary beam, E=95 MeV/nucleon, bombarding a ^{9}Be target at RIKEN facility. The reaction products were analyzed by fragment separator RIPS, energy loss and TOF methods. The ^{24}O beam was tracked using two multiwire drift chambers. γ rays were detected by an array of 48 NaI(Tl) detectors. The mass and charge of the fragments following the $^{1}H+^{24}O$ reaction were analyzed using Bρ-TOF-ΔE technique, by using two multiwire drift chambers for Bρ, plastic scintillator charged particle hodoscope for TOF and energy-loss information. Neutrons were detected using a plastic scintillator placed at a distance of 4.7 m from the target. Measured (^{22}O)n coincidence. The decay energy spectrum was reconstructed from the measured four momenta of ^{22}O fragment and emitted neutron. A resonance was observed at a decay energy of 50 keV, which corresponded to the first excited state of ^{23}O decaying by neutrons. Shell-model calculations.

^{23}O Levels

E(level)	J^π	L	C^2S	Comments
0.0	$1/2^+$			J^π: From Adopted Levels.
2.78×10^3 *13*	$5/2^+$	2	4.1 *4*	E(level): deduced from measured E(resonance)=50 keV *3* (2014Ts04), and S(n)(^{23}O)=2730 keV *130* (2017Wa10). L,J^π: from longitudinal momentum distribution. σ_{1n}(expt)=61 mb *6* (2014Ts04). C^2S: deduced from experimental σ and single-particle σ calculated using distorted wave impulse approximation (DWIA) and eikonal approximation.

^{2}H(^{22}O,p^{23}O) 2007El02,2008El02

Based on XUNDL: Compiled by: B. Singh (McMaster), April 5, 2007.
^{22}O(d,p) in inverse kinematics.
2007El02,2008El02 – Target: CD_2; Projectile: ^{22}O beam at an energy of 34 MeV/nucleon was produced from fragmentation of primary beam of ^{40}Ar, E=94 MeV/nucleon, bombarding a ^{9}Be target at RIKEN facility. The reaction products were analyzed by fragment separator RIPS, energy loss and time-of-flight methods. The position of the incident particles was determined by parallel-plate avalanche detectors. The scattered ^{23}O particles were detected and analyzed by a silicon telescope. The protons were detected by an array of 156 CsI(Tl) scintillation detectors. The γ rays were detected with a stack of 80 NaI(Tl) detectors. Neutrons emitted from the decay of excited states of ^{23}O were detected by a neutron wall of four layers of plastic scintillators. The time-of-flight method was used to obtain the energy of the neutrons. Also measured angular distribution of one of the inelastic channels from 0.5° to 3.2°. Analysis of $\sigma(\theta)$ data by DWBA calculations. Deduced excitation energy spectrum of ^{23}O, FWHM ≈ 200 keV.

^{23}O Levels

E(level)	J$^\pi$	L	S	Comments
0.0	1/2$^+$			J$^\pi$: From Adopted Levels. Configuration: $\nu s_{1/2}$.
4000† *20*	(3/2$^+$)	2	0.5 *1*	Possible configuration: $\nu d_{3/2}$. σ=0.84 mb *17*.
5300† *40*				It is a state in fp shell. Possible configuration $\nu p_{3/2}$ with S ≈ 1.0. Also a smaller probability for $\nu f_{7/2}$ state with S ≈ 0.02. σ=0.33 mb *10*.

† Unbound state.

^{9}Be(^{24}O,^{23}O) 2018Di09

Secondary beam of ^{24}O, E=92.3 MeV/nucleon, on ^{9}Be target (thickness 188 mg/cm^{2}) located at target position in the S800 spectrograph. ^{24}O was produced from fragmentation of primary beam of ^{48}Ca, E=140 MeV/nucleon, on a ^{9}Be target. The ^{24}O beam with 1% momentum spread was selected with the A1900 fragment separator at NSCL. The projectile-like neutron-removal residues were characterized with the spectrograph. Two cathode readout drift chambers, an ionization chamber for energy-loss measurements, and a plastic scintillator that served as trigger and time-of-flight reference. Measured one-neutron removal cross section of ^{24}O.

^{23}O Levels

E(level)†	J$^{\pi}$†	Comments
0.0	1/2^{+}	σ_{1n}(expt)=74 mb *11*. Determined a FWHM of 115 MeV/c *13* for the intrinsic ^{23}O parallel momentum distribution by fitting the measured values.

† From Adopted Levels.

^{9}Be(^{26}F,2n^{22}O) 2011Ho05

Based on XUNDL: Compiled by M. Birch and B. Singh (McMaster); August 6, 2011.

Be target (thickness 470 mg/cm^2); ^{26}F beam, E=85 MeV/nucleon, produced at the Coupled Cyclotron Facility at NSCL. Used Modular Neutron Array (MoNA) to measure E(n), ^{22}O(n-n) coincidence and identified ^{22}O recoil fragments by energy loss and time-of-flight (TOF). Deduced a two-neutron cascade from a resonant state in ^{24}O decaying to ^{23}O and finally to ^{22}O g.s.

^{23}O Levels

E(level)	J^{π}†	Γ	L	Comments
0.0	1/2$^+$			
2.8×10^3	(5/2)$^+$	100 keV	2	E(level): from observed neutron-neutron sequential emission of ^{22}O fragment -nn coin; first neutron with E(n)≈0.6 MeV from a level at ≈7.5 MeV in ^{24}O, the second with E(n)<0.1 MeV from a 2.8 MeV level in ^{23}O, the latter considered as 45 keV *2* resonance in ^{23}O (2011Ho05). L,Γ: assumed value for Breit-Wigner line shape to describe two resonances for simulating the sequential decay of E=600−keV resonance in ^{24}O through this state using Monte Carlo simulations. Decays by neutron to ^{22}O g.s.

† From Adopted Levels.

^{9}Be(^{26}Ne,2pnX) 2007Sc32,2008Fr10

Other: 2008Ch07 – ^{9}Be(^{48}Ca,X), E=60 MeV/nucleon.
Based on XUNDL:
Compiled from 2007Sc32 by S. Geraedts and B. Singh (McMaster) Sep 17, 2007.
2007Sc32,2008Fr10: ^{9}Be(^{26}Ne,2pnX) – ^{26}Ne beam, E=86 MeV/nucleon, provided by NSCL at MSU. The ^{26}Ne beam produced in the primary reaction ^{9}Be(^{40}Ar,X) with E(^{40}Ar)=140 MeV/nucleon. The fragments were separated by A1900 fragment separator. ^{26}Ne beam purity about 93%. Measured (neutron)(fragment) coincidences using position-sensitive parallel-plate avalanche counters (PPAC) for charged fragments and Modular neutron array (MoNA) of plastic scintillators for neutrons.

^{23}O Levels

E(level)	J$^{\pi}$	Γ	Comments
0.0	1/2^{+}		J$^{\pi}$: From Adopted Levels.
2.79×10^{3} *13*	5/2^{+}	<5 keV	%n≈100 This state decays mainly by neutrons. Calculated partial γ-ray width=0.15 meV, corresponding to γ-decay lifetime of 4.5 ps. E(level),J$^{\pi}$: 5/2^{+} hole state, 45 keV *2* (2007Sc32,2008Fr10) above S(n). Γ_{decay} from 2008Ch07. 2007Sc32 note the width (100 keV) due to experimental conditions overshadows the Wigner limit by about 3 orders of magnitude and so its lifetime was not determined. However, note their calculated value of total decay width Γ_{decay}=5 eV is extremely small. [Measured values in 2007Sc32 and 2008Ch07 should be considered as upper limit due to experimental resolution – email communication with co/corresponding author M. Thoennessen (March 10, 2017)].

C(^{24}O,n^{23}O) 2009Ka14

Based on XUNDL: Compiled by B. Singh (McMaster); May 1, 2009.

One-neutron knockout reaction.

2009Ka14: ^{24}O beam, E=920 MeV/nucleon, was produced from fragmentation of ^{48}Ca, E=1 GeV/nucleon, on a thick Be target at GSI facility. The nuclei produced in fragmentation process were separated and identified event-by-event using FRS and with the magnetic rigidity, energy loss (ΔE) and time-of-flight information. The charge of the incident nuclei was measured using a multisampling ionization chamber. The secondary (reaction) target was 4.05 g/cm^2 thick carbon. The outgoing ^{23}O fragments were tracked using two time-projection chambers and then transported for Bρ-ΔE-TOF analysis. Measured momentum distribution. Comparison of experimental spectroscopic factor with shell-model calculations using various interactions. The data in this experiment did not show any significant d-wave component for the population of first excited 5/2$^+$ state.

^{23}O Levels

E(level)	J$^\pi$	S	Comments
0.0	1/2$^+$	1.74 *19*	J$^\pi$: From Adopted Levels. Measured momentum distribution has a Gaussian width=99 MeV/c *4*. Measured one-neutron removal cross section=63 mb *7*.

C(^{23}O,^{22}O),Pb(^{23}O,^{22}O)

Other references: 2004Co25, 2000Sa47.

2005No01: Pb(^{23}O,^{22}O) – ^{23}O beam, E=422 MeV/nucleon, produced by ^{40}Ar(C,X), E=500 MeV/nucleon. Recoil fragment separator, CsI γ-ray coincidence.

2004Co11, 2005Co24: C(^{23}O,^{22}O)- ^{23}O beam produced by ^{40}Ar(C,X) E=938 MeV/nucleon. Recoil fragment separator, NaI γ-ray coincidence.

2002Ka20: C(^{23}O,^{22}O) – ^{23}O beam, E=72 MeV/nucleon, produced by ^{40}Ar(C,X), E=92 MeV/nucleon. Recoil fragment separator, particle identification by time-of-flight information, pulse height information from NaI(Tl) E and ΔE (Si) detectors. Measured momentum spectrum of one-neutron removal fragment ^{22}O. FWHM (Γ)=94 MeV/c *12* (Lorentzian fitting). Deduced spin-parity for ^{23}O g.s. from fitting of the measured momentum data. SPEG spectrometer,

2000Sa47: C(^{23}O,^{22}O) – ^{23}O beam produced by ^{40}Ar(C,X), E=70 MeV/ nucleon at GANIL. The reaction products were collected and selected according to magnetic rigidity using SISSI device coupled with the beam analysis spectrometer. Ion identification by energy loss from a gas ionization chamber and time-of-flight information. Measured momentum distribution and one-neutron removal cross section, deduced spin and parity for ^{23}O g.s.

^{23}O Levels

E(level)	J$^\pi$	L	S	Comments
0.0	1/2$^+$	0	0.77 *10*	J$^\pi$,L: From analysis of single neutron removal cross sections determined from ^{22}O γ-ray emission yields and compared to theoretical models based on the Eikonal approximation (2004Co11, 2005Co24). 2002Ka20 propose 1/2$^+$ or 5/2$^+$. 2000Sa47 propose 1/2$^+$ from their work. S: C^{2}S from 2005No01.

^{12}C(^{24}F,p^{23}O) 2003Th07

Also ^{12}C(^{25}F,pn^{23}O) and ^{12}C(^{26}F,p2n^{23}O).
Other references: 2004Th13, 2003Th10 − both are conf. paper − from the same research group of 2003Th07.
One-proton knockout reaction.
2003Th07: ^{24}F beam, E=46.7 MeV/nucleon, was produced from fragmentation of ^{48}Ca, E=110 MeV/nucleon, on a thick Be target. The fragments were separated by A1900 fragment separator at NSCL. Three 500−μm thick Si surface barrier detectors followed by three 5000−μm thick Li-drifted Si diodes. Fragments were identified by energy loss (ΔE) and time-of-flight information. The secondary (reaction) target was 146 mg/cm^2 thick ^{12}C. The outgoing ^{23}O fragments were tracked by ΔE-E signals. Deduce one-proton knock out cross section, spectroscopic factor.

^{23}O Levels

E(level)	J$^\pi$	C^{2}S	Comments
0.0	1/2$^+$	6.6 *9*	J$^\pi$: From Adopted Levels. C^{2}S: For ^{12}C(^{24}F,p^{23}O). Measured cross section=6.6 mb *10* for ^{12}C(^{24}F,p^{23}O), 6.4 mb *9* for ^{12}C(^{25}F,pn^{23}O), and 8.9 mb *24* for ^{12}C(^{26}F,p2n^{23}O).

Adopted Levels, Gammas

Q(β^-)=8440 *30*; S(n)=7580 *40*; S(p)=13290 *70*; Q(α)=−15000 *40* 2017Wa10
Q(β^-n)=3.24×10^3 *3* (2017Wa10).
S(2n)=12810 *30*, S(2p)=36.52×10^3 *14* (2017Wa10).
1970Ar01: First production – ^{232}Th(^{22}Ne,X), E=174 MeV.
2006Kh08: Measured cross section=2112 mb *16* at magnetic rigidity ($\beta\rho$)= 2.753 Tm, E=53.64 MeV/u and cross section=2048 mb *13* at $\beta\rho$=2.575 Tm, E=46.92 MeV/u for Si(^{28}Ne,X) and related reduced strong absorption radius $<r_0^2>$=1.170 fm^2 *6*. The later one is used to study the isospin dependence of the reduced strong absorption radius.
2000Oz01: Measured ^{23}F production cross-sections: σ_F=94 μb *30* from ^{40}Ar fragmentation, E=1.06 GeV/u, on Be target.

^{23}F Levels

Cross Reference (XREF) Flags

A	^{23}O β^- decay (97 ms)	D	^{9}Be(^{36}S,Xγ)
B	^{24}O β^-n decay	E	^{22}Ne(^{18}O,^{17}F)
C	^{4}He(^{22}O,^{23}Fγ)		

E(level)†	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	(5/2$^+$)	2.23 s *14*	A CDE	%β^-=100; %β^-n<14 $<r^2>^{1/2}$(^{23}F)=2.79 fm *4* (matter radius) (2001Oz03). J$^\pi$: From single neutron removal cross section, core fragment longitudinal momentum distributions and calculations (2004Sa14, 2000Sa47). L=2 and configuration π d$_{5/2}$ (2004Sa14). T$_{1/2}$: From 1974Go17 (^{23}F β^- decay) – summed yield(t) of 1702-, 1822-, 3431-, and 2734-keV γ rays in four 1.7-sec periods. %β^-n: From 1995ReZZ and 2008ReZZ.
2246 *8*	(1/2)$^+$		A C E	J$^\pi$: L=(0) in (^{22}O,^{23}Fγ) (2006Mi16) and log *ft*=4.3 from 1/2$^+$ parent (^{23}O β^- Decay).
2920 *3*			A CDE	
3373 *11*			A C	
3831 *5*			A CD	
3865 *15*	(1/2$^+$,3/2$^+$)‡		A C	
3964 *28*			C	
4061 *11*	(3/2$^+$)		A C E	J$^\pi$: L=(2) in (^{22}O,^{23}Fγ) (2006Mi16) and log *ft*=4.3 from 1/2$^+$ parent (^{23}O β^- Decay). Configuration: πd$_{3/2}$ ((^{22}O,^{23}Fγ) – 2006Mi16).
4610 *12*	(1/2$^+$,3/2$^+$)‡		A C	
4732 *69*			C	
4923 *13*			C	
5000? *60*			E	E(level): Possible multiplet.
5547 *8*	(1/2$^+$,3/2$^+$)‡		A C	
5593 *15*	(1/2$^+$,3/2$^+$)‡		A C	
6250? *80*			E	E(level): Possible multiplet.
6365 *60*			C	
6629 *25*			C	
6905 *41*			C	
8.18×10^3 *11*			E	neutron unbound state.

† From γ ray energies, otherwise from particle dataset as of the 'XREF'.
‡ From log *ft* values from 1/2$^+$ parent (^{23}O β^- Decay).

Adopted Levels, Gammas (continued)

$\gamma(^{23}F)$

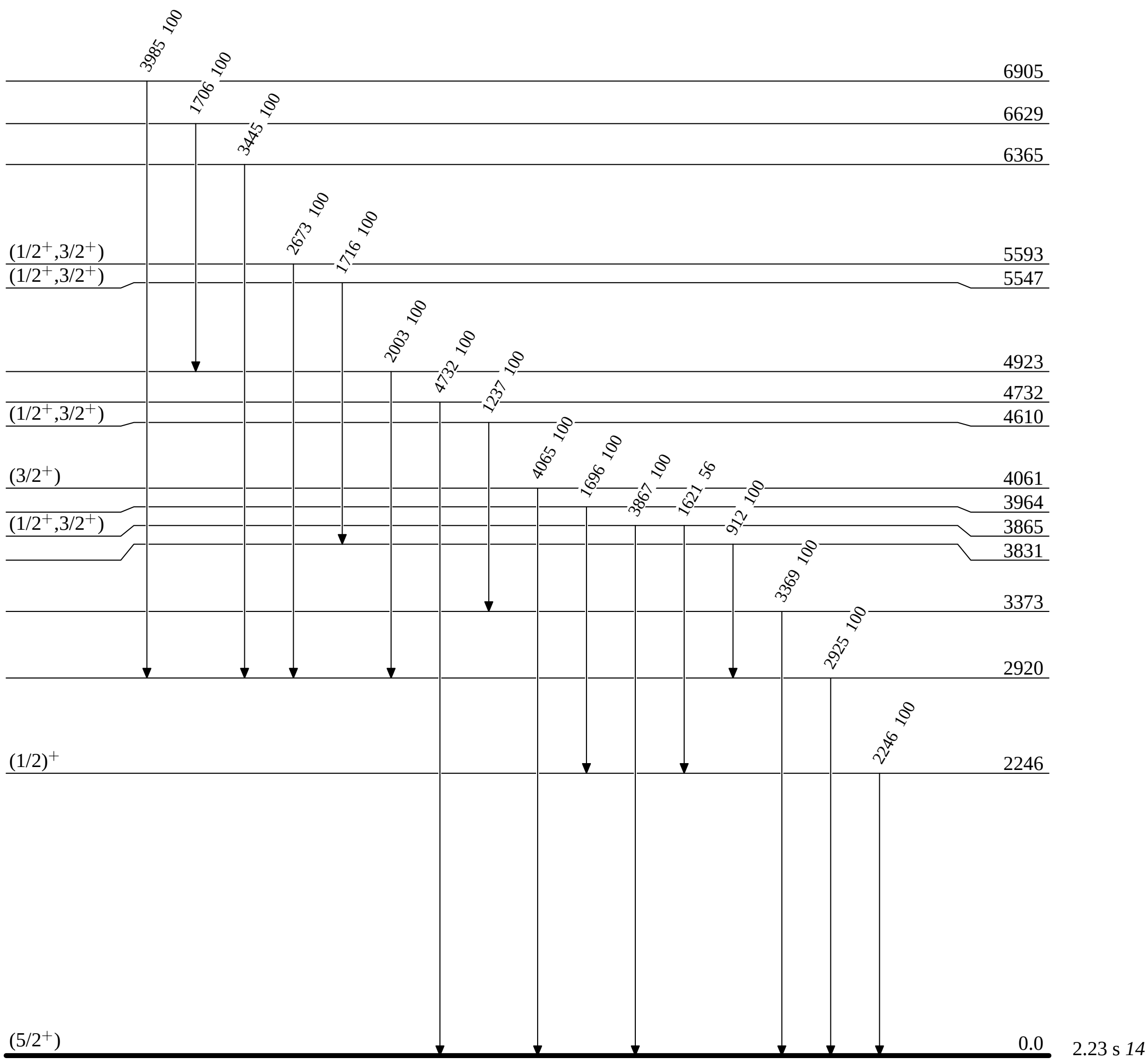
E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Comments
2246	(1/2)+	2246‡ *8*	100	0.0	(5/2+)	
2920		2925‡ *10*	100	0.0	(5/2+)	
3373		3369‡ *13*	100	0.0	(5/2+)	
3831		912‡ *4*	100	2920		
3865	(1/2+,3/2+)	1621 *6*	56 *10*	2246	(1/2)+	E_γ,I_γ: Reported in ^{23}O β^- Decay only.
		3867‡ *15*	100 *16*	0.0	(5/2+)	
3964		1696# *28*	100	2246	(1/2)+	
4061	(3/2+)	4065‡ *16*	100	0.0	(5/2+)	
4610	(1/2+,3/2+)	1237 *4*	100	3373		
4732		4732# *69*	100	0.0	(5/2+)	
4923		2003# *19*	100	2920		
5547	(1/2+,3/2+)	1716 *6*	100	3831		
5593	(1/2+,3/2+)	2673 *14*	100	2920		
6365		3445# *60*	100	2920		
6629		1706# *25*	100	4923		
6905		3985# *51*	100	2920		

† From ^{23}O β^- Decay, except otherwise noted.
‡ From weighted average of data from ^{23}O β^- Decay and (^{22}O,p2nγ), considering total uncertainty of the latter dataset. Final uncertainty is the lowest input value.
# From (^{22}O,^{23}Fγ).

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



$^{23}_{9}F_{14}$

^{23}O β^- decay (97 ms) 2007Su05

Parent: ^{23}O: E=0.0; J$^\pi$=1/2$^+$; $T_{1/2}$=97 ms *8*; Q(β^-)=11.34×10^3 *13*; %β^- decay=100
^{23}O-%β^- decay: %β^-=100. %β^-n=7 *2* (2007Su05).
Other reference: 1990Mu06.
Based on XUNDL: Compiled by S. Geraedts, J. Roediger and B. Singh (McMaster), Apr 26, 2007.
^{23}O source was produced from primary ^{48}Ca beam, E=140 MeV/nucleon, fragmentation on a thick ^{9}Be target at NSCL facility. The fragments were separated by A1900 fragment separator on the basis of magnetic rigidities. The beam of ^{23}O was used in a pulsed mode with a time period of 300 ms. The β-decay of ^{23}O was monitored during the beam-off period of 300 ms. The detection system consisted of an implantation detector (plastic scintillator), an array of 16 neutron time-of-flight detectors and eight γ-ray detectors of SeGA array. Particle (^{23}O) identification was achieved by time-of-flight and energy loss information in silicon detectors. Measured Eγ, Iγ, $\gamma\gamma$, (particle)γ coin, $\gamma\beta$ coin, delayed neutrons, isotopic half-life by timing of γ rays, β rays and delayed neutrons. Comparisons with shell-model calculations.
1990Mu06: Projectile fragmentation reaction of ^{48}Ca beam at 44 MeV/nucleon on Be-target was used at GANIL. Fragment identification was carried out using LISE spectrometer. At the exit from LISE, fragments were implanted into semiconductor telescope. Measured ^{23}O half-life.

^{23}F Levels

E(level)‡	J$^\pi$†	Comments
0.0	(5/2$^+$)	
2244 *8*	(1/2)$^+$	J$^\pi$: 1/2$^+$ in 2007Su05.
2926 *10*		
3367 *13*		
3837 *11*		
3865 *9*	(1/2$^+$,3/2$^+$)	
4066 *16*	(3/2$^+$)	
4604 *14*	(1/2$^+$,3/2$^+$)	
5553 *13*	(1/2$^+$,3/2$^+$)	
5599 *14*	(1/2$^+$,3/2$^+$)	
7580+x		E(level): From S(n)=7580 *40* (^{23}F) and x<3.76E3 *14* [from Q(β^-) (^{23}O=11.34E3 *13*-S(n)(^{23}F) (2017Wa10)].

† From Adopted Levels.
‡ From least-squares fit to gamma energies by the evaluators.

β^- radiations

E(decay)	E(level)	Iβ^-†‡	Log *ft*	Comments
(1.9×10^3@ *19*)	7580+x	7 *2*		Iβ^-: %β^-n 7 *2* (from ^{23}O Adopted Levels).
(5.74×10^3 *13*)	5599	5.2 *10*	4.31 *11*	
(5.79×10^3 *13*)	5553	2.1 *6*	4.72 *14*	
(6.74×10^3 *13*)	4604	3.1 *9*	4.86 *14*	
(7.27×10^3 *13*)	4066	17.1 *17*	4.27 *7*	
(7.48×10^3 *13*)	3865	15.8 *19*	4.36 *8*	
(7.97×10^3# *13*)	3367	1.4 *14*	>5.5	Iβ^-: No feeding quoted by 2007Su05. Log *ft*: Lower limit.
(9.10×10^3 *13*)	2244	45.8 *16*	4.30 *5*	
(1.134×10^4 *13*)	0.0			Iβ^-: g.s. β feeding can be expected <3 considering β to the excited states and %β^-n=7 *2*, which yields a log *ft* > 5.9. For ΔJ=2$^+$ and $\Delta\pi$=no expected log *ft* ~12.

† From γ-ray intensity balance.

Continued on next page (footnotes at end of table)

^{23}O β^- decay (97 ms) 2007Su05 (continued)

β^- radiations (continued)

‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.
@ Estimated for a range of levels.

$\gamma(^{23}F)$

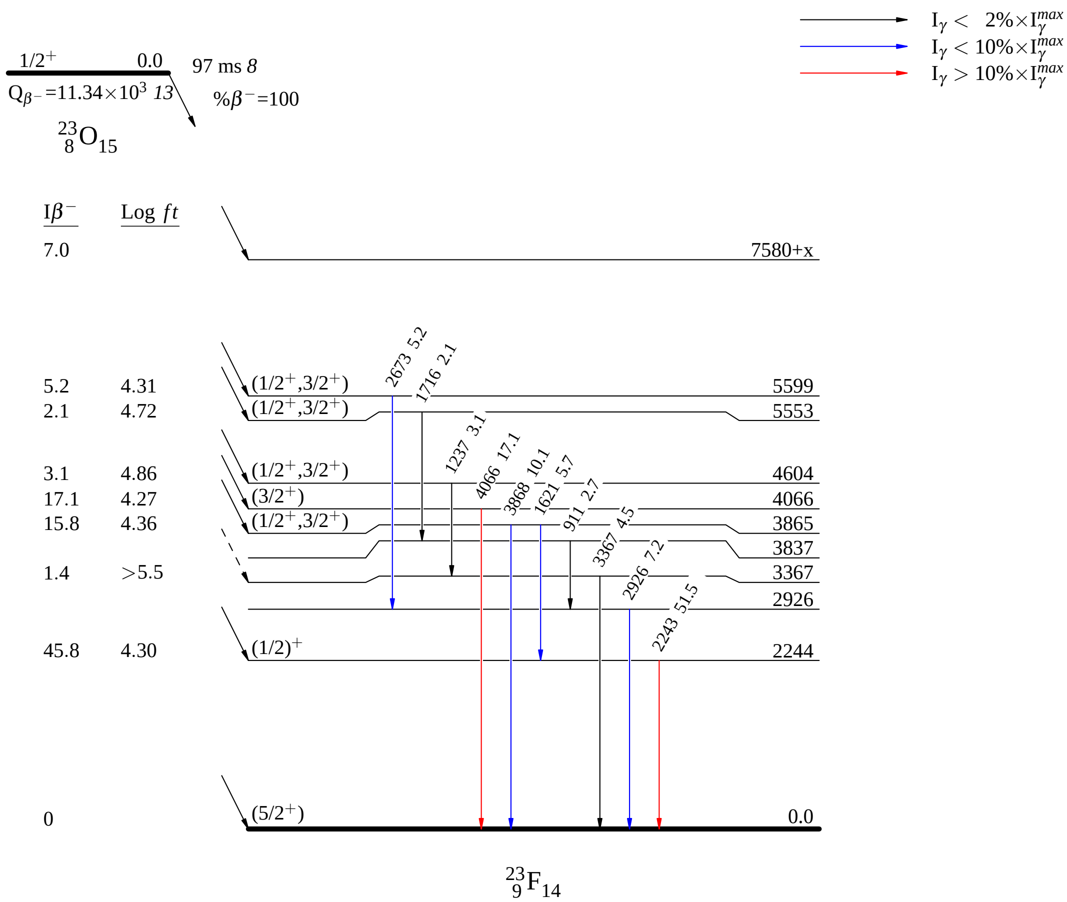
E_γ	I_γ †	E_i(level)	J_i^π	E_f	J_f^π
911 *4*	2.7 *12*	3837		2926	
1237 *4*	3.1 *9*	4604	$(1/2^+,3/2^+)$	3367	
1621 *6*	5.7 *10*	3865	$(1/2^+,3/2^+)$	2244	$(1/2)^+$
1716 *6*	2.1 *6*	5553	$(1/2^+,3/2^+)$	3837	
2243 *8*	51.5 *12*	2244	$(1/2)^+$	0.0	$(5/2^+)$
2673 *9*	5.2 *10*	5599	$(1/2^+,3/2^+)$	2926	
2926 *10*	7.2 *18*	2926		0.0	$(5/2^+)$
3367 *13*	4.5 *10*	3367		0.0	$(5/2^+)$
3868 *15*	10.1 *16*	3865	$(1/2^+,3/2^+)$	0.0	$(5/2^+)$
4066 *16*	17.1 *17*	4066	$(3/2^+)$	0.0	$(5/2^+)$

† Absolute intensity per 100 decays.

^{23}O β^- decay (97 ms) 2007Su05

Decay Scheme

Intensities: I_γ per 100 parent decays



^{24}O β^-n decay 1990Mu06,2015Ca09,1999Re16

Parent: ^{24}O: E=0.0; $J^\pi=0^+$; $T_{1/2}$=72 ms *5*; Q(β^-n)=7.14×10^3 *17*; %β^-n decay=41 *6*

^{24}O-$T_{1/2}$: From 2015Bi05 (Weighted average of 61 ms *+32−19* (1990Mu06), 65 ms *5* (1999Re16), and 80 ms *5* (2015Ca09)).

^{24}O-%β^-n decay: From 2015Bi05 (Weighted average of 58 *12* (1990Mu06) and 39 *4* (corrected value from 43 *4* in 2015Ca09).

Other reference: 2001Pe14.

1990Mu06: Projectile fragmentation reaction of ^{48}Ca beam at 44 MeV/nucleon on Be-target was used at GANIL. Fragment identification was carried out using LISE spectrometer. At the exit from LISE, fragments were implanted into semiconductor telescope. The beta-delayed neutrons were detected by means of a neutron detector surrounding the semi-conductor telescope. These neutrons were detected in coincidence with the β-ray detected in a Si(Li) detector. Measured ^{24}O half-life, %β^-n.

2015Ca09: ^{24}O was produced via fragmentation of 77.6 MeV/nucleon ^{36}S primary beam on a ^{9}Be target of thickness=237 mg/cm^2, and separated by LISE achromatic spectrometer at GANIL. Isotope identification was performed by energy loss in two silicon detectors (ΔE) of thickness 500 μm and time-of-flight. ^{24}O isotopes implanted in double-sided-silicon-strip-detector (DSSSD). A Si(Li) detector was placed after DSSSD to control implantation depth. Four segmented Ge clover detectors of EXOGAM array placed around DSSSD detector. Measured Eγ, Iγ, $\gamma\gamma$ and $\beta\gamma$ coincidences. Measured ^{24}O half-life and %β-n branch.

1999Re16,2001Pe14: Projectile fragmentation reactions of Ta(^{36}S,X), E(^{36}S)=2.8 GeV; Magnetic Spectrometer (LISE3); nuclides were identified by TOF and energy loss in Si; 6 Si and 4 HPGe and 42 ^{3}He proportional counters; Measured: ^{24}O half-life, %β^-n.

^{4}He(^{22}O,^{23}Fγ) 2006Mi16

Others: 2005Sh46, 2005Mi32, 2007Mi25 – All from the same research group and 2006Mi16 supersedes all the other papers.
Based on XUNDL: Compiled by B. Singh and J. Roediger (McMaster), May 16, 2005.
Includes ^{4}He-induced reactions in inverse kinematics: ^{4}He(^{22}O,^{23}Fγ), ^{4}He(^{23}F,^{23}Fγ), ^{4}He(^{24}F,^{23}Fγ), and ^{4}He(^{25}Ne,^{23}Fγ).
Beams of ^{22}O, ^{23}F, ^{24}F, and ^{25}Ne were produced as secondary beams from 63 MeV/nucleon ^{40}Ar primary beam impinging on a ^{9}Be target. Fragments were analyzed by RIPS separator at RIKEN facility. The secondary beam particles were identified event-by-event according to the energy loss signals from a silicon detector and the time of flight between two plastic scintillators at 5 meters apart along the beamline. The secondary beams were allowed to bombard a liquid helium target. The reaction products detected by a ΔE-E telescope. The identification of the reaction products were carried out using time-of-flight (TOF), energy loss(ΔE), and energy (E). The ΔE-E telescope consisted of 9 silicon (for ΔE measurement) and 36 NaI(Tl) (for E measurement) detectors. The gamma rays from the reaction products were detected with an array (DALI2) of 150 NaI(Tl) detectors. Measured Eγ, $\gamma\gamma$, $\gamma(\theta)$ and angular distribution of the outgoing ^{23}F particles.
Relative cross sections of population of levels are given by 2006Mi16 in a bar chart.

^{23}F Levels

E(level)[a]	J$^{\pi}$	L	Comments
0.0	(5/2^{+})		J$^{\pi}$: From Adopted Levels.
2268[†‡@] *21*	(1/2^{+})	(0)	(2J+1)C^{2}S=0.73 *+21−33*, C^{2}=isospin Clebsch-Gordan coefficient. L: from observed population strength of the state in α inelastic scattering, proton transfer in (^{22}O,^{23}F), DWBA comparison.
2920[‡#@] *22*			
3.38×10^{3}[&] *3*			
3833[&] *25*			
3.86×10^{3}[&] *4*			
3.96×10^{3}[#] *4*			
4.06×10^{3}[†] *4*	(3/2^{+})	(2)	(2J+1)C^{2}S=0.95 *+29−35*, C^{2}=isospin Clebsch-Gordan coefficient. L: from observed population strength of the state in α inelastic scattering, proton transfer in (^{22}O,^{23}F), DWBA comparison. Configuration: $\pi d_{3/2}$ (2006Mi16).
4.62×10^{3}[†@] *4*			
4.73×10^{3}[&] *7*			
4.92×10^{3}[†‡#] *3*			
5.54×10^{3}[#@] *3*			
5.56×10^{3}[†] *6*			
6.37×10^{3}[†] *7*			
6.63×10^{3}[@] *4*			
6.91×10^{3}[†‡] *6*			

† Populated in (^{22}O,^{23}Fγ).
‡ Populated in (^{23}F,^{23}Fγ).
# Populated in (^{24}F,^{23}Fγ).
@ Populated in (^{25}Ne,^{23}Fγ).
& Populated in all four reactions.
a From Eγ and recoil correction.

^{4}He(^{22}O,^{23}Fγ) 2006Mi16 (continued)

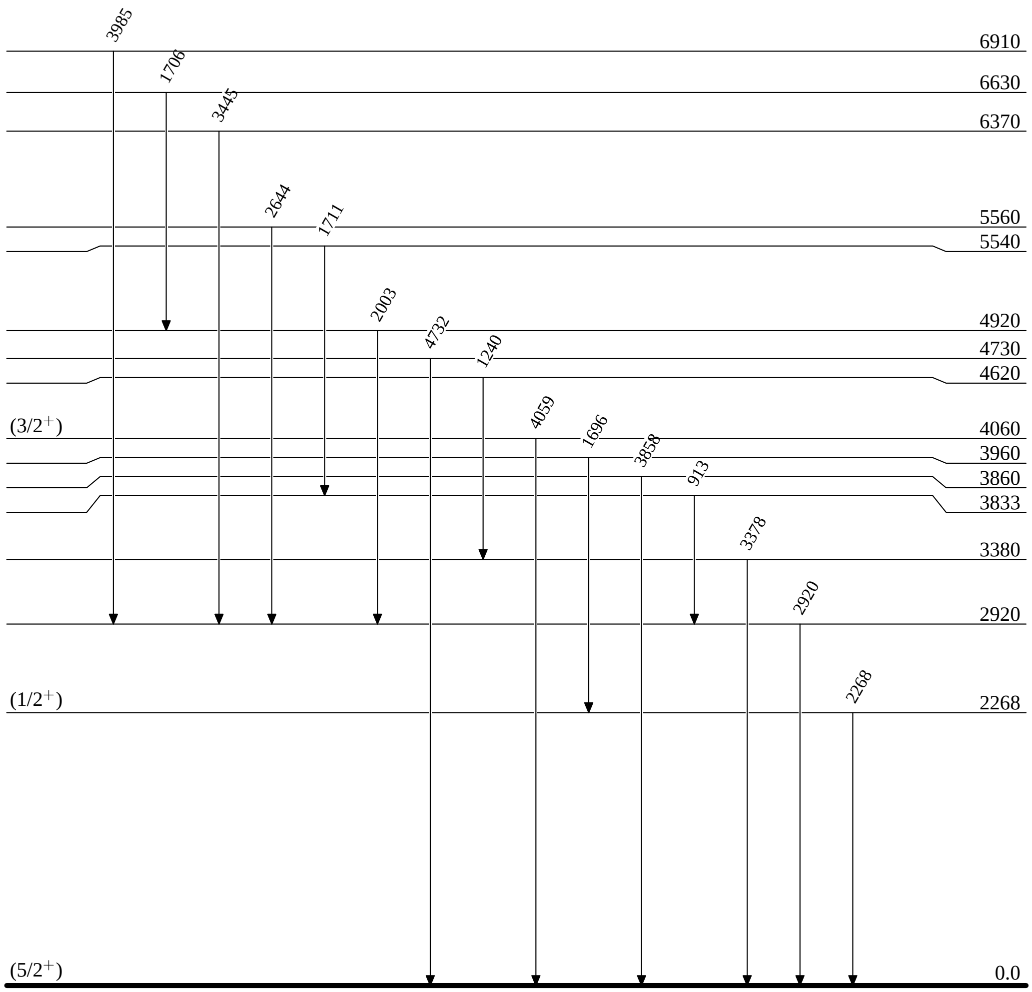
γ(^{23}F)

E_{γ}†	E_i(level)	J_i^{π}	E_f	J_f^{π}	Comments
913 *10*	3833		2920		E_{γ}: Uncertainty from 7 (stat) 7 (syst).
1240 *15*	4.62×10^3		3.38×10^3		E_{γ}: Uncertainty from 12 (stat) 9 (syst).
1696 *28*	3.96×10^3		2268	$(1/2^+)$	E_{γ}: Uncertainty from 25 (stat) 13 (syst).
1706 *25*	6.63×10^3		4.92×10^3		E_{γ}: Uncertainty from 21 (stat) 13 (syst).
1711 *15*	5.54×10^3		3833		E_{γ}: Uncertainty from 8 (stat) 13 (syst).
2003 *19*	4.92×10^3		2920		E_{γ}: Uncertainty from 12 (stat) 15 (syst).
2268 *21*	2268	$(1/2^+)$	0.0	$(5/2^+)$	E_{γ}: Uncertainty from 12 (stat) 17 (syst).
2644 *53*	5.56×10^3		2920		E_{γ}: Uncertainty from 49 (stat) 20 (syst).
2920 *22*	2920		0.0	$(5/2^+)$	E_{γ}: Uncertainty from 3 (stat) 22 (syst).
3378 *28*	3.38×10^3		0.0	$(5/2^+)$	E_{γ}: Uncertainty from 11 (stat) 26 (syst).
3445 *60*	6.37×10^3		2920		E_{γ}: Uncertainty from 54 (stat) 26 (syst).
3858 *38*	3.86×10^3		0.0	$(5/2^+)$	E_{γ}: Uncertainty from 24 (stat) 29 (syst).
3985 *51*	6.91×10^3		2920		E_{γ}: Uncertainty from 41 (stat) 30 (syst).
4059 *33*	4.06×10^3	$(3/2^+)$	0.0	$(5/2^+)$	E_{γ}: Uncertainty from 11 (stat) 31 (syst).
4732 *69*	4.73×10^3		0.0	$(5/2^+)$	E_{γ}: Uncertainty from 59 (stat) 36 (syst).

† Statistical and systematic uncertainties in quadrature (systematic uncertainty 0.76% of Eγ – Fig. 3. caption – 2006Mi16).

$^{4}He(^{22}O,^{23}F\gamma)$ 2006Mi16

Level Scheme



$^{23}_{9}F_{14}$

^{22}Ne(^{18}O,^{17}F) 1989Or04

No significant revision from previous evaluation (2007Fi02).

^{22}Ne(^{18}O,^{17}F) at E=108 MeV using the 14 UD Pelletron facility at ANU. Enriched targets. The gaseous neon target was confined in a gas cell. The reaction products were momentum-analyzed by an Enge split-pole spectrometer equipped with a multi-element gas filled detector. The energy resolution ~420 keV FWHM.

^{23}F Levels

E(level)	Comments
0.0	
2310 *80*	
2930 *80*	
4050 *50*	
5000 *60*	E(level): Broad resonance, possibly unresolved multiplet.
6250 *80*	E(level): Broad resonance, possibly unresolved multiplet.
8.18×10^3 *11*	E(level): ΔE dominated by energy calibration extrapolation; neutron unbound state; larger uncertainty is because of extrapolation of calibration.

^{9}Be(^{36}S,Xγ) 2002Az02

Others: 2002Az01, 2002Gu08 – Same research group of 2002Az02.
Minor change from previous evaluation (2007Fi02).
2002Az02 (also 2002Az01, 2002Gu08): ^{23}F produced from projectile fragmentation of ^{36}S beam, E=77 MeV/nucleon, on a Be-target at GANIL. The SPEG spectrometer along with an array of 74 BaF_2 detectors and 4 Ge detectors were used. FWHM 35 keV at 1500 keV γ-ray emitted at 35% of the speed of light.

^{23}F Levels

E(level)‡	J^{π}†
0.0	(5/2$^+$)
2900	(7/2$^+$)
3810	(9/2$^+$)

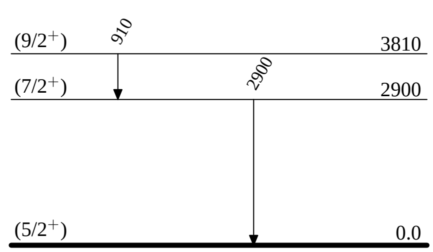
† From shell model calculations.
‡ From γ-ray energies.

γ(^{23}F)

E_γ	E_i(level)	J^{π}_i	E_f	J^{π}_f
910	3810	(9/2$^+$)	2900	(7/2$^+$)
2900	2900	(7/2$^+$)	0.0	(5/2$^+$)

^{9}Be(^{36}S,Xγ) 2002Az02

Level Scheme



$^{23}_{9}F_{14}$

Adopted Levels, Gammas

$Q(\beta^-)$=4375.80 *10*; S(n)=5200.65 *10*; S(p)=15236 *12*; $Q(\alpha)$=−10911.8 *26* 2017Wa10
Other reaction:
1979Gr16: $^{27}Al(\alpha,^8Be)$, E=109 MeV, first observation of the $(\alpha,^8Be)$ reaction.
2018MuZY list 23 resonance levels for ^{23}Ne.

^{23}Ne Levels

Cross Reference (XREF) Flags

A	^{23}F β^- decay	E	$^{22}Ne(n,n),(n,\gamma)$:res	I	$^{23}Na(n,p)$
B	$^{21}Ne(t,p)$	F	$^{22}Ne(d,p\gamma)$	J	$^{23}Na(n,p\gamma)$
C	$^{22}Ne(n,\gamma)$ E=thermal	G	$^{22}Ne(d,p)$,(pol d,p)	K	$^{208}Pb(^{22}Ne,^{23}Ne\gamma)$
D	$^{22}Ne(n,\gamma)$ E=15-60 keV	H	$^{23}Na(\mu^-,\gamma)$		

E(level)†	J^π	$T_{1/2}$&	XREF	Comments
0.0	5/2$^+$	37.25 s *10*	ABCD FGHIJK	%β^-=100 μ=−1.0794 *10*; Q=0.145 *13* $\delta<r^2>(^{20}Ne,^{23}Ne)$=−0.572 fm^2 *34* (2013An02, 2011Ma48). The r.m.s. charge radius $<r^2>^{1/2}$=2.910 fm *7* (2013An02). J^π: 5/2 from LASER spectroscopy (2005Ge06, 2013Ma15), L=2 in (d,p). $T_{1/2}$: From 37.151 s *56* (wt. ave. of 37.126 s *30* and 37.276 s *67* with external uncertainty (2015La19 − also 37.153 s *28* with statistical uncertainty)), 37.11 s *6* (from 2007Gr18), 37.24 s *12* (from 1974Al03), 37.6 s *1* (1957Pe12), 38.0 s *3* (1958Nu41), and 37.5 s *1* (1959Al10) − using the Limitation of Relative Statistical Weight (LWM) method (1985ZiZY). Wt. ave. 37.25 s *9* with χ^2=6.7 and χ^2_{crit}=3.0 at 99% C.L. Unweighted ave. 37.43 s *14*. Other values (outlier − Chauvenet's criterion): 38.7 s *4* (1967Yu01), 40.2 s *4* (1950Br78). μ: From 2019StZV (in 1994Hi09 −1.0795 *10* β-NMR). Others: −1.077 *4* (2005Ge06 − CFBLS/β-NMR), −1.08 *1* (1968Do07), 1.0817 *9* (2014StZZ). Q: From 2005Ge06, 2016St14 − CFBLS/β-NMR.
1016.926 *20*	1/2$^+$	178 ps *10*	ABCD FGHIJK	J^π: L=0 in (d,p). $T_{1/2}$: from 1966Fo02 (d,pγ) − pγ(t) coincidence. Other: 208 ps *110* (d,pγ) (1974Ch35).
1701.59 *17*	(7/2$^+$)	<70 fs	AB FGH J	J^π: From $\gamma(\theta)$ in 1969Na02 (n,pγ), D(+Q) γ to 5/2$^+$, γ from 3/2$^+$ and 5/2$^+$.
1822.26 *6*	3/2$^+$	<70 fs	ABCD FGHIJ	J^π: L=0+2 in (t,p) from a 3/2$^+$ g.s.
2315.1 *3*	5/2$^+$@	<70 fs	AB FGHIJ	J^π: L=2 in (d,p).
2516.8 *3*	(5/2,7/2)	<70 fs	AB FG J	J^π: From $\gamma(\theta)$ in 1969Na02 (n,pγ), log *ft*=6.1 from 5/2$^+$.
3220.69 *5*	3/2$^-$	<70 fs	BCD FG	J^π: L=1 in (d,p) and ≠1/2 from $\gamma(\theta)$ and correlation studies (1967Ho08 − (d,pγ)).
3431.6 *3*	3/2$^+$@	<70 fs	Ab FGH	J^π: L=2 in (d,p).
3458.49 *8*	(1/2,3/2,5/2$^+$)	<70 fs	bC F H	J^π: γ's to 1/2$^+$ and 3/2$^+$.
3830.9 *4*	(3/2,5/2,7/2)$^+$	<70 fs	Ab F	J^π: log *ft*=4.6 from 5/2$^+$.
3836.35 *6*	1/2$^-$@	<70 fs	bCD FG	J^π: L=1 in (d,p).
3842.3 *9*		<70 fs	b F	
3987.8 *5*	(3/2)$^+$@	<70 fs	b FG	J^π: L=2 in (d,p).
4010 *3*		<70 fs	b F	
4270 *15*			B G	
4436.1 *4*	(3/2,5/2,7/2)$^+$		AB G	J^π: log *ft*=4.7 from 5/2$^+$.
4764 *5*			B G	
4867 *15*			B G	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Ne Levels (continued)

E(level)†	J$^\pi$	XREF	Comments
4940 *5*		G	
4995 *15*		b G	
5029 *5*		b G	
5068 *5*		G	
5185 *6*	(3/2$^+$,5/2$^+$)	b G	J$^\pi$: L=(2) in (d,p).
5200.71 *6*	1/2$^+$	bCD	J$^\pi$: Capture-state spin, assuming s-capture.
(5220 *5*)	5/2$^-$,7/2$^-$	b G	J$^\pi$: L=3 in (d,p).
5265?		G	
5340?		B G	XREF: B(5366).
5460.8‡ *3*	1/2$^-$	E G	J$^\pi$: From ^{22}Ne(n,γ) resonance data.
5478.7‡ *3*	1/2$^+$	B E	J$^\pi$: From ^{22}Ne(n,γ) resonance data.
5522 *10*		G	
5560 *15*		G	
5609.2‡ *5*	1/2$^-$	E G	J$^\pi$: From ^{22}Ne(n,γ) resonance data.
5646# *10*		B G	
5672 *5*	1/2$^+$	E	J$^\pi$: From ^{22}Ne(n,γ) resonance data.
5726 *10*		G	
5740.2‡ *6*	3/2$^+$	B E	J$^\pi$: L=0 in (t,p).
5785 *15*		G	
5861.0‡ *7*	3/2$^-$	E G	XREF: G(5840). J$^\pi$: From ^{22}Ne(n,γ) resonance data.
5899 *40*		B	
5968 *5*	1/2$^+$	E	J$^\pi$: From ^{22}Ne(n,γ) resonance data.
6093 *40*		B	
6329? *40*		B	
6445 *40*		B	

† From least-squares fit to γ-ray energies, except otherwise noted.
‡ From (n,n),(n,γ):res.
# From (d,p),(pol d,p).
@ From (pol d,p) – vector analyzing power – 1974WoZA.
& From (d,pγ), except otherwise noted.

γ(^{23}Ne)

E$_i$(level)	J$^\pi_i$	E$_\gamma$†	I$_\gamma$†	E$_f$	J$^\pi_f$	Mult.	δ	Comments
1016.926	1/2$^+$	1016.90 *2*	100	0.0	5/2$^+$	[E2]		B(E2)(W.u.)=0.75 *5*
1701.59	(7/2$^+$)	1701.51 *18*	100	0.0	5/2$^+$	D(+Q)	+0.11 *12*	E$_\gamma$,δ: From 1969Na02 (n,pγ).
1822.26	3/2$^+$	1822.22 *8*	100	0.0	5/2$^+$			E$_\gamma$: Weighted average of 1822.25 *21* (^{23}F β^- decay), 1822.19 *6* (n,γ), and 1822.8 *3* (d,pγ).
2315.1	5/2$^+$	492.6# *4*	89‡ *4*	1822.26	3/2$^+$			
		614.0‡ *15*	6.9‡ *23*	1701.59	(7/2$^+$)			
		1298.2‡ *9*	17‡ *4*	1016.926	1/2$^+$			
		2315.0# *5*	100‡ *4*	0.0	5/2$^+$			
2516.8	(5/2,7/2)	815.3# *4*	100‡ *11*	1701.59	(7/2$^+$)			
		2516.6# *5*	44‡ *18*	0.0	5/2$^+$			I$_\gamma$: Other: 12 *4* (^{23}F β^- decay).
3220.69	3/2$^-$	1398.45 *6*	1.91 *9*	1822.26	3/2$^+$			I$_\gamma$: 3.2 *11* in (d,pγ).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{23}Ne)$ (continued)

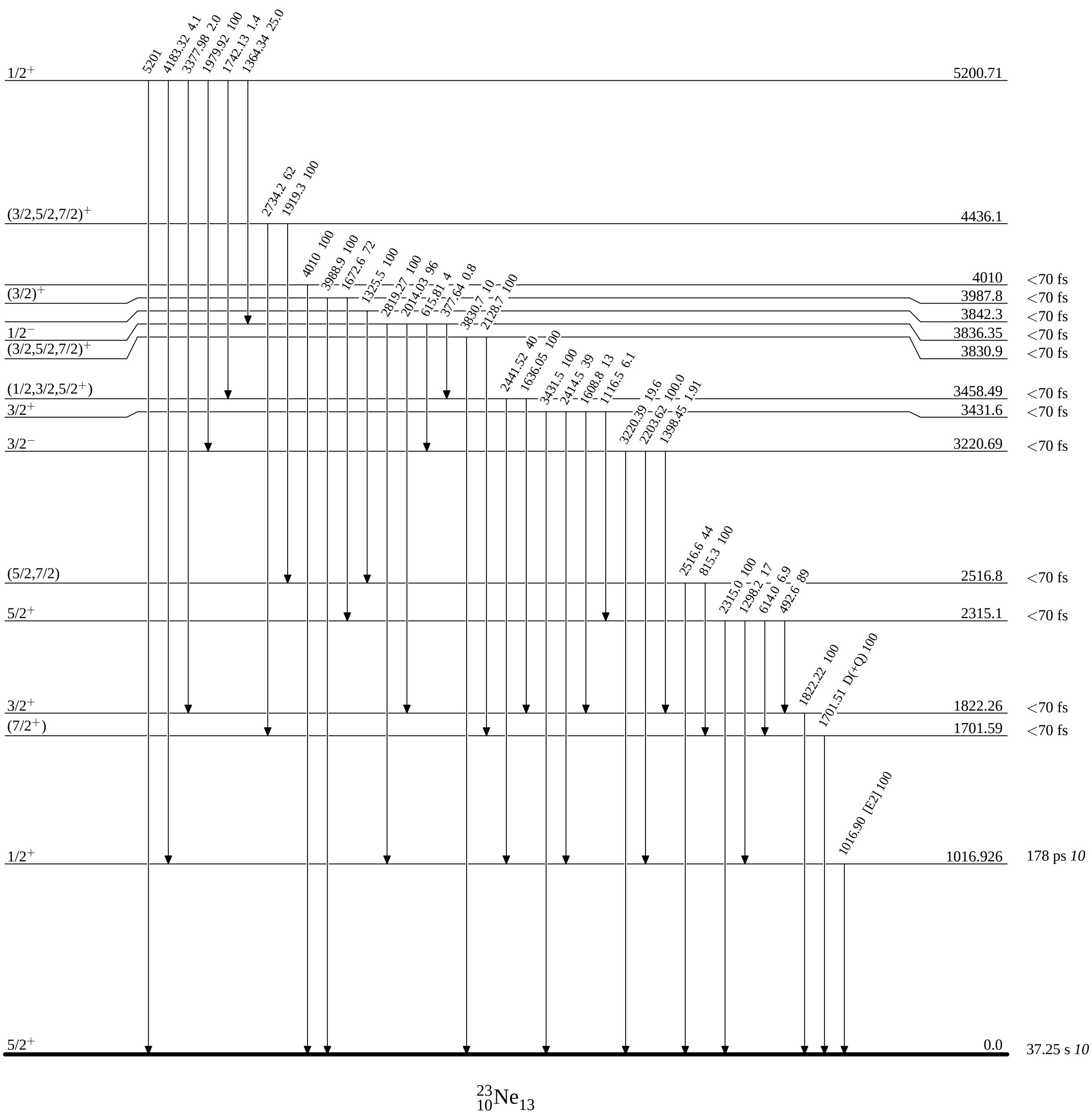
E_i(level)	J^π_i	E_γ †	I_γ †	E_f	J^π_f	Comments
3220.69	3/2⁻	2203.62 *7*	100.0 *9*	1016.926	1/2⁺	
		3220.39 *12*	19.6 *3*	0.0	5/2⁺	
3431.6	3/2⁺	1116.5‡ *6*	6.1‡ *15*	2315.1	5/2⁺	
		1608.8‡ *11*	13‡ *3*	1822.26	3/2⁺	
		2414.5# *5*	39‡ *6*	1016.926	1/2⁺	
		3431.5# *4*	100‡ *7*	0.0	5/2⁺	
3458.49	(1/2,3/2,5/2⁺)	1636.05 *10*	100 *8*	1822.26	3/2⁺	
		2441.52 *29*	40 *8*	1016.926	1/2⁺	I_γ: Other: 82 *15* (d,pγ).
3830.9	(3/2,5/2,7/2)⁺	2128.7# *7*	100@ *16*	1701.59	(7/2⁺)	
		3830.7# *4*	10‡ *1*	0.0	5/2⁺	
3836.35	1/2⁻	377.64 *16*	0.8 *2*	3458.49	(1/2,3/2,5/2⁺)	
		615.81 *13*	4 *1*	3220.69	3/2⁻	
		2014.03 *7*	96 *1*	1822.26	3/2⁺	
		2819.27 *12*	100 *3*	1016.926	1/2⁺	
3842.3		1325.5‡ *8*	100	2516.8	(5/2,7/2)	
3987.8	(3/2)⁺	1672.6 *4*	72‡ *5*	2315.1	5/2⁺	
		3988.9 *16*	100‡ *10*	0.0	5/2⁺	
4010		4010‡ *3*	100	0.0	5/2⁺	
4436.1	(3/2,5/2,7/2)⁺	1919.3@ *5*	100@ *13*	2516.8	(5/2,7/2)	
		2734.2@ *5*	62@ *8*	1701.59	(7/2⁺)	
5200.71	1/2⁺	1364.34 *4*	25.0 *3*	3836.35	1/2⁻	
		1742.13 *10*	1.4 *1*	3458.49	(1/2,3/2,5/2⁺)	
		1979.92 *6*	100 *1*	3220.69	3/2⁻	
		3377.98 *18*	2.0 *1*	1822.26	3/2⁺	
		4183.32 *18*	4.1 *2*	1016.926	1/2⁺	
		5201		0.0	5/2⁺	

† From (n,γ) E=Thermal, except otherwise noted.
‡ From (d,pγ).
\# Weighted average of data from ^{23}F β^- decay and (d,pγ).
@ From ^{23}F β^- decay.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



$^{23}_{10}Ne_{13}$

^{23}F β^- decay 1974Go17

Parent: ^{23}F: E=0.0; J^π=(5/2$^+$); $T_{1/2}$=2.23 s *14*; Q(β^-)=8440 *30*; %β^- decay=100

^{23}F was produced by ^{10}Be(^{18}O,αp) with beam energy of 42 MeV. The target was enriched to 94% in ^{10}Be. Ge(Li) and NE102 detectors were used. Measured half-life, Eβ, Eγ, Iβ, Iγ and $\beta\gamma$ coincidences.

^{23}Ne Levels

E(level)†	J^π#	$T_{1/2}$	Comments
0.0	5/2$^+$	37.25 s *10*	$T_{1/2}$: from Adopted Levels.
1016.9 *4*	1/2$^+$		
1701.52 *15*	(7/2$^+$)		
1822.29 *21*	3/2$^+$		
2314.9 *6*	5/2$^+$		
2516.6 *5*	(5/2,7/2)		
3220.69‡ *5*	3/2$^-$‡		
3431.5 *4*	3/2$^+$		
3830.9 *4*	(3/2,5/2,7/2)$^+$		
3836.35‡ *6*	1/2$^-$‡		
4435.9 *5*	(3/2,5/2,7/2)$^+$		
5201+x			E(level): From S(n)=5200.65 *10* (^{23}Ne) and x<3239 *30* [from Q(β^-) (^{23}F)=8440 *30*-S(n)(^{23}Ne) (2017Wa10)].

† From least-squares fit to γ-ray energies.
‡ From Adopted Levels. Listed for beta feeding in Table II (1974Go17).
# From Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ^-†‡	Log *ft*	Comments
(1.6×10^3# *16*)	5201+x	<14		Iβ^-: %β^-n < 14 (from ^{23}F Adopted Levels).
(4.00×10^3 *3*)	4435.9	9	4.7	
(4.60×10^3 *3*)	3836.35	<1.1	>5.9	Iβ^-: From 1974Go17.
(4.61×10^3 *3*)	3830.9	22	4.6	
(5.01×10^3 *3*)	3431.5	12	5.0	
(5.22×10^3 *3*)	3220.69	<1.2	>6.1	Iβ^-: From 1974Go17.
(5.92×10^3 *3*)	2516.6	2.5	6.1	
(6.13×10^3 *3*)	2314.9	5.6	5.8	
(6.62×10^3 *3*)	1822.29	11	5.6	
(6.74×10^3 *3*)	1701.52			Iβ^-: γ-ray intensity balance yields −1 *4*. Expected as an allowed transition from (5/2$^+$) to (7/2$^+$).
(7.42×10^3 *3*)	1016.9	<3	>6.4	
(8.44×10^3 *3*)	0.0	30 *8*	5.7 *1*	Iβ^-: From 1987DuZU.

† From γ-ray intensity balance, except where otherwise noted.
‡ Absolute intensity per 100 decays.
# Estimated for a range of levels.

$^{23}F\ \beta^-$ decay 1974Go17 (continued)

$\gamma(^{23}Ne)$

Iγ normalization: Normalized assuming $\Sigma I\gamma$(g.s.)=63 *11* (100 − 30 *8* (g.s. feeding (1987DuZu)) − 7 *7* (1/2 of the %β^-n limit of <14 (1995ReZZ,2008ReZZ))).

E_γ †	I_γ ‡	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	Comments
493.0 *7*	10.8 *28*	2314.9	5/2$^+$	1822.29	3/2$^+$			
815.2 *5*	24.8 *47*	2516.6	(5/2,7/2)	1701.52	(7/2$^+$)			
1016.7 *5*	20.1 *55*	1016.9	1/2$^+$	0.0	5/2$^+$			
1701.44 *15*	100.0 *47*	1701.52	(7/2$^+$)	0.0	5/2$^+$	D(+Q)	+0.11 *12*	
1822.25 *21*	47.4 *26*	1822.29	3/2$^+$	0.0	5/2$^+$			
1919.3 *5*	19.3 *25*	4435.9	(3/2,5/2,7/2)$^+$	2516.6	(5/2,7/2)			
2128.8 *7*	68 *11*	3830.9	(3/2,5/2,7/2)$^+$	1701.52	(7/2$^+$)			
2314.2 *8*	7.7 *27*	2314.9	5/2$^+$	0.0	5/2$^+$			
2414.3 *4*	14.8 *34*	3431.5	3/2$^+$	1016.9	1/2$^+$			
2515.9 *13*	2.9 *10*	2516.6	(5/2,7/2)	0.0	5/2$^+$			E_γ: Seen only in coincidence spectra.
2734.2 *5*	11.9 *16*	4435.9	(3/2,5/2,7/2)$^+$	1701.52	(7/2$^+$)			
3431.4 *4*	25.4 *16*	3431.5	3/2$^+$	0.0	5/2$^+$			
3830.7 *4*	6.8 *9*	3830.9	(3/2,5/2,7/2)$^+$	0.0	5/2$^+$			

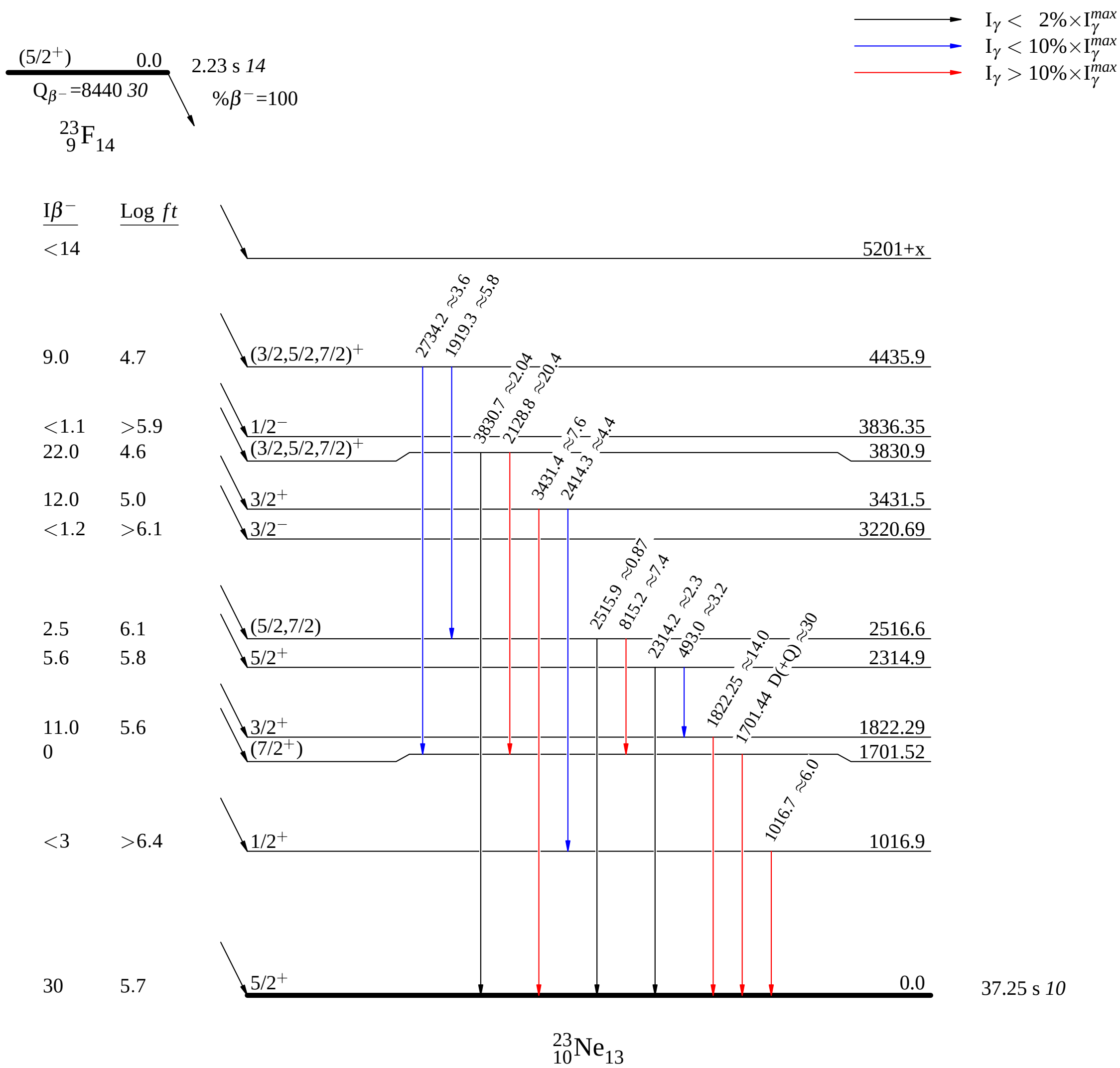
† From 1974Go17.
‡ For absolute intensity per 100 decays, multiply by ≈0.30.

^{23}F β^- decay 1974Go17

Decay Scheme

Intensities: I_γ per 100 parent decays

Legend



^{21}Ne(t,p) 1975De33

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

Triton beams having energies 3 and 3.25 MeV were used. 91% enriched ^{21}Ne target was used. The reaction products were detected using four solid state telescopes covering an angular range from 20 to 160 degrees. Measured $\sigma(\theta)$. Deduced energies and spin-parity of the levels. FWHM 40-50 keV.

^{23}Ne Levels

E(level)†	J^{π}	L	Comments
0.0			
1017‡			
1702‡			
1822‡		0+2	
2315‡			
2517‡			
3221‡			
3445#	$3/2^+$	0	E(level): Average of 3431.6 and 3458.5.
3837@			E(level): Average of 3830.9, 3836.4 and 3842.3.
3999#			E(level): Average of 3987.8 and 4010.
4270‡			
4436‡			
4764‡			
4867‡			
5012#		0	E(level): Average of 4995 and 5029.
5202			E(level): 1975De33 show doublet of 5186 and 5226 in Table I, appears to be a triplet compared to level energies of 5185, 5200, and 5220 in the adopted dataset. Listed energy is the average of these three values.
5366 *40*			
5481 *40*			
5649 *40*			
5745 *40*	$3/2^+$	0	
5899 *40*			
6093 *40*			
6329 *40*			E(level): Energy of the upper member of doublet.
6445 *40*			

† From 1975De33, unless otherwise stated.
‡ From Adopted Levels, rounded value without uncertainty. 1975De33 list level energy from literature.
# Unresolved doublet in 1975De33. Listed energy is the average of Adopted Level energies.
@ Unresolved triplet in 1975De33. Listed energy is the average of Adopted Level energies.

^{22}Ne(n,γ) E=thermal 2009BeZQ,1986Pr05

Others: 1986Pr05, 1971Be34, 1970Se14, 2005ReZY (private communication).
2009BeZQ: Target – 99.87% enriched ^{22}Ne gas. The experiment was carried out at the PGAA facilities of II-HAS at the Budapest Research Reactor. The de-exciting gamma rays were detected using a BGO-shielded HPGe detector. Measured Eγ, Iγ. 2005ReZY is an earlier work at the same facility of 2009BeZQ.
1986Pr05: Target – natural neon gas (purity 99.99%). Measured Eγ, Iγ with a high resolution pair spectrometer. Reported five γ rays, all are present in 2009BeZQ.
1971Be34: Target – natural neon gas (70% + 30% helium) target. The experiment was performed at the research reactor FRG 1 in Geesthacht. Measured Eγ, Iγ with a Ge(Li) detector. Reported twelve γ rays, nine of those are present in 2009BeZQ. The other three γ rays are not reported in 1970Se14.
1970Se14: Natural neon gas target. Experiment was performed at the 1 MW heavy water reactor in Stockholm. Measured Eγ, Iγ with a Ge(Li) detector. Reported twenty two γ rays, seven of those are present in 2009BeZQ.
Measured thermal neutron capture cross section 52.7 mb *7* (2009BeZQ, 2018MuZY).

Data from 2009BeZQ, 99.87% enriched ^{22}Ne gas target. γ-ray energies from 1986Pr05 are also considered.

^{23}Ne Levels

E(level)†	Jπ‡
0.0	5/2+
1016.901 *20*	1/2+
1822.15 *5*	3/2+
3220.52 *5*	3/2−
3458.30 *8*	(1/2,3/2,5/2+)
3836.13 *6*	1/2−
(5200.44 *6*)	1/2+

† From least-squares fit of γ-ray energies.
‡ From Adopted Levels.

γ(^{23}Ne)

Iγ normalization: From 100/σ, where σ=52.7 mb *7*. ΣIγ (g.s.) = 100 yields 1.919 *12*.

E_γ†	I_γ‡#	E_i(level)	J^π_i	E_f	J^π_f	Comments
377.64 *16*	0.04 *1*	3836.13	1/2−	3458.30	(1/2,3/2,5/2+)	E_γ: 377.64 *16* (2009BeZQ).
615.80 *13*	0.19 *4*	3836.13	1/2−	3220.52	3/2−	E_γ: 615.81 *13* (2009BeZQ).
1016.88 *2*	38.57 *29*	1016.901	1/2+	0.0	5/2+	E_γ: 1016.90 *2* (2009BeZQ).
1364.30 *4*	9.82 *10*	(5200.44)	1/2+	3836.13	1/2−	E_γ: 1364.34 *4* (2009BeZQ).
1398.40 *6*	1.37 *5*	3220.52	3/2−	1822.15	3/2+	E_γ: 1398.45 *6* (2009BeZQ).
1635.99 *10*	0.62 *5*	3458.30	(1/2,3/2,5/2+)	1822.15	3/2+	E_γ: 1636.05 *10* (2009BeZQ).
1742.06 *10*	0.56 *5*	(5200.44)	1/2+	3458.30	(1/2,3/2,5/2+)	E_γ: 1742.13 *10* (2009BeZQ).
1822.11 *6*	7.21 *9*	1822.15	3/2+	0.0	5/2+	E_γ: 1822.19 *6* (2009BeZQ).
1979.86 *6*	39.31 *34*	(5200.44)	1/2+	3220.52	3/2−	E_γ: Weighted ave. of 1979.83 *6* (2009BeZQ – 1979.92 *6*) and 1979.89 *6* (1986Pr05). Uncertainty lowest input value.
2013.94 *7*	4.76 *7*	3836.13	1/2−	1822.15	3/2+	E_γ: 2014.03 *7* (2009BeZQ).
2203.55 *6*	32.29 *29*	3220.52	3/2−	1016.901	1/2+	E_γ: Weighted ave. of 2203.51 *7* (2009BeZQ – 2203.62 *7*) and 2203.58 *6* (1986Pr05). Uncertainty lowest input value.
2441.38 *29*	0.25 *5*	3458.30	(1/2,3/2,5/2+)	1016.901	1/2+	E_γ: 2441.52 *29* (2009BeZQ).
2819.13 *12*	4.96 *17*	3836.13	1/2−	1016.901	1/2+	E_γ: Weighted ave. of 2819.08 *12* (2009BeZQ –

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^{22}Ne(n,γ) E=thermal 2009BeZQ,1986Pr05 (continued)

γ(^{23}Ne) (continued)

E_γ [†]	I_γ [‡#]	E_i(level)	J_i^π	E_f	J_f^π	Comments
						2819.27 *12*) and 2819.22 *16* (1986Pr05). Uncertainty lowest input value.
3220.25 *12*	6.32 *9*	3220.52	3/2⁻	0.0	5/2⁺	E_γ: Weighted ave. of 3220.15 *12* (2009BeZQ – 3220.39 *12*) and 3220.42 *16* (1986Pr05). Uncertainty lowest input value.
3377.71 *18*	0.80 *4*	(5200.44)	1/2⁺	1822.15	3/2⁺	E_γ: 3377.98 *18* (2009BeZQ).
4183.01 *18*	1.60 *7*	(5200.44)	1/2⁺	1016.901	1/2⁺	E_γ: Weighted ave. of 4182.91 *18* (2009BeZQ – 4183.32 *18*) and 4183.20 *25* (1986Pr05). Uncertainty lowest input value.

† From 2009BeZQ, recoil fraction subtracted. Values including recoil in 2009BeZQ are listed in the comments section.

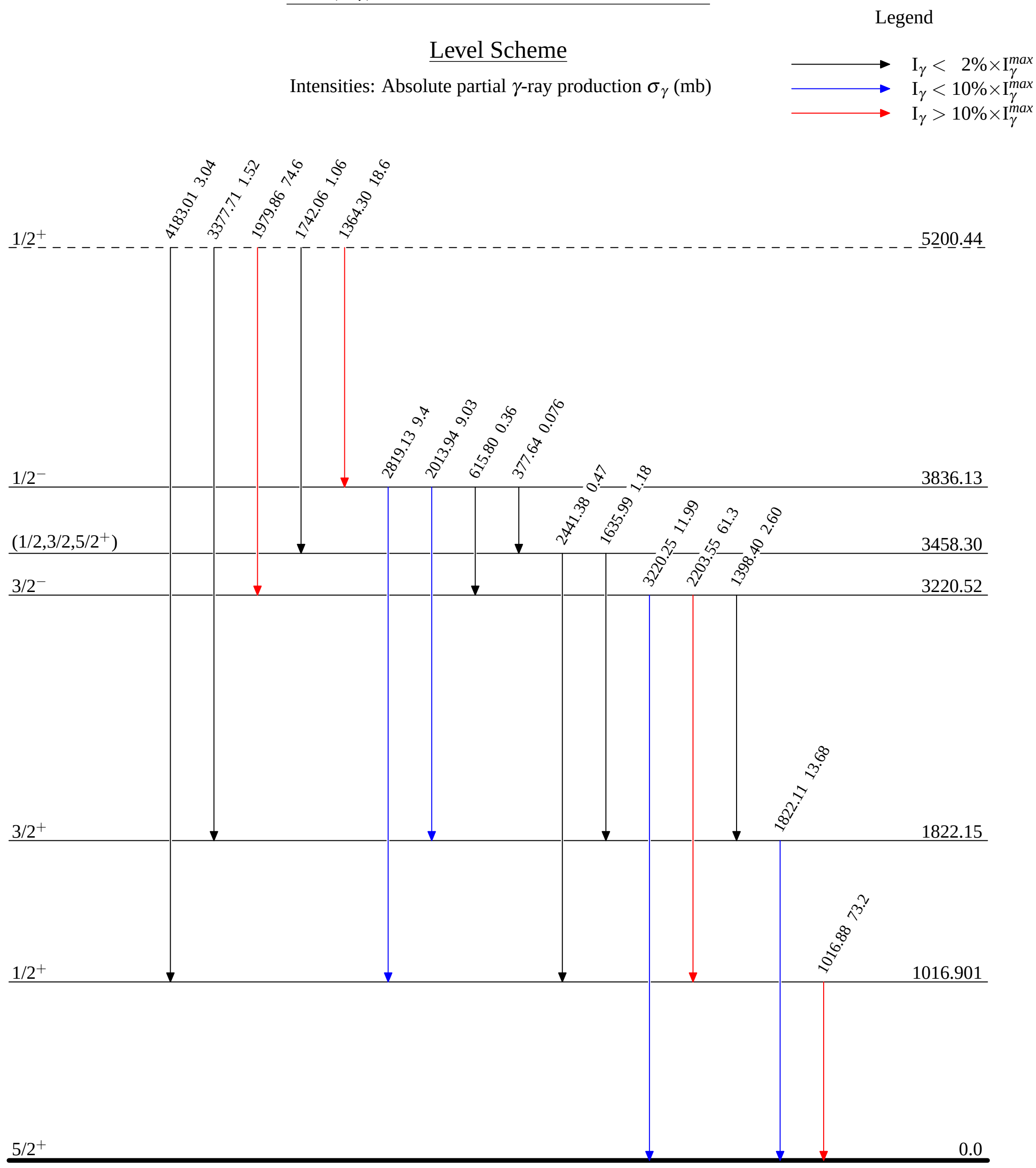
‡ From 2009BeZQ in units of mb.

For intensity per 100 neutron captures, multiply by 1.897 *25*.

^{22}Ne(n,γ) E=thermal 2009BeZQ,1986Pr05

Level Scheme

Intensities: Absolute partial γ-ray production σ_γ (mb)



$^{23}_{10}Ne_{13}$

^{22}Ne(n,γ) E=15-60 keV 2003To18

No significant change from previous evaluation (2007Fi02).

Measurement was carried out at the Research Laboratory for Nuclear Reactors at the Tokyo Institute of Technology. Pulsed neutron beam, the prompt gamma rays were detected using a pair of anti-Compton NaI(Tl) spectrometers. The measurements were carried out cyclically on natural or enriched Ne, empty cell, Au and blank samples. The de-exciting gamma rays were measured for E(n)=15-40 keV and 41-60 keV. Evidences were found for the importance of p-wave neutron capture process along with the contribution from s-wave neutron capture process.

^{23}Ne Levels

E(level)	J^{π}†	Comments
0.0	5/2$^+$	
1017	1/2$^+$	
1823	3/2$^+$	
3221	3/2$^-$	
3836	1/2$^-$	
(5201)		E(level): Sn+15-60 keV. Numerical Sn value given for γ-ray placement.

† From Adopted Levels.

γ(^{23}Ne)

E_γ†	I_γ	E_i(level)	J^π_i	E_f	J^π_f
1017		1017	1/2$^+$	0.0	5/2$^+$
1365	40	(5201)		3836	1/2$^-$
1823	70	1823	3/2$^+$	0.0	5/2$^+$
1980	100#‡	(5201)		3221	3/2$^-$
2013	30#‡	3836	1/2$^-$	1823	3/2$^+$
2204	>115	3221	3/2$^-$	1017	1/2$^+$
2819	40	3836	1/2$^-$	1017	1/2$^+$
3221	33	3221	3/2$^-$	0.0	5/2$^+$
3378	24	(5201)		1823	3/2$^+$
4184	44	(5201)		1017	1/2$^+$
5201	20	(5201)		0.0	5/2$^+$

† From level energy differences.

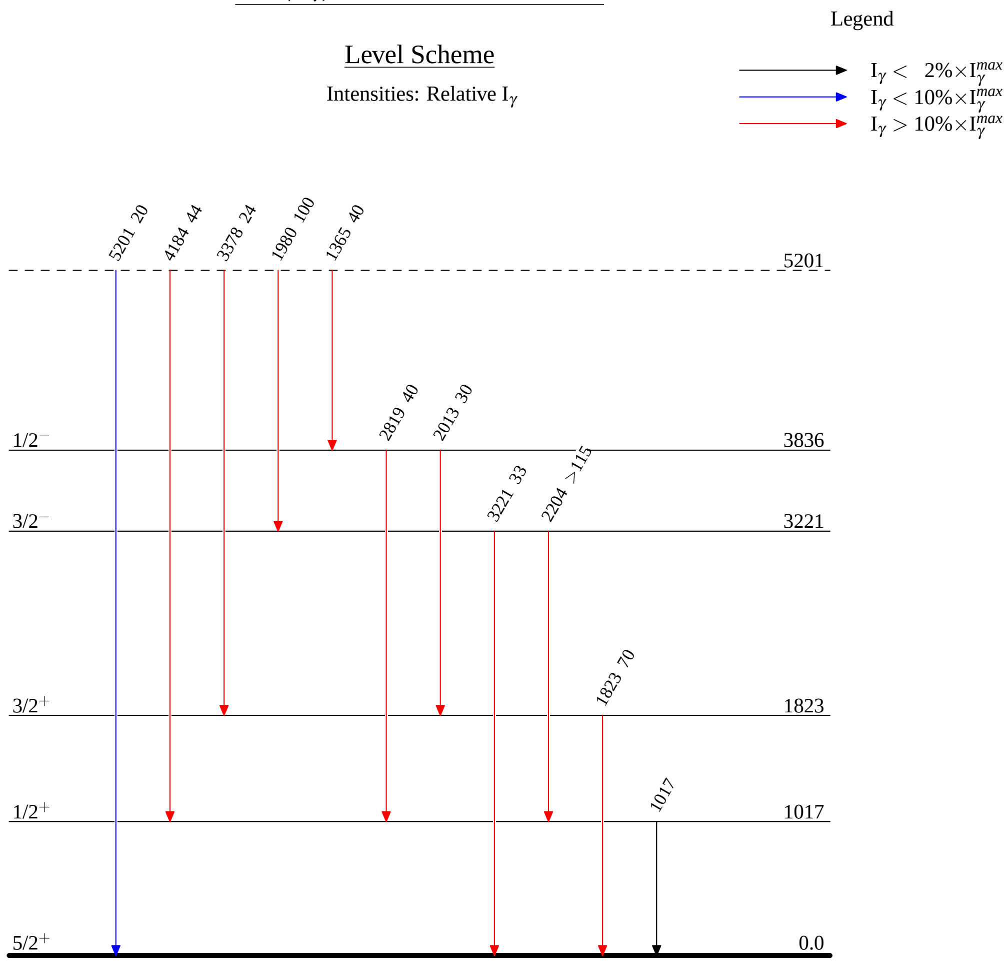
‡ Unresolved intensity of 1980 and 2013 γ was divided using adopted branching.

Intensities extracted from E=41-60 keV spectrum (see Fig. 2(b) of 2003To18) and corrected for efficiency assuming standard efficiency of 5x5 inch NaI(Tl) detector (extracted by the evaluator of 2007Fi02).

^{22}Ne(n,γ) E=15-60 keV 2003To18

Level Scheme

Intensities: Relative I_γ



$^{23}_{10}Ne_{13}$

^{22}Ne(n,n),(n,γ):res 2014He25

Other: 2002Be37.

2014He25: Target – 99.8% enriched ^{22}Ne gas target in stainless steel cylinder at 150 atmospheric pressure. Neutrons were produced from ^{7}Li(p,n)^{7}Be reaction with a pulsed proton beam of 1.0 ns width and a variable repetition rate of 1 MHz and 250 kHz for the capture and transmission runs, respectively. 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 30 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. Deduced Maxwellian-averaged cross sections (MACS) for stellar (n,γ) from 5 to 100 kT (keV). At kT=30 keV thermal energy, MACS value is 53.2 μb *27* for ^{22}Ne.

2002Be37: E=25-215 keV; measured capture σ; deduced astrophysical reaction rates.

^{23}Ne Levels

Γ_γ=200 eV was used as the adjusted value for each resonance to fit the experimental MACS values.
g=$(2J_{res}+1)/((2J_n+1)(2J_{^{22}Ne\ g.s.}+1))$.

E(level)†	Jπ‡	L‡	Comments
5460.7 *3*	1/2−	1	Γ_n=8.23 keV *19* Resonance energy=272.0 keV *3* (Lab). g=1.
5478.6 *3*	1/2+	0	Γ_n=28.61 keV *47* Resonance energy=290.7 keV *3* (Lab). g=1.
5608.9 *5*	1/2−	1	Γ_n=8.20 keV *31* Resonance energy=427.1 keV *5* (Lab). g=1.
5672.0 *5*	1/2+	0	Γ_n=118.8 keV *21* Resonance energy=493.1 keV *5* (Lab). g=1.
5739.9 *6*	3/2+	2	Γ_n=5.10 keV *18* Resonance energy=564.1 keV *6* (Lab). g=2.
5860.7 *7*	3/2−	1	Γ_n=37.5 keV *11* Resonance energy=690.4 keV *7* (Lab). g=2.
5967 *5*	1/2+	0	Γ_n=27.2 keV *51* Resonance energy=802 keV *5* (Lab). g=1.

† From Sn(^{23}Ne)=5200.65 *10* (2017Wa10)+E(n)(c.m. system), deduced from reported resonance energies (Lab) in Table II of 2014He25. E(n)(c.m.) – mass of ^{22}Ne/(mass of ^{22}Ne + mass of n)×E(n) (Lab).

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

^{22}Ne(d,pγ) 1974Ch35,1967Ho08

Other references: 1966Fo02, 1950Pr64.

1974Ch35: Deuteron beam with varying energies from 4.5 to 4.8 MeV using the tandem accelerator facility at Uppsala was used. Enriched ^{22}Ne gaseous target (with enrichment more than 99.9%) was used. The target material was confined in a gas cell. The emitted particles from the gas cell were detected using an annular surface barrier detector placed very close to 180 degree with respect to the initial beam direction. Large volume Ge(Li) detectors were used for detection of gamma rays. Measured pγ, $\gamma\gamma$, Eγ, DSA.

1967Ho08: Natural neon and enriched (99.9%) ^{22}Ne gas targets bombarded by deuteron beam, E=2.72, 2.85, 3.40, 3.52 MeV; NaI(Tl) and solid state detectors; Measured Eγ, γ-ray branching ratio, pγ coincidence, angular correlation measurements, $\gamma(\theta)$; Deduced spin-parity for excited levels.

^{23}Ne Levels

E(level)†	J$^\pi$	T$_{1/2}$‡	Comments
0.0	5/2$^+$		J$^\pi$: From Adopted Levels.
1017.14 *19*		178 ps *10*	T$_{1/2}$: From pγ(t) coincidence in 1966Fo02. Other: 208 ps *110* from mean lifetime of 300 ps *+150−165* (1974Ch35) by Doppler shift attenuation factor.
1702.1 *4*	3/2,7/2	<70 fs	J$^\pi$: From summed correlation results for 1702 keV transition and analysis (1967Ho08).
1822.9 *3*	3/2	<70 fs	J$^\pi$: From combined correlation results for 1822 keV transition and analysis (1967Ho08).
2315.8 *4*		<70 fs	
2518.0 *8*		<70 fs	
3221.3 *4*	3/2$^-$	<70 fs	J$^\pi$: ≠1/2 in 1967Ho08 from $\gamma(\theta)$ and correlation measurements for 1/2$^-$ and 3/2$^-$ from L=1 in (d,p) 1970Ho22.
3432.4 *5*		<70 fs	
3458.3 *6*		<70 fs	
3830.6 *10*		<70 fs	
3837.6 *9*		<70 fs	
3843.5 *11*		<70 fs	
3988.5 *6*		<70 fs	
4010 *3*		<70 fs	

† From least-squares fit to γ-ray energies.

‡ Estimated by evaluator of 1978En02, on the basis of the observation that the relevant γ-rays are fully Doppler shifted as reported by 1974Ch35, except for 1017.1 keV level.

γ(^{23}Ne)

E$_\gamma$†	I$_\gamma$‡	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Comments
492.7 *5*	154 *7*	2315.8		1822.9	3/2	I$_\gamma$: Branching: 89 *4* from 154 *7* (1974Ch35), while 100 *4* from 45 *2* (1967Ho08).
614.0 *15*	12 *4*	2315.8		1702.1	3/2,7/2	I$_\gamma$: Branching: 6.9 *23* from 15 *12* (1974Ch35), while <16 from <7 (1967Ho08).
815.8 *7*	55 *6*	2518.0		1702.1	3/2,7/2	
1017.1 *2*	1000	1017.14		0.0	5/2$^+$	
1116.5 *6*	24 *6*	3432.4		2315.8		I$_\gamma$: Branching: 6.1 *15* from 24 *6* (1974Ch35), while <17 from <9 (1967Ho08).
1298.2 *9*	29 *7*	2315.8		1017.14		I$_\gamma$: Branching: 17 *4* from 29 *7* (1974Ch35) and 22 *4* from 10 *2* (1967Ho08).
1325.5 *8*	23	3843.5		2518.0		
1398.8 *9*	39 *13*	3221.3	3/2$^-$	1822.9	3/2	I$_\gamma$: Branching: 3.2 *11* from 39 *13* (1974Ch35), while <5 from <4 (1967Ho08).
1608.8 *11*	53 *13*	3432.4		1822.9	3/2	I$_\gamma$: Branching: 13 *3* from 53 *13* (1974Ch35), while 26 *6* from 14 *3* (1967Ho08).
1635.3 *6*	96 *12*	3458.3		1822.9	3/2	
1672.6 *4*	372 *27*	3988.5		2315.8		

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^{22}Ne(d,pγ) 1974Ch35,1967Ho08 (continued)

$\gamma(^{23}Ne)$ (continued)

E_γ †	I_γ ‡	E_i(level)	J^π_i	E_f	J^π_f	Comments
1702.0 *4*	68	1702.1	3/2,7/2	0.0	5/2$^+$	
1822.8 *3*	305	1822.9	3/2	0.0	5/2$^+$	
2014.7 *9*	144 *16*	3837.6		1822.9	3/2	
2128.5 *10*	76 *13*	3830.6		1702.1	3/2,7/2	
2204.0 *4*	1204 *46*	3221.3	3/2$^-$	1017.14		I_γ: Branching: 100 *4* from 1204 *46* (1974Ch35) and 100.0 *24* from 82 *2* (1967Ho08).
2315.9 *9*	174 *22*	2315.8		0.0	5/2$^+$	I_γ: Branching: 100 *13* from 174 *22* (1974Ch35) and 100 *4* from 45 *2* (1967Ho08).
2415.5 *9*	155 *25*	3432.4		1017.14		I_γ: Branching: 39 *6* from 155 *25* (1974Ch35) and 59 *11* from 32 *6* (1967Ho08).
2441.1 *10*	79 *14*	3458.3		1017.14		
2518.3 *17*	24 *10*	2518.0		0.0	5/2$^+$	
2819.9 *18*	179 *26*	3837.6		1017.14		
3220.8 *8*	300 *32*	3221.3	3/2$^-$	0.0	5/2$^+$	I_γ: Branching: 25 *3* from 300 *32* (1974Ch35) and 22.0 *24* from 18 *2* (1967Ho08).
3432.9 *13*	396 *38*	3432.4		0.0	5/2$^+$	I_γ: Branching: 100 *10* from 396 *38* (1974Ch35) and 100 *7* from 54 *4* (1967Ho08).
3830.0 *25*	13 *8*	3830.6		0.0	5/2$^+$	
3988.9 *16*	520 *54*	3988.5		0.0	5/2$^+$	
4010 *3*	135	4010		0.0	5/2$^+$	

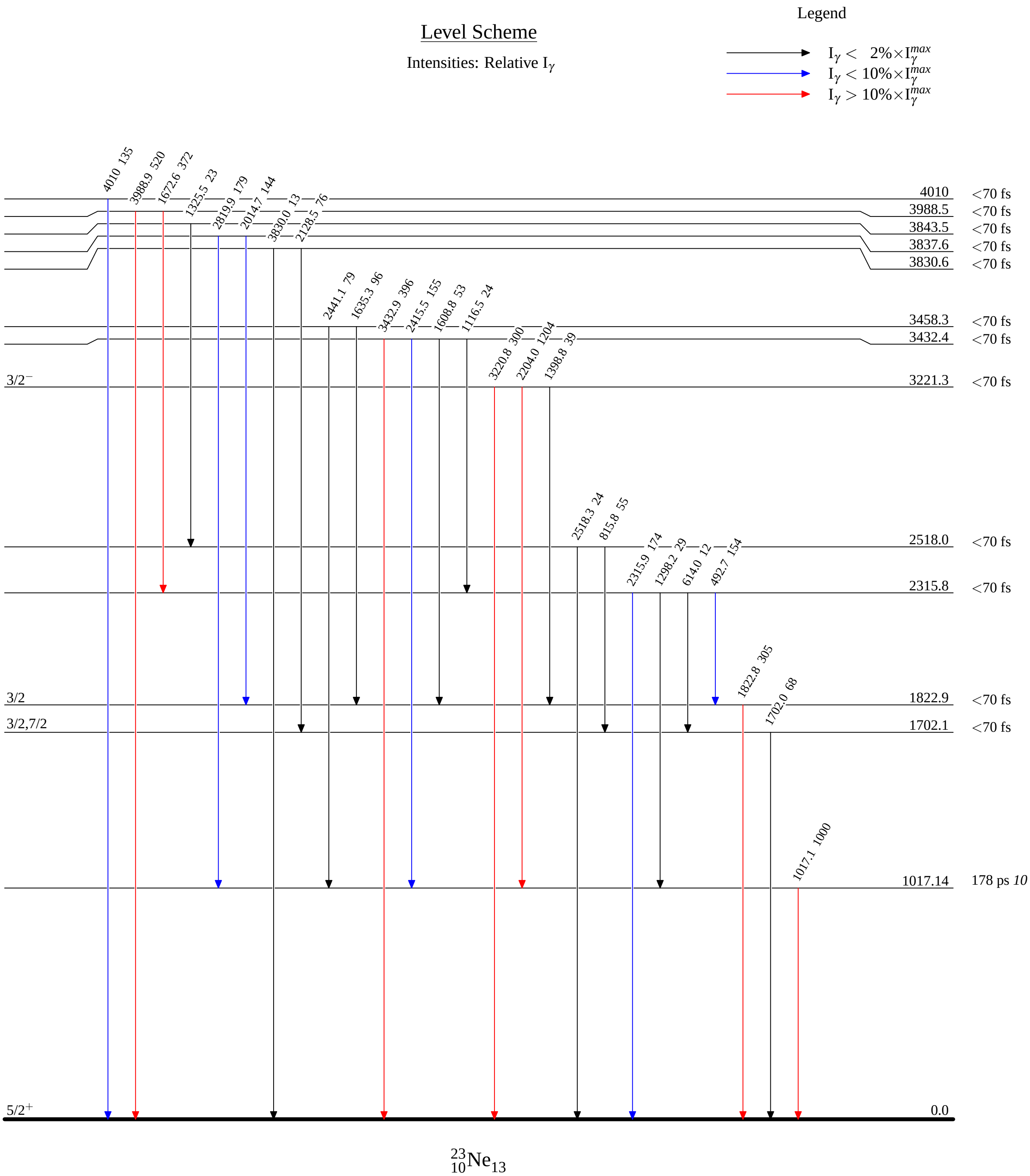
† Measured using Ge(Li) detector at 90°.

‡ Measured using Ge(Li) detector at 55°. The uncertainties were not given for gammas from levels deexciting by a single transition. Other uncertainties deduced using data in Table I of 1974Ch35.

^{22}Ne(d,pγ) 1974Ch35,1967Ho08

Level Scheme

Intensities: Relative I_γ



^{22}Ne(d,p),(pol d,p) 1960Fr04,1974WoZA,1970Ho22

$J^\pi(^{22}Ne)=0^+$.

Other references: 1990Ch41, 1969Ch21, 1969Na02, 1967Lu04, 1967Du01, 1965Pu01.

1960Fr04: ^{22}Ne(d,p), E=4.75-7.5 MeV; Magnetic spectrograph was used for analysis of the reaction products. Both natural (9% ^{22}Ne) and enriched (59% ^{22}Ne) neon gas targets were used. Measured level energies.

1974WoZA: ^{22}Ne(pol d,p), E=12 MeV; Measured $\sigma(\theta)$.

1970Ho22: ^{22}Ne(d,p), E=12.1 MeV. Enriched gas target. Measured σ(Ep,θ). Performed DWBA calculations. Deduced level energies, orbital angular momentum transfer, level spins and parities, and spectroscopic factors.

1990Ch41: ^{22}Ne(d,p), E=24.1 MeV. Solidified ^{22}Ne target. The outgoing proton particles were detected at the focal plane of a Q3D spectrometer. Performed DWBA analysis.

1969Ch21: ^{22}Ne(d,p), E=3 MeV. Measured σ(Ep,θ). Gas target was used.

1969Na02: ^{22}Ne(d,p), E=4-6 MeV, measured σ(Ep,(θ). Also ^{23}Na(n,pγ).

1967Du01: ^{22}Ne(d,p), E=3 MeV, angular distribution measurement for the first excited level.

1967Lu04: ^{22}Ne(d,p), E=12.1 MeV. Enriched ^{22}Ne gas target (with 99.7% enrichment) was used. Particle identification was carried out using detector telescope consisting of a ΔE (transmission-type surface barrier diode) detector and an E (lithium-drifted silicon diode) detector. Measured σ(Ep,θ). Performed DWBA calculations.

1965Pu01: ^{22}Ne(d,p) – Measured angular-distribution.

^{23}Ne Levels

E(level)[†]	J^π[‡]	L[@]	S[a]	Comments
0.0		2	0.23	
1018 *7*	1/2+[#]	0	0.39	
1703 *7*				
1826 *8*		2	0.023	
2314 *8*	5/2+	2	0.07	
2520 *8*				
3218 *8*	3/2−[#]	1	0.73	
3433 *8*	3/2+	2	0.38	
3836 *10*	1/2−	1	0.14	
3988 *8*	(3/2)+	2	0.32	
4270 *15*				
4431 *12*				
4764 *5*				
4867 *15*				E(level): from 1960Fr04.
4940 *5*				
4995 *15*				E(level): from 1960Fr04.
5029 *5*				
5068 *5*				
5185 *6*	(3/2+,5/2+)[#]	(2)	0.23	S: from 1970Ho22.
5220 *5*		3[&]		
5265?				
5340?				
5462 *5*		1[&]		
5522 *10*				
5560 *15*				
5606 *10*				
5646 *10*				
5726 *10*				
5785 *15*				
5840 *15*				

† E(level)<4700 keV from 1960Fr04, E(level)>4700 keV from 1990Ch41 (unless otherwise stated).
‡ From 1974WoZA ((pol d,p) – vector analyzing power), except where otherwise noted.

Continued on next page (footnotes at end of table)

^{22}Ne(d,p),(pol d,p) 1960Fr04,1974WoZA,1970Ho22 (continued)

^{23}Ne Levels (continued)

[#] From 1970Ho22, based on L value and literature data.
[@] From 1970Ho22, except otherwise noted.
[&] From 1990Ch41.
[a] From 1967Lu04 (the average of the two possible values as mentioned in Table 2), unless otherwise stated.

^{23}Na(μ^-,γ) 1996Jo21

Others: 1994Go07, 1993Go09, 1993Go27 – same research group of 1996Jo21.

1996Jo21,1994Go07: ^{23}Na target was a 5.0 cm diameter and 0.5 cm thick disk of pure metallic sodium packed in a thin-walled polyethylene container under a N_2 atmosphere. The target was placed 45° with the beam direction. Three plastic scintillators, one mounted on the downstream facing the collimator, two mounted on the upstream and downstream facing the target. Two n-type HPGe detectors placed 90° with respect to the beam direction surrounded by Compton suppressed by BGO and NaI crystals. Measured Eγ, yield per muon stop, γ-γ coin. Studied hyperfine dependence of exclusive μ- capture on ^{23}Na.

^{23}Ne Levels

E(level)†	J$^\pi$	Comments
0.0		
1017.1 *8*		
1702.1 *10*	7/2$^+$	J$^\pi$: From 1996Jo21.
1823.1 *8*		
2315.1 *8*		
3432.2 *8*		
3458.2 *10*	1/2$^+$	J$^\pi$: From 1996Jo21. (1/2,3/2,5/2$^+$) in Adopted Levels.

† From least-squares fit to γ-ray energies, assuming ΔE=1 keV.

γ(^{23}Ne)

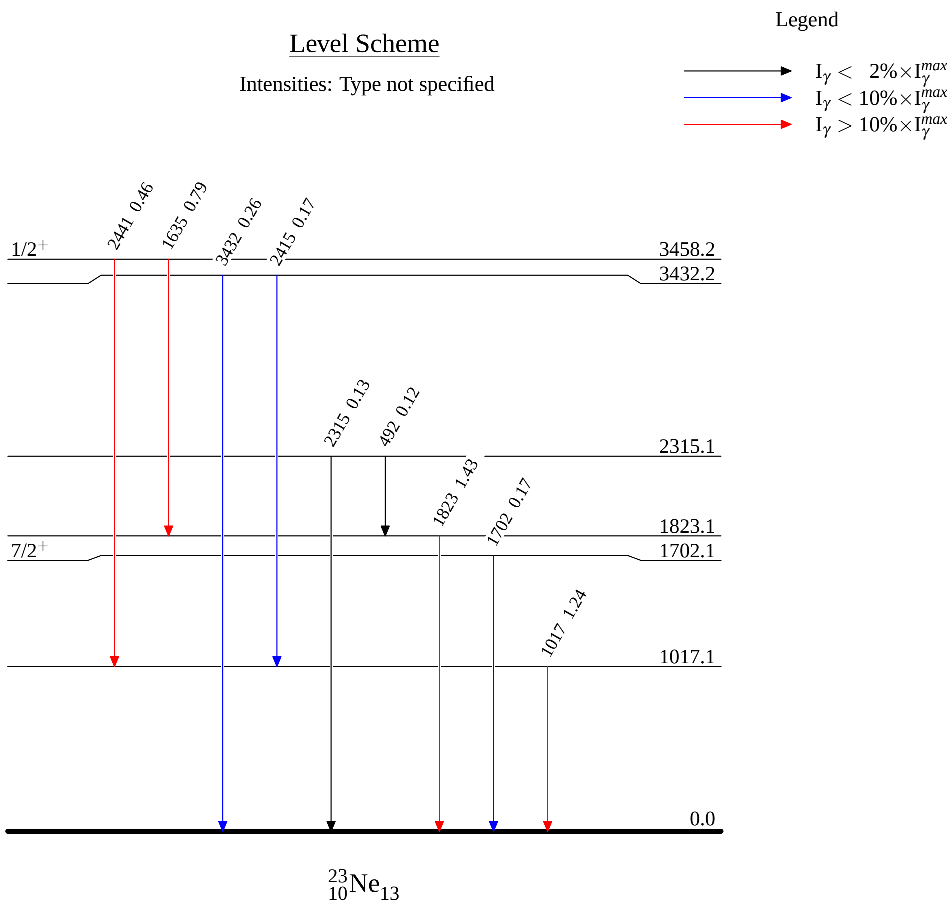
E$_\gamma$†	I$_\gamma$‡	E$_i$(level)	J$^\pi_i$	E$_f$
492	0.12 *4*	2315.1		1823.1
1017	1.24 *28*	1017.1		0.0
1635	0.79 *17*	3458.2	1/2$^+$	1823.1
1702	0.17 *4*	1702.1	7/2$^+$	0.0
1823	1.43 *30*	1823.1		0.0
2315	0.13 *4*	2315.1		0.0
2415	0.17 *4*	3432.2		1017.1
2441	0.46 *10*	3458.2	1/2$^+$	1017.1
3432	0.26 *5*	3432.2		0.0

† From 1996Jo21.
‡ from 1996Jo21. Yield per 100 μ- stop (not capture).

^{23}Na(μ^-,γ) 1996Jo21

Level Scheme

Intensities: Type not specified



^{23}Na(n,p) **1995Si19**

Nearly monoenergetic neutron beam, E=198 MeV, obtained from ^{7}Li(p,n) reaction and a neutron flux at secondary target was 1 × 10^5 #/sec.cm^2. Na targets (thickness 100 mg/cm^2) between 6.0 μm Mylar in Cu support frames. Target stack of four ^{23}Na, one CH_2 (for calibration), one Mylar (for background subtraction). Protons were momentum analyzed in the Medium Resolution Spectrometer at five angles from 0° to 24° in step of 6°. Measured differential cross sections. Overall energy resolution 900 keV. Deduce Gamow-Teller (GT) transition probabi1ities to low lying 1/2$^+$, 3/2$^+$, and 5/2 Ne states and the GT$^+$ strength distribution up to 25000 keV excitation energy.

An expected value of unit cross section of 8.90 mb/sr *45* was used by 1995Si19 to determine the values of B^{+}_{GT}.

^{23}Ne Levels

E(level)†	J$^\pi$†	Comments
0	5/2$^+$	σ(1.5°)=0.300 mb *51*, B^{+}_{GT}=0.038 *6*.
1017	1/2$^+$	σ(1.5°)=0.364 mb *55*, B^{+}_{GT}=0.048 *7*.
1823	3/2$^+$	σ(1.5°)=0.312 mb *58*, B^{+}_{GT}=0.041 *8*.
2315	5/2$^+$	σ(1.5°)≤0.162 mb, B^{+}_{GT}≤0.021 *8*.
3445 *13*	3/2$^+$ to 1/2$^+$	E(level): 3432-3458. σ(1.5°)=2.35 mb *24*, B^{+}_{GT}=0.318 *33*.

† As listed in 1995Si19.

^{23}Na(n,pγ) 1969Na02

E=8-9 MeV; Measured σ(E; Eγ, $\gamma(\theta)$). NaI(Tl) detector. Electron, proton, γ were separated by pulse shape discrimination. Deduced ^{23}Ne excited levels, spin and parity, mixing ratio.

^{23}Ne Levels

E(level)†	J$^\pi$‡
0.0	5/2$^+$
1020	1/2$^+$
1700	7/2$^{(+)}$#
1830	3/2$^{(+)}$
2310	3/2$^+$,5/2$^+$
2520	5/2,7/2,9/2#

† From Fig. 9 in 1969Na02,
‡ From 1969Na02, $\gamma(\theta)$ measurement and literature, except where otherwise noted.
# From 1969Na02, $\gamma(\theta)$ measurement.

γ(^{23}Ne)

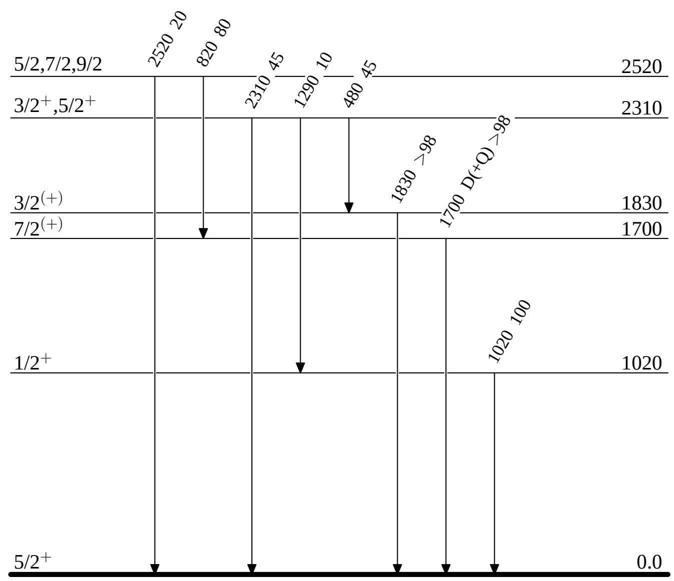
E$_i$(level)	J$^\pi_i$	E$_\gamma$†	I$_\gamma$‡	E$_f$	J$^\pi_f$	Mult.	δ	Comments
1020	1/2$^+$	1020	100	0.0	5/2$^+$			
1700	7/2$^{(+)}$	1700	>98	0.0	5/2$^+$	D(+Q)	+0.11 *12*	δ: From +0.23 ≤ δ ≤ +0.01 (1969Na02).
1830	3/2$^{(+)}$	1830	>98	0.0	5/2$^+$			
2310	3/2$^+$,5/2$^+$	480	45	1830	3/2$^{(+)}$			
		1290	10	1020	1/2$^+$			
		2310	45	0.0	5/2$^+$			
2520	5/2,7/2,9/2	820	80	1700	7/2$^{(+)}$			
		2520	20	0.0	5/2$^+$			

† From level energy differences. Measured data (numerical value) not listed in 1969Na02.
‡ From 1969Na02.

^{23}Na(n,pγ) 1969Na02

Level Scheme

Intensities: % photon branching from each level



$^{23}_{10}Ne_{13}$

^{208}Pb(^{22}Ne,^{23}Neγ) 2012Bo09

Based on XUNDL: Compiled by E. Thiagalingam and B. Singh (McMaster), July 17, 2012.

^{22}Ne beam at E=128 MeV, ^{208}Pb target (thickness 300 μg/cm^2). ^{208}Pb was sandwiched between two ^{12}C layers. The PRISMA magnetic spectrometer along with the γ-array CLARA consisting of 21 HPGe clover detectors were used for the experiment at the Legnaro National Laboratories of INFN. Identification of the reaction products was carried out from the event by event analysis of energy loss, time-of-flight and ion-trajectories. Measured particle-γ coincidences, Eγ.

^{23}Ne Levels

E(level)	J$^{\pi}$†
0.0	5/2$^+$
1017	1/2$^+$

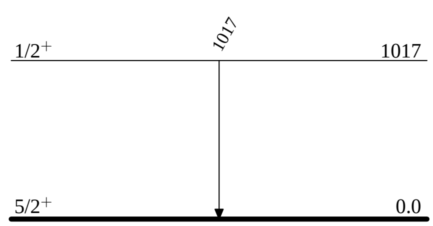
† From Adopted Levels.

γ(^{23}Ne)

E$_\gamma$	E$_i$(level)	J$^{\pi}_i$	E$_f$	J$^{\pi}_f$
1017	1017	1/2$^+$	0.0	5/2$^+$

^{208}Pb(^{22}Ne,^{23}Neγ) 2012Bo09

Level Scheme



$^{23}_{10}$Ne$_{13}$

Adopted Levels, Gammas

Q(β^-)=−4056.179 *32*; S(n)=12419.66 *17*; S(p)=8794.10 *2*; Q(α)=−1.047×10^4 2017Wa10

Q(β^-): From measured value: 4056.182 *32* (2019Ka30) and 4056.179 *32* erratum of 2019Ka30 – Phys. Rev. C 101, 049901 (2020). Other: −4056.34 *16* (2017Wa10).

Other reactions:
^{19}F(α,p): 2018Da14 (E=6 MeV) – 1st excited state was populated.
^{20}Ne(α,pγ): 1975Gr04 (E=10,12 MeV) – measured $T_{1/2}$.
^{23}Na(d,d): 1981Ru09 (E=13.6 MeV).
^{23}Na(^{3}He,^{3}He): 1980Tr02 (E=41 MeV), 1982Ve13 (E=25 MeV), 1973Ro18 (E=11 MeV).
^{25}Mg(p,^{3}He): 1976Na18 (E=40 MeV), 1969Ha38 (E=45 MeV).
^{27}Al(e,α): 1979Fl04 (E=120 MeV).
^{208}Pb(pol ^{23}Na,^{23}Na): 1988Ka29 (E=170 MeV).

^{23}Na Levels

Cross Reference (XREF) Flags

A	^{23}Ne β^- decay	L	^{20}Ne(^{7}Li,α)	W	^{23}Na(p,p′γ)
B	^{23}Mg ε decay	M	^{21}Ne(^{3}He,p)	X	^{23}Na(α,α')
C	^{24}Al β^+p decay	N	^{22}Ne(p,γ)	Y	Coulomb excitation
D	^{7}Li(^{16}O,γ)	O	^{22}Ne(d,n)	Z	^{24}Mg(d,^{3}He)
E	^{11}B(^{16}O,α)	P	^{22}Ne(d,nγ)	Others:	
F	^{12}C(^{12}C,pγ)	Q	^{22}Ne(^{3}He,d),(^{3}He,dγ)	AA	^{24}Mg(t,α),(t,$\alpha\gamma$)
G	^{12}C(^{15}N,α)	R	^{22}Na(n,p),(n,α): res	AB	^{25}Mg(d,α)
H	^{12}C(^{16}O,αpγ)	S	^{23}Na(γ,γ')	AC	^{26}Mg(p,$\alpha\gamma$)
I	^{19}F(α,γ)	T	^{23}Na(e,e′)	AD	^{27}Al(d,^{6}Li)
J	^{19}F(^{6}Li,d)	U	^{23}Na(n,n′γ)	AE	^{150}Nd(^{26}Mg,^{23}Naγ)
K	^{20}Ne(α,p)	V	^{23}Na(p,p′),^{22}Ne(p,p′)		

E(level)[†]	J$^\pi$	T or Γ[c]	XREF	Comments
0.0[f]	3/2$^+$	stable	ABCDEFGHI KLMNOPQRSTU WXYZ	XREF: Others: AA, AB, AC, AD, AE μ=+2.21750 *3*; Q=+0.104 *1* Matter radius <r^2>$^{1/2}$=2.83 fm *3* and 2.83 fm *4* (1998Su07). Charge radius <r^2>$^{1/2}$=2.9936 fm *21* (2013An02). J$^\pi$: 3/2 from Atomic beam, optical spectroscopy: 1933Gr03, 1933Jo04, 1934El02, 1934Ra01. Parity from L=2 in ^{22}Ne(^{3}He,d). μ: From 2019StZV – NMR (+2.2174982 *233* in 2012An18 – ab initio calculation). Other values: +2.2176556 *6* – NMR (1954Wa37), +2.217522 *2* – ABMR (1974Be50). Q: Optical spectroscopy (2008Py02/2006Da14, 2016St14). Other values: +0.1045 *10* (1999Ke12,2014StZZ), +0.109 *3* (1992Su01), +0.095 *15* (1992Vo09), many others in the literature.
440.2[f] *4*	5/2$^+$	1.14 ps *7*	AB DEFGHI K MNOPQ S U WXYZ	XREF: Others: AA, AB, AC, AD J$^\pi$: L=2 in (^{3}He,d), 5/2 in 1966Po06 (p,$\alpha\gamma$) based on their $\gamma(\theta)$ measurements and references therein including Coul. Ex. (1956Te33) $\gamma(\theta)$ data. T or Γ: From mean lifetime of 1.64 ps *10*: Weighted average of 1.8 ps *+4–3* (1959Ra10 – (p,p′)); 1.50 ps *25* (1961Am04),

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	T or Γ[c]	XREF	Comments
				1.8 ps *2* (1969Ru01), 1.80 ps *28* (1962Mo17), and 1.62 ps *10* (1966Sk01), 1.30 ps *30* (1963Sw01,1963Sw02) – all from (γ,γ′); 1.63 ps *20* (1973Wa26) and 1.80 ps *11* (1990Ti02) from (^{12}C,pγ); 1.69 ps *22* (1977Sc36 – DSA see Coul Ex.), 1.40 ps *30* (1975Gr04), 1.50 ps *30* (1959Bo44), 1.42 ps *22* and 1.37 ps *24* (both from Coul Ex.).
2076.2[f] *4*	7/2$^+$	27 fs *3*	A DEFGHI KLMNO Q STU WXYZ	XREF: Others: AA, AB, AC, AD J^π: L(t,α)=4 from 0$^+$ target and M1+E2 γ to 5/2$^+$, 7/2 from (p,p′γ) (1968So07). T or Γ: From mean lifetime of 39 fs *5*: Weighted average of 37 fs *9* (1970Bi14), 28 fs *7* (1973Me11), 42 fs *7* (1975An14) and 35 fs *5* (1979Sm02) – all from (p,γ); 50 fs *15* (1973Fr07 – (^{12}C,pγ)); 49 fs *11* (1967Af03 – (α,p)), 46 fs *8* (1969Sa16 – (e,e′)), 45 fs *9* (1971Ra13 – (γ,γ′)), 50 fs *7* (1977Sc36 – Coul Ex.), 37 fs *9* (1975Gr04 – (α,pγ)), and 27 fs *9* (1989Ge09 – (n,n′γ)). Other mean lifetimes: 19 fs *4* (1971Du07 – (p,γ)) – yields higher χ^2 than critical if considered, 120 fs *60* (1977Sc36 – DSA see Coul Ex.), 210 fs *60* (1972Du05 – (p,p′γ)).
2390.9 *3*	1/2$^+$	0.60 ps *14*	B EFG I KLMNOPQ S U W Z	XREF: Others: AA, AB, AC, AD J^π: L(d,n)=0 from 0$^+$ target. T or Γ: From mean lifetime of 866 fs *200*: weighted average of 760 fs *240* (1979Sm02), 850 fs *200* (1975An14), and 750 fs *600* (1970Bi14), 580 fs *+370−190* (1971Du07) – all from (p,γ); 950 fs *200* (1969Po06), 700 fs *250* (1970Ma15), and 1550 fs *400* (1972Du05) – from (p,p′γ), 1200 fs *600* (1973Fr07 – (^{12}C,pγ)). Other: >500 fs (1973Me11) from (p,p′γ)).
2640.5[g] *6*	1/2$^-$	76 fs *9*	efG I LMN PQ S U W Z	XREF: Others: AA, AB, AC, AD J^π: L=1 in ^{22}Ne(^{3}He,d),(^{3}He,dγ). 1/2 from γ-ray angular correlation studies – (p,αγ) (1972Li02). T or Γ: From mean lifetime of 109 fs *13*: Weighted average of 113 fs *18* (1975An14), 100 fs *20* (1970Bi14), 88 fs *+20−14* (1971Du07), 92 fs *18* (1979Sm02), 119 fs *13* (1983Ke12 – unc 5 from w.a. in ref. – evaluators take lowest value) – all from (p,γ); 135 fs *20* (1971Ra13 – (γ,γ′)), 100 fs *+80−40* (1970Ma15 – (p,p′γ)), 95 fs *35* (1973Fr07 – (^{12}C,pγ)), and 200 fs *80* (1969Po06 – (p,p′γ)). Others: 365 fs *100* (1972Du05 – (p,p′γ)), 390 fs *20* (1989Ge09 – (n,n′γ)), 58 fs *10* (1973Me11 – (p,γ)).
2703.8[f] *5*	9/2$^+$	88 fs *7*	eFGH KLMN Q U WX Z	XREF: Others: AA, AB, AC, AD XREF: K(2680). J^π: L=4 in (t,α) from 0$^+$ target and E2 to 5/2$^+$; 9/2 from angular correlation measurements (p,p′γ) (1968So07). T or Γ: From mean lifetime of 127 fs *10*: Weighted average of 200 fs *100* (1969Po06), 100 fs *+80−40* (1970Ma15), 100 fs *30* (1972Du05) – all from (p,p′γ); 125 fs *30* (1973Fr07), 110 fs *20* (1973Wa26), 139 fs *10* (1990Ti02) – from (^{12}C,pγ); 130 fs *30* (1975An14 – (p,γ)), 105 fs *20* (1975Gr04 – (α,pγ), and 260 fs *110* (1989Ge09 – (n,n′γ)). Other: 65 fs *15* (1973Me11 – (p,γ)) – yields higher χ^2 than critical if considered.
2982.0 *5*	3/2$^+$	3.3 fs *4*	A EFG I KLMNOPQ S U W Z	XREF: Others: AA, AB, AC, AD

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	T or Γ[c]	XREF	Comments
				J^π: L=2 in ^{22}Ne(^{3}He,d),(^{3}He,dγ). 5/2 excluded by 1971Ra13 (γ,γ′) based on δ analysis of 2541.3γ and linear polarization measurements from their earlier experiment. T or Γ: From mean lifetime of 4.7 fs *6*: Weighted average of 4.0 fs *+13−10* (1971Du07), 2.8 fs *20* (1973Me11), 3.4 fs *10* (1975An14) 6.3 fs *10* (1970Bi14) − all from (p,γ); 3.8 fs *8* (1984Vo02), 9 fs *4* (1972Sh07) 4.7 fs *8* (1966Ra19), 5.4 fs *6* (1971Ra13) − all from (γ,γ′)). Other mean lifetime values: <3 fs (1979Sm02 − (p,γ); <100 fs (1973Fr07 − (^{12}C,pγ)); <25 fs (1972Du05), <79 (1970Ma15), <50 fs (1969Po06) all from (p,p′γ).
3677.9[g] *5*	3/2$^-$	21 fs *3*	EFG I LMN Q U W Z	XREF: Others: AA, AB, AC, AD J^π: L=1 in ^{22}Ne(^{3}He,d),(^{3}He,dγ). 3/2 from γ-ray angular correlation studies − (p,αγ) (1972Li02). T or Γ: From mean lifetime of 31 fs *4*: Weighted average of 35 fs *6* (1970Bi14), 24 fs *+5−4* (1971Du07), 26 fs *4* (1973Me11), 43 fs *9* (1979Sm02), 42 fs *7* (1975An14) − all from (p,γ); 70 fs *40* (1972Du05 − (p,p′γ)). Other: <40 fs (1973Fr07 − (^{12}C,pγ)).
3847.9[g] *5*	5/2$^-$	87 fs *21*	eFG I kLMN Q U W Z	XREF: Others: AA, AB, AC, AD XREF: U(3853)AD(3863). J^π: E1(+M2) to 7/2$^+$, γ to 3/2$^+$, and RUL. T or Γ: From mean lifetime of 125 fs *30*: Weighted average of 115 fs *35* (1970Bi14), 170 fs *60* (1971Du07), 95 fs *30* (1973Me11), 120 fs *35* (1979Sm02), 140 fs *30* (1975An14) − all from (p,γ); 120 fs *35* (1973Fr07 − (^{12}C,pγ)); 170 fs *50* (1972Du05) − (p,p′γ).
3914.6 *4*	5/2$^+$	6.9 fs *14*	eFG I kLMN Q S U W Z	XREF: Others: AA, AB, AC, AD J^π: L=2 in (t,α), (^{3}He,d), and (d,n). 5/2 1970Po08 (t,αγ) − based on γ-ray angular distribution measurements and RUL. T or Γ: From mean lifetime of 12 fs *2*: Weighted average of 12 fs *2* (1970Bi14), 7.4 fs *25* (1971Du07), 11 fs *3* (1973Me11), 10 fs *4* (1979Sm02), 14 fs *3* (1975An14) − all from (p,γ); 14 fs *2* (1984Vo02 − (γ,γ′)). Others: 25 fs *14* (1973Fr07 − (^{12}C,pγ)), 60 fs *15* (1972Du05 − (p,p′γ)).
4429.63[‡] *16*	1/2$^+$	0.21 fs *2*	F KLMNO Q STU W Z	XREF: Others: AA, AB, AC, AD XREF: T(4500). J^π: L=0 in (d,^{3}He), (^{3}He,d), and (t,α). T or Γ: From mean lifetime of 0.30 fs *3*: Weighted average of 0.29 fs *3* (1964Me11), 0.24 fs *4* (1972Sh07), and 0.34 fs *4* (1984Vo02), 0.35 fs 7 (1985Ba36) − all from (γ,γ′). Others: 0.94 fs *8* (e,e′), <25 fs (1973Fr07 − (^{12}C,pγ)), 2 fs *2* (1973Me11 − (p,γ)), <45 fs (1972Du05) − (p,p′γ)).
4775.2 *5*	7/2$^+$	<1.4[‡] fs	E G KLMNO Q U W Z	XREF: Others: AA, AB, AC, AD J^π: L=4 in ^{24}Mg(t,α), 4335γ M1+E2 to 5/2$^+$.
5378.56[‡] *15*	5/2$^+$	143[#] as *21*	FG KLMNO Q S UV Z	XREF: Others: AA, AB, AC, AD J^π: L=2 in (^{3}He,d) and (t,α). M1(+E2) to 7/2$^+$.
5534.2[f] *6*	11/2$^+$	10.4[d] fs *6*	EFGH L Q UV Z	XREF: Others: AA, AB, AC, AD

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}	T or Γ[c]	XREF	Comments
				J^{π}: From 1975Jo03 (^{12}C,pγ), based on particle γ-ray linear polarization and angular correlation measurements of 3458γ.
5741.0[#] *15*	5/2$^+$	394[#] as *27*	eFG NO Q S UV	XREF: Others: AA, AB, AC, AD XREF: AA(5748). J^{π}: L=2 in ^{22}Ne(^{3}He,d) and p$\gamma(\theta)$ (1989Ba42 – (p,γ)).
5766.03[‡] *16*	3/2$^+$	351[#] as *41*	e G N S UV	XREF: Others: AA, AB, AD J^{π}: M1+E2 γ to 3/2$^+$, γ's to 1/2$^-$ and 5/2$^-$.
5776 *6*			G Q Z	XREF: Others: AB E(level): From (d,α).
5925.8 *5*	7/2$^+$	13 fs *5*	FG LmN Q UV	XREF: Others: AA, AB, AC, AD XREF: U(5934)AD(5910). J^{π}: From p$\gamma(\theta)$ measurements of resonance level → 5740 → g.s. cascade and transition strength analysis (1989Ba42 – (p,γ)). E2 γ to 3/2$^+$.
5965.9 *9*	3/2$^-$	<11 fs	eF Lm O Q S UV Z	XREF: Others: AA, AD XREF: O(5940)AA(5971)AD(5950). J^{π}: L=1 in (t,α),(t,$\alpha\gamma$), γ to 5/2$^+$ and RUL ($\neq$1/2$^-$ from B(M2)(W.u.)>6.8).
6041.9[g] *6*	7/2$^-$	6 fs *2*	eFG L N Q UV	XREF: Others: AA, AB, AC, AD J^{π}: From p$\gamma(\theta)$ measurements and transition strength analysis (1989Ba42 – (p,γ)). (E2) to 3/2$^-$.
6115.1 *6*	(11/2)$^+$	35[d] fs *9*	FGH L Q V	XREF: Others: AA, AB, AC, AD J^{π}: M1 to 9/2$^+$, γ to 7/2$^+$, M1+E2 γ from 13/2$^+$ at 7268-keV level.
6194.6[‡] *2*	5/2$^-$	<70 fs	G L N Q V	XREF: Others: AA, AB, AC J^{π}: From p$\gamma(\theta)$, γ to 1/2$^-$, and transition strength analysis (1989Ba42 – (p,γ)).
6235.4[f] *6*	(13/2$^+$)	16[d] fs *8*	FGH KL N Q V	XREF: Others: AA, AB, AC, AD J^{π}: (E2) to 9/2$^+$ and (M1+E2) to 11/2$^+$, band assignment.
6305.6 *6*	1/2$^+$		Jkl NOPQ V Z	XREF: Others: AA, AB, AC XREF: Z(6263). J^{π}: L=0 in ^{22}Ne(d,n).
6354.2[g] *5*	9/2$^-$	21[d] fs *5*	FG Jkl N Q V	XREF: Others: AA, AB, AC, AD XREF: J(6340). J^{π}: E2 to 5/2$^-$, band assignment.
6578.0 *6*	(9/2$^+$,5/2$^+$)	<11 fs	F jKl Q S V	XREF: Others: AC, AD J^{π}: 5/2,9/2 from 6137γ angular correlation measurements (1972Li02) (p,$\alpha\gamma$), M1+E2 to 7/2$^+$. 9/2$^+$,(5/2$^+$) in 1989Ba42 (p,γ).
6618.3 *8*	(7/2,5/2)$^+$	<0.7 fs	FG j l N Q V	XREF: Others: AB, AD XREF: AD(6602). J^{π}: M1+E2 to 5/2$^+$, γ from (9/2$^+$) at 8319.5.
6735.5[‡] *2*	3/2$^+$	415[#] as *50*	F J L N Q S V	XREF: Others: AB J^{π}: L=2 in ^{22}Ne(^{3}He,d) and RUL.
6820.2 *8*	5/2$^-$	<8 fs	eF J N Q V	XREF: Others: AB, AD J^{π}: L=3 in (^{6}Li,d), 5/2 from p$\gamma(\theta)$ (1989Ba42 – (p,γ)).
6867.7[‡] *2*	5/2$^+$,3/2$^+$	<6 fs	e k N Q V	XREF: Others: AB J^{π}: L=2 in ^{22}Ne(^{3}He,d).
6881.2 *11*			F	

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}	T or Γ[c]	XREF	Comments
6920.6[‡] *2*	3/2$^-$		Jkl NO Q V Z	XREF: Others: AB J^{π}: L=1 in ^{22}Ne(^{3}He,d) and (d,^{3}He), γ to 5/2$^+$.
6947.4[‡] *2*	(3/2$^+$)	<28 fs	F l N Q S V	J^{π}: L=(2) in ^{22}Ne(^{3}He,d), and γ's to 1/2$^+$ and 1/2$^-$.
7055.3 *11*			F	
7070.8[‡] *2*			l N S V z	XREF: Others: AB, AD
7081.9[‡] *3*	3/2$^-$	258[#] as *31*	J l NO Q S V z	XREF: Others: AB J^{π}: L=1 in ^{22}Ne(d,n) and ^{22}Ne(^{3}He,d) and γ to 5/2$^+$.
7125.8 *7*	(9/2)	13[#] fs *5*	F j Q S V	XREF: Others: AD J^{π}: D+Q γ to 7/2$^+$. 5/2 and 7/2 are also possible. 9/2$^+$ in 2013Je04 (^{12}C,pγ).
7133.5[‡] *9*	3/2$^+$,5/2$^+$	200[#] as *26*	j N Q S V	XREF: Others: AB J^{π}: L=2 in ^{22}Ne(^{3}He,d) and γ's to 1/2$^+$ and 7/2$^+$.
7150 *3*				XREF: Others: AB
7185.3 *6*	(9/2$^+$)		F J N Q V	XREF: Others: AB, AD J^{π}: D+Q γ to 7/2$^+$. D+Q γ from 11/2$^+$ at 9210.4.
7268.1 *6*	13/2$^+$	18[d] fs *6*	FGH Kl q V	XREF: Others: AB, AD J^{π}: E2 γ to 9/2$^+$, M1+E2 γ to 11/2$^+$.
7280.3[‡] *11*	5/2$^-$,7/2$^-$	9 fs *6*	F J l N q V	XREF: N(7277.1). J^{π}: L=3 in (^{6}Li,d).
7385 *5*	1/2$^-$,3/2$^-$		G j Q	XREF: Others: AB, AD E(level),J^{π}: From (d,α) and L=1 in ^{22}Ne(^{3}He,d).
7393.4 *7*	(11/2$^+$)	18[d] fs *11*	F j N V	XREF: Others: AB J^{π}: (M1+E2) γ to 9/2$^+$. 7/2$^+$ and 9/2$^+$ are also possible.
7412.4[‡] *3*	5/2$^+$,7/2$^+$,9/2$^+$	<35 fs	G N Q V	XREF: Others: AB J^{π}: γ cascades from resonance state (7/2$^-$) at 9396.4 $\rightarrow$ 7412 $\rightarrow$ 7/2$^+$ state at 2076 ((p,γ) – 1989Ba42)).
7451.5[‡] *9*	5/2$^+$,3/2$^+$	<3 fs	G k NO Q V	XREF: Others: AB J^{π}: L=2 in ^{22}Ne(^{3}He,d). L=(2) in (d,n).
7477.4 *11*			F jk	
7488.9 *7*	1/2$^-$,3/2$^-$	<3 fs	F j N Q V	XREF: Others: AB J^{π}: L=1 in ^{22}Ne(^{3}He,d).
7563.9 *11*	(5/2)$^+$	0.26[#] fs *18*	F J L N Q S V	XREF: Others: AB J^{π}: L=2 in (^{6}Li,d), D+Q γ from 7/2$^-$ at 9396.4.
7687.0 *7*			FG Jk Q V	XREF: Others: AB
7724.4[‡] *2*			Jk N Q V	XREF: Others: AB
7750.6 *11*	(5/2$^-$,3/2$^-$)		kL NO Q V	XREF: Others: AB J^{π}: L=(2) in (d,n).
7835.7 *7*	7/2,(5/2$^+$)	<3.5 fs	FG Jk N Q V	XREF: Others: AB, AD J^{π}: $\gamma(\theta)$ measurements for γ from 7/2 resonance state, γ to 9/2$^+$, D(+Q) γ to 5/2$^+$ (p,γ).
7872.6 *8*	3/2,(5/2$^+$)[b]	<3.5 fs	F L N V	XREF: Others: AB, AD

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)†	J^{π}	T or Γ^{c}	XREF	Comments
				XREF: L(7862). J^{π}: D+Q γ to $5/2^{+}$, γ to $1/2^{+}$.
7876.2 *9*	$5/2^{b}$	<12 fs	J N	
7891.2‡ *3*	$5/2^{+}$	162$^{\#}$ as *12*	J NO Q S V	T=3/2 J^{π}: L=0 in (p,^{3}He) – 1969Ha38 (listed above in 'Other reactions') from $5/2^{+}$ target; L=2 in ^{22}Ne(^{3}He,d).
7964 *3*			G N Q V	XREF: Others: AB, AD E(level): From (p,p′).
7974.0 *11*		<28^{d} fs	FG J Q	XREF: Others: AB, AD
7991.5 *6*	(11/2)	19$^{\#}$ fs *8*	F S V	J^{π}: D+Q γ to $9/2^{+}$ and ($13/2^{+}$) states. $11/2^{+}$ in 2013Je04 (^{12}C,pγ).
8061 *3*	$5/2^{+}$,7/2,$9/2^{+}$		FG N Q V	XREF: Others: AB, AD E(level): From (p,p′). J^{π}: γ′s to $5/2^{+}$ and $9/2^{+}$.
8100 *9*			Q	XREF: Others: AB E(level): From (d,α).
8122$^{\&}$ *7*			Q	XREF: Others: AB
8149$^{\&}$ *5*			Q	XREF: Others: AB
8173$^{\&}$ *7*			Q	XREF: Others: AB
8220$^{\&}$ *5*			Q	XREF: Others: AB
8261.0‡ *5*			N Q V	XREF: Others: AB XREF: Q(8254).
8301.6 *11*	$5/2^{-}$,$7/2^{-}$	<59^{d} fs	eF kL NO Q V	J^{π}: L=3 in ^{22}Ne(d,n).
8319.5 *9*			eF k V	XREF: Others: AB, AD XREF: V(8329)AD(8335). J^{π}: $9/2^{+}$ in 2013Je04 (^{12}C,pγ).
8360.0‡ *9*			J N Q S V	XREF: Others: AB
8417.4‡ *2*	$3/2^{+}$	<21 fs	NO Q V	XREF: Others: AB J^{π}: L=2 in ^{22}Ne(d,n), 3/2 from p$\gamma(\theta)$ (1989Ba42 – (p,γ)).
8432.6 *11*			F	
8475.7‡ *5*	$3/2^{+}$,$5/2^{+}$		FG J L N Q V	XREF: Others: AB, AD XREF: F(8483)Q(8468). J^{π}: L=2 in ^{22}Ne(^{3}He,d).
8503 *3*			Q V	XREF: Others: AB E(level): From (p,p′).
8558 *2*			L Q V	XREF: Others: AB, AD E(level): Weighted average of data from (^{3}He,d),(^{3}He,dγ), (d,α), and (p,p′).
8611.1‡ *9*			N Q V	XREF: Others: AB, AD
8631.0‡ *9*			F N S V	XREF: Others: AD
8651.2 *11*	$1/2^{+}$	0.53$^{\#}$ fs *7*	FG J L Q S V	XREF: Others: AB J^{π}: L=0 in ^{22}Ne(^{3}He,d).
8665.0 *18*	$1/2^{+}$	128 as *22*	NOPQ S V	T=(3/2) J^{π}: L=0 in ^{22}Ne(^{3}He,d). T or Γ: Weighted average of data in (γ,γ′) and (d,nγ).
8721$^{\#}$ *2*			F Q S V	XREF: Others: AB, AD XREF: AD(8705).
8798.7 *8*			FG l O Q V	XREF: Others: AB, AD

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J$^\pi$	T or Γ[c]	XREF	Comments
				J$^\pi$: (3/2,7/2)$^+$ in (^{12}C,pγ). L=0 in (d,n) implies 1/2$^+$. γ rays to 5/2$^+$ and 5/2$^-$.
8820.8 *7*	(9/2$^-$)		FG J l V	XREF: Others: AB J$^\pi$: L=5 in (^{6}Li,d) from 1/2$^+$ target, D+Q γ to 7/2$^+$.
8827.9 *11*	1/2$^+$	211[#] as *70*	F N PQ S	J$^\pi$: L=0 in ^{22}Ne(^{3}He,d).
8862?	1/2$^+$		Q	J$^\pi$: L=0 in ^{22}Ne(^{3}He,d).
8894?	1/2$^+$		Q	J$^\pi$: L=0 in ^{22}Ne(^{3}He,d).
8945.1 *8*	(3/2$^+$)		F jK N	XREF: Others: AD J$^\pi$: D+Q γ to 1/2$^+$. 2016De34 (p,γ) argue only 3/2$^+$ state was populated by low energy proton beam, as 7/2$^-$ state is strongly disfavored by the angular momentum barrier, considering the doublet at 8944 keV with tentative spin-parity of 3/2$^+$ and 7/2$^-$.
8946.8 *6*	(7/2$^-$)	21[d] fs *10*	F j O Q V	XREF: Others: AB J$^\pi$: L=3 in ^{22}Ne(^{3}He,d). γ from (11/2$^-$) at 11271.9.
8963.9 *11*			F	
8975.3[‡] *7*	3/2$^+$,5/2$^+$		F Q V	XREF: Others: AB J$^\pi$: L=2 in ^{22}Ne(^{3}He,d).
9000?			Q	
9039.5 *8*	(15/2)		FGH L v	XREF: Others: AB XREF: L(9024). J$^\pi$: 2804γ D+Q to (13/2$^+$). 15/2$^+$ in 2013Je04 (^{12}C,pγ) and (^{16}O,αpγ).
9042.6 *8*	(7/2,9/2)$^+$	10[d] fs *5*	F N Q v	XREF: Others: AB, AD J$^\pi$: From (^{12}C,pγ), γ to 5/2$^+$ and 7/2$^+$ states.
9072 *3*			V	XREF: Others: AB, AD E(level): From (p,p′).
9101.5 *7*	(13/2$^+$)		F jkl Q V	XREF: Others: AB J$^\pi$: Q γ to 9/2$^+$, D+Q to (11/2$^+$).
9113 *3*			jkl V	
9172.8 *11*			FG Q V	XREF: Others: AB
9210.4 *6*	(11/2$^+$)		F j	XREF: Others: AD J$^\pi$: D+Q γ to 9/2$^+$, γ to 7/2$^+$.
9211.0[‡] *8*	3/2$^-$	4.1[#] fs *15*	F j N Q S V Z	XREF: Others: AB XREF: F(9207)Z(9223). J$^\pi$: L=1 in (d,^{3}He). D γ to 5/2$^+$.
9212.9[@] *11*			F	
9252.10[‡] *10*	1/2$^+$		N Q V	XREF: Q(9257). J$^\pi$: L=0 in ^{22}Ne(^{3}He,d).
9285.4 *11*	3/2$^+$,5/2$^+$		F Q V	XREF: Others: AB, AD J$^\pi$: L=2 in ^{22}Ne(^{3}He,d).
9292.7 *9*			F	J$^\pi$: (7/2,11/2) and (11/2$^+$) in (^{12}C,pγ).
9325.8 *11*	(9/2$^+$,13/2$^+$)		F K Q V	XREF: Others: AB XREF: K(9.36E3). J$^\pi$: From (dσ/dΩ) (θ) and DWBA calculations (α,p).
9396.4[‡] *3*	7/2$^-$		F N Q V	XREF: Others: AB, AD J$^\pi$: pγ(θ) and from an acceptable fraction for the reduced proton width of the Wigner limit for a lp=3 capture (1989Ba42 – (p,γ)). D+Q γ′s to 5/2$^-$ and 9/2$^-$.

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	T or Γ[c]	XREF	Comments
9401.0 7			F N	XREF: Others: AB, AD
9404.8 5	1/2	65 eV	N	J^π: From $\gamma(\theta)$ (1962Br21 – (p,γ)).
9426.1[‡] 5	$3/2^-$		J N Q V Z	XREF: Others: AB J^π: L=1 in (d,^{3}He), D+Q γ to $1/2^+$ and $5/2^+$.
9475 4			Q V	XREF: Others: AB E(level): Weighted average of data from (p,p′) and (^{3}He,d),(^{3}He,dγ).
9487.7[‡] 8	3/2		N V	J^π: From p$\gamma(\theta)$ (1973Me11 – (p,γ)).
9541.5 12	$(13/2^+)$		F Q V	XREF: Others: AB J^π: D+Q γ to $11/2^+$.
9582 3			Q V	XREF: Q(9588).
9608.2[‡] 2	$3/2^+$	6 eV	N Q V	J^π: L=2 in ^{22}Ne(^{3}He,d). γ to $5/2^-$ and p$\gamma(\theta)$.
9626[#] 3	$1/2^+$[a]	2.2[#] fs 8	S V	XREF: Others: AB
9628.3[g] 9	$11/2^-$	2.8[d] fs 14	F	J^π: D γ to $7/2^-$, D+Q γ to $9/2^-$ in (^{12}C,pγ), band assignment.
9652.2[‡] 10	$(3/2^+,5/2^+)$		N q	J^π: γ to $1/2^+$ and $7/2^+$.
9655.6[‡] 10	$(1/2^+)$	105 eV	N q V	XREF: V(9651). J^π: From (p,p′) (1968Ke11); 3/2,5/2 in 1973Me11 – (p,γ) from γ placement to $1/2^+$ and $7/2^+$.
9674.1[‡] 10	$3/2^+,5/2^+$		N Q V	XREF: Others: AB J^π: γ′s to $1/2^+$ and $7/2^+$. D+Q γ′s to $3/2^+$ and $5/2^+$.
9682.7[‡] 4	$(3/2^+)$		N Q V	J^π: 3/2 from p$\gamma(\theta)$ (1973Me11 – (p,γ)). D+Q γ′s to $5/2^+$. γ to $7/2^+$.
9700.9[‡] 10	$3/2^+$	29 eV	J NO Q V	J^π: L=2 in ^{22}Ne(^{3}He,d). D+Q γ to $1/2^-$ and γ to $7/2^+$.
9732.53[‡] 13	7/2		N Q V	XREF: Others: AB J^π: D+Q to $5/2^+$ and $9/2^+$.
9738 3	$1/2^-,3/2^-$		V Z	XREF: Z(9728). J^π: L=1 in (d,^{3}He).
9755.5[‡]	$3/2^+$		N Q V	J^π: γ′s to $1/2^+$, $1/2^-$, $5/2^+$, $5/2^-$.
9802.9[f] 8	$(15/2^+)$	4.2[d] fs 14	F H V	XREF: Others: AB J^π: E2 to $11/2^+$, (M1+E2) γ to $(13/2^+)$, band assignment.
9815.7[‡] 4	$5/2^+$		G J N Q V	XREF: G(9810). J^π: γ′s to $1/2^+$ and $9/2^+$. D+Q γ to $3/2^+$.
9835.4[‡] 10	$3/2^+$	47 eV	E N Q V	XREF: Q(9844). J^π: L=2 in ^{22}Ne(^{3}He,d). $3/2^+$ from (p,p′) (1968Ke11).
9850.1[‡] 5	$1/2^+$[a]	150 eV	N V	J^π: γ′s to $1/2^+$, $1/2^-$, $5/2^+$.
9875.6 9			F V	
9890.9[‡] 6	3/2		N Q V	J^π: γ′s to $1/2^+$, $1/2^-$, $5/2^+$, $5/2^-$.
9917.5 11	$(3/2^+,5/2,7/2^+)$		F N Q V	J^π: γ′s to $3/2^+$, $7/2^+$.
9924.3 11	(3/2,7/2)		F	J^π: γ to $5/2^+$.
9939 3			k Q V	XREF: Q(9944).
9964.6 12	(9/2,13/2)		F k V	XREF: V(9958). J^π: D+Q γ to $11/2^+$.
9988.2 12	$11/2^-$		F V	XREF: V(9984). J^π: Q γ to $7/2^-$.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	T or Γ[c]	XREF	Comments
10003.2[‡] *6*	1/2$^-$[a]	475 eV	N V	
10017.4[‡] *10*	5/2$^+$[a]	69 eV	G NO Q V	J^π: L=2 in (d,n), γ's to 1/2$^+$ and 9/2$^+$.
10033.8 *9*			F j Q V	
10036.4 *11*			F j	
10049.1[‡] *6*			N	
10070.9[‡]	(5/2,7/2)		N V	J^π: Proposed in 1979Sm02 (p,γ), based on $\gamma(\theta)$ measurements.
10075.9[‡] *5*	3/2,5/2		N Q	J^π: γ's to 1/2$^-$ and 7/2$^+$.
10085.3[‡] *5*	1/2$^+$[a]	1270 eV	N V	J^π: γ's to 1/2$^+$ and 5/2$^+$.
10114.8[‡] *5*	1/2$^+$[a]	4200 eV	N V	J^π: γ's to 1/2$^+$, 3/2$^+$, 3/2$^-$.
10125.9[‡] *5*	5/2		N V	J^π: γ's to 3/2$^+$, 3/2$^-$, 7/2$^+$, 7/2$^-$.
10156.4 *11*			F	
10164.2 *5*			N V	XREF: V(10160).
10169.6[‡] *2*	5/2$^+$[a]	65 eV	N Q V	XREF: V(10173). J^π: M1+E2 γ's to 3/2$^+$ and 7/2$^+$.
10183 *3*			V	
10212.9 *12*			F V	
10221 *3*			G Q V	E(level): From (p,p′).
10231.7[‡] *4*	5/2$^+$[a]	4 eV	N V	J^π: E1+M2 to 3/2$^-$ and 7/2$^-$.
10237.8 *11*			F	
10243.7[‡] *14*	1/2$^+$[a]	2450 eV	j N V	XREF: V(10250). J^π: In 1968Ke11 (p,p′), based on measured $\sigma(\theta)$ mb/sr and fitting. L=0 (p,p′) (1967Ka10).
10281.5[‡] *6*	3/2$^+$		j N V	XREF: V(10272). J^π: γ's to 1/2$^-$ and 7/2$^+$.
10296 *3*			V	
10318.0[‡] *6*	3/2$^-$[a]	2000 eV	N V	XREF: V(10313).
10333.8 *11*			F V	
10338.7[‡] *7*	(1/2$^-$)[a]	190 eV	N V	
10346.1[‡] *7*	5/2$^+$		g N V	J^π: γ's to 1/2$^+$, 7/2$^+$, 7/2$^-$. In (p,p′) (1968Ke11) 3/2$^+$,5/2$^+$.
10353.8[‡] *7*	3/2$^+$[a]	210 eV	g N V	J^π: γ's to 1/2$^+$, 1/2$^-$, 7/2$^+$.
10354.0[g] *7*	13/2$^-$	<0.69 fs	F	J^π: D γ to 11/2$^+$, Q γ to 9/2$^-$, and band assignment. T or Γ: From τ < 1 fs (2013Je04). Other: <18 fs (τ < 25 fs (1973Fr07)).
10404.8 *12*	(11/2$^-$)		F V	J^π: (D) γ to (13/2$^+$).
10408.8 *11*			F	
10438.5 *11*	5/2$^+$[a]	25 eV	F N V	J^π: γ's to 3/2$^-$, 3/2$^+$, 7/2$^+$. D+Q γ to 7/2$^+$ and 3/2$^+$.
10448.7 *12*			N V	XREF: V(10439).
10478.8[‡] *7*	3/2$^+$[a]	470 eV	J N V	XREF: V(10472). J^π: γ's to 1/2$^-$, 1/2$^+$, 5/2$^-$, 5/2$^+$.
10496 *3*			V	
10501.9[‡] *7*	3/2$^-$[a]	920 eV	N V Z	XREF: Z(10490). J^π: L=1 in (d,^{3}He); γ to 5/2$^+$.
10507.8[‡] *7*	1/2$^+$[a]	560 eV	N V	J^π: γ's to 1/2$^+$, 1/2$^-$, 5/2$^+$.
10519.1[‡] *7*	5/2$^+$[a]	100 eV	N V	XREF: V(10514). J^π: M1+E2 to 3/2$^+$ and (5/2,7/2)$^+$.
10534.1[‡] *7*			N V	XREF: V(10529).
10549.2[‡] *9*	5/2$^+$[a]	540 eV	N V	XREF: V(10545).
10574.6[‡] *8*	3/2$^-$[a]	1100 eV	N V	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	T or Γ[c]	XREF	Comments
10590.7 *7*	(13/2⁻)		FG V	J^π: D γ to 11/2⁺, D+Q γ to (13/2⁺), γ to 9/2⁻.
10616.9[‡] *8*	5/2⁺,3/2⁺[a]	425 eV	N V	
10665 *3*			V	
10677 *3*	(3/2⁻)[a]	23 keV	V	
10698.0 *9*	(7/2,11/2)		F	J^π: (D) γ to 9/2⁺, D+Q γ to 9/2⁻.
10701 *3*	(3/2⁻)[a]	400 eV	V	
10759.8 *12*			F	
10770 *3*	3/2⁺,5/2⁺[a]	<5 eV	V	
10798.0 *11*			F	
10824 *4*	(3/2⁺)[a]	1700 eV	V	
10826 *3*	(3/2⁻)[a]	26000 eV	V	
10838 *3*	3/2⁺,5/2⁺[a]	100 eV	O V	E(level): From (p,p′).
10860.9 *8*			F	
10869 *3*	(3/2⁻)[a]	21000 eV	V	
10903 *4*	(1/2⁻)[a]	53 eV	V	
10906.5 *40*	(1/2⁻)[a]	2850 eV	V	
10906.8 *40*	(5/2⁺)[a]	900 eV	V	
10918 *3*	(1/2⁺)[a]	55 eV	V	
10923.0 *11*			F	
10933 *3*	(3/2⁺)[a]	3500 eV	F O V	XREF: O(10940).
10949 *4*	(1/2⁺)[a]	5200 eV	V	
10953 *4*	(7/2⁻)[a]	65 eV	V	
10967 *4*	(5/2⁺,3/2⁺)[a]	400 eV	V	
10973 *3*	(3/2⁺)[a]	18 eV	V	
10980 *3*	(3/2⁻)[a]	6000 eV	G V	E(level): From (p,p′).
10992 *4*	(1/2⁺)[a]	20600 eV	V	
10993 *4*	(3/2⁺)[a]	60 eV	V	
11004 *3*			V	
11041 *3*	(1/2⁺)[a]	500 eV	V	
11073.7[f] *10*	(17/2⁺)	34.7[d] fs *69*	F H	J^π: (E2) γ to (13/2⁺), D+Q to (15/2), band assignment.
11088 *3*	(1/2⁻)[a]	800 eV	V	
11108 *4*	(5/2⁺)[a]	135 eV	V	
11112 *3*	(3/2)⁺[a]	4100 eV	V	J^π: L=2 (p,p′) (1967Ka10).
11133 *3*			V	
11155 *3*			V	
11198 *4*	(3/2⁺)[a]	800 eV	V	
11240 *3*	(3/2⁻)[a]	12200 eV	V	
11250 *4*	(3/2⁺)[a]	20000 eV	V	
11266 *4*	(3/2⁻)[a]	600 eV	V	
11271.9 *9*	(11/2⁻)	12.5[d] fs *21*	F	J^π: (E1) γ to 13/2⁺.
11273 *4*	(3/2⁺)[a]	1750 eV	V	
11276 *4*	(3/2⁺)[a]	500 eV	V	
11279 *4*	(3/2⁺)[a]	4000 eV	j O V	
11288 *3*	(1/2⁺)[a]	11000 eV	G j V	E(level): From (p,p′).
11302 *4*	(3/2⁺)[a]	300 eV	V	
11328 *4*	(1/2⁻)[a]	80000 eV	V	
11333 *4*	(5/2⁺)[a]	4000 eV	V	
11333.7 *40*	(3/2⁻)[a]	2000 eV	V	
11335 *4*	(3/2⁺)[a]	750 eV	V	
11350 *4*	(1/2⁻)[a]	4000 eV	V	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	T or Γ[c]	XREF	Comments
11354 *4*	(1/2+)[a]	13500 eV	V	
11424.7 *9*	(11/2)		F	Jπ: D γ to 13/2−. (11/2+) in (12C,pγ).
11431 *3*	(1/2−)[a]	35000 eV	V	
11495 *4*	(7/2−)[a]	5500 eV	V	
11519 *4*	(5/2+)[a]	3050 eV	j V	
11528 *3*	(5/2+)[a]	6900 eV	j V	
11538 *4*	(5/2+)[a]	130 eV	O V	E(level): From (p,p′).
11538.8 *9*	(15/2+)		F	Jπ: γ to 11/2+ and (13/2+) states. Excitation energy.
11556 *3*	1/2+[a]	3100 eV	G V	E(level): From (p,p′).
11580 *3*	(5/2+)[a]	600 eV	G j V	
11612 *4*	(3/2−)[a]	3200 eV	G j V	
11622 *3*			V	
11651.6 *9*	(13/2+)		F	Jπ: γ to (9/2+) and 11/2+ states.
11664 *4*	(1/2−,3/2−)[a]	14000 eV	G V	E(level): From (p,p′).
11691 *4*	(1/2+)[a]	1900 eV	G V	
11700 *4*	(3/2)−[a]	7000 eV	G V	Jπ: L=1 (p,p′) (1967Ka10).
11708 *4*	(5/2+)[a]	3200 eV	G V	
11.72×10³ *2*	(13/2+)		K	Jπ: From (dσ/dΩ) (θ) and DWBA calculations (α,p).
11747 *4*	(7/2−)[a]	2300 eV	G O V	
11762 *4*	(1/2−)[a]	15000 eV	G V	E(level): From (p,p′).
11820 *4*			V	
11840 *7*			V	
11865 *4*	(3/2)+	16 keV	V	Jπ: L=2 (p,p′) (1967Ka10). Γ from (p,p′).
11897 *4*			V	
11.92×10³ *3*			K O	XREF: O(11880).
11980 *4*			V	
12013.5 *11*			F V	XREF: V(12018).
12050			G	
12074 *4*			V	
12105 *4*		16 keV *2*	V	Γ from (p,p′).
12122 *5*		4 keV *2*	I K V	XREF: V(12129).
12184 *5*	(3/2)+	12 kev 2	I V	Jπ: L=2 (p,p′) (1967Ka10). Γ from (p,p′).
12202 *5*		9 keV *4*	I V	Other: Γ=28 keV (p,p′).
12230 *10*			J	
12272 *5*		6 keV *3*	I K	
12290 *4*			V	
12317 *5*			G I V	XREF: G(12330).
12334?			V	
12351 *4*			V	
12378 *4*		11 keV	V	Γ from (p,p′).
12419.8 *2*	(7/2+,5/2+)	116 eV *20*	R V	Jπ: Based on measured Γ_{p0}/Γ_{p1} and shell model calculations (n,γ). Other: Γ=14 keV (p,p′) − discrepant value.
12453 *4*		9 keV	V	Γ from (p,p′).
12488 *5*	(13/2+)	5 keV *2*	I K	Jπ: From (dσ/dΩ) (θ) and DWBA calculations (α,p).
12545 *5*		6[e] keV *3*	G I V	XREF: G(12540)V(12533).
12557?			V	
12593.1 *9*		<14[d] fs	F I V	XREF: I(12602)V(12584). Γ=34 keV (p,p′).

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

E(level)[†]	J$^{\pi}$	T or Γ[c]	XREF	Comments
12625 *5*		25 keV	V	Γ from (p,p′).
12640 *5*		10 keV *5*	I	
12729 *5*		13 keV *2*	I V	Other: Γ=24 keV (p,p′).
12800 *5*		6 keV *3*	I k V	
12818 *5*		5[e] keV *2*	G I k	XREF: G(12820).
12848 *5*		11 keV *5*	I	
12852 *5*		9 keV *4*	I	
12927 *7*		6[e] keV *3*	G IJ	E(level): Unweighted average of data from (^{6}Li,d), (α,γ), and (^{15}N,α).
13050			G	
13074 *5*		12 keV *6*	I	
13110 *10*	(1/2^{+})		E J	XREF: E(13150). J$^{\pi}$: From (^{16}O,α) based on σ(θ).
13184 *5*		9 keV *4*	I	
13196 *5*		9 keV *4*	I	
13210			G	
13248 *5*		10[e] keV *5*	IJ	E(level): From (α,γ).
13279 *5*		14 keV *7*	I	
13337 *5*		8 keV *4*	I K	
13399 *5*		13 keV *6*	I	
13460 *5*		23 keV *11*	I	
13509 *5*		10 keV *5*	I	
13528 *5*			I	
13.56×10^{3} *4*			K	
13.68×10^{3} *3*			K	
13720			E G	XREF: E(13820).
13.97×10^{3} *3*			K	
14080			G	
14240 *60*	(3/2^{+})		E K	J$^{\pi}$: From (^{16}O,α) based on σ(θ).
14370 *10*			G k O	E(level): From (d,n).
14440			G k	
14.65×10^{3} *5*	(3/2^{+})		E K	XREF: E(14700). J$^{\pi}$: From (^{16}O,α) based on σ(θ).
14.77×10^{3} *5*			K	
14.91×10^{3} *5*			K	
14.99×10^{3} *5*			G K	XREF: G(14980).
15.26×10^{3} *5*			K	
15.52×10^{3} *5*			G K	XREF: G(15450).
15.61×10^{3} *5*			K	
15900			G	
15980			G	
16320			G	
16600			G	
19590.6 *21*	(5/2^{+})	1.9 keV *8*	N	T=5/2 J$^{\pi}$: Isobaric analogue state of ^{23}F g.s. (1985Ev01).
25400		0.67 MeV *20*	D	Γ from ^{7}Li(^{16}O,γ).

† From least-squares fit to γ-ray energies, except otherwise noted.
‡ From (p,γ).
# From (γ,γ′).
@ Might be the same level of 9211.0-keV. In (^{12}C,pγ) 2013Je04 tabulated this level (9212) based on 6230γ, while in (p,γ) by

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Adopted Levels, Gammas (continued)

^{23}Na Levels (continued)

2015De33 and earlier literature placed a comparable γ ray from 9211-keV level.

[&] From (^{3}He,d),(^{3}He,dγ).

[a] From (p,p′) (1968Ke11), based on measured $\sigma(\theta)$ mb/sr and fitting with single-level, Breit-Wigner formula for resonances <2.1 MeV and multilevel, multichannel R-matrix code for resonances above >2.1 MeV.

[b] From 1989Ba42 based on $\gamma(\theta)$ measurements, γ feeding from/to resonance levels/low lying levels, and RUL (for levels with measured/known lifetimes).

[c] From (p,γ), except where noted. Doppler shift attenuation method (DSAM). For weighted average, the listed uncertainty is the lowest input value. Γ data from (p,p′),(p,p′γ), except where otherwise noted.

[d] From (^{12}C,pγ).

[e] From (α,γ).

[f] Band(A): K^π=1/2$^+$ g.s. band.

[g] Band(B): K^π=1/2$^-$ band.

Adopted Levels, Gammas (continued)

$\gamma(^{23}Na)$

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
440.2	5/2+	440.5 6	100	0.0	3/2+	M1+E2	+0.065 5		B(M1)(W.u.)=0.225 14; B(E2)(W.u.)=32 6 E_γ: Unweighted average of 439.80 15 (^{12}C,pγ) and 441.1 4 (p,p′γ)). δ: Weighted average of +0.08 2 (1966Po06 − (p,$\alpha\gamma$)), +0.06 4 (1968So07 − (p,p′γ)), +0.08 3 (1970Po08 − (t,$\alpha\gamma$)), +0.05 3 (1971Da14 − (t,$\alpha\gamma$)), 0.09 1 (1972Li02 − (p,$\alpha\gamma$)), 0.045 15 (1960Mi05 − (p,p′γ)), 0.09 4 (1962Br21 − (p,γ)), and 0.060 5 (1977Sc36).
2076.2	7/2+	1636.6[#] 8	100.00 11	440.2	5/2+	M1+E2	+0.19 1	1.12×10^{-4}	B(M1)(W.u.)=0.164 19; B(E2)(W.u.)=14.6 22 δ: Weighted average of +0.20 2 (1966Po06 − (p,$\alpha\gamma$)), +0.24 7 (1968So07 − (p,p′γ)), +0.18 4 (1970Po08 − (t,$\alpha\gamma$)), +0.16 2 (1971Da14 − (t,$\alpha\gamma$)), +0.22 2 (1972Li02 − (p,$\alpha\gamma$)), and +0.18 2 (1970Ma15 − (p,p′γ)).
		2076.7[#] 8	9.77[c] 11	0.0	3/2+	E2		3.55×10^{-4}	B(E2)(W.u.)=12.2 15 Mult.,δ: From (p,$\alpha\gamma$). M3<7.3% from δ=−0.14 14 (p,$\alpha\gamma$).
2390.9	1/2+	1950.6[‡] 4	52.2[c] 6	440.2	5/2+	E2		2.94×10^{-4}	B(E2)(W.u.)=2.9 7
		2390.6[‡] 4	100.0 6	0.0	3/2+				
2640.5	1/2−	2639.8[#] 8	100	0.0	3/2+	[E1]		1.05×10^{-3}	B(E1)(W.u.)=0.00060 7
2703.8	9/2+	627.4[#] 6	59.8[@] 3	2076.2	7/2+	M1+E2	+0.10 2		B(M1)(W.u.)=0.38 3; B(E2)(W.u.)=6.E+1 3 δ: From (p,$\alpha\gamma$).
		2263.3[#] 8	100.0[@] 5	440.2	5/2+	E2		4.46×10^{-4}	B(E2)(W.u.)=17.4 14
2982.0	3/2+	591[@] 1	0.51 17	2390.9	1/2+	[M1]			B(M1)(W.u.)=0.10 4 I_γ: Other value: 6.8 23 (^{12}C,pγ).
		2541.3[#] 9	70.1 3	440.2	5/2+	M1+E2	−0.09 3	4.72×10^{-4}	B(M1)(W.u.)=0.166 21; B(E2)(W.u.)=1.4 10 δ: Weighted average of −0.09 9 (1970Ma15 − (p,p′γ)), −0.07 21 (1970Po08 − (t,$\alpha\gamma$)), −0.05 7 (1971Da14 − (t,$\alpha\gamma$)), 0.05 5 (1972Li02 − (p,$\alpha\gamma$)), and 0.15 5 (1971Ra13 − (γ,γ')). I_γ: Other values: 77.3 23 (^{12}C,pγ), 82 4 (p,$\alpha\gamma$), 64 3 (p,p′γ). Unweighted average of all available data: 72.8 25.
		2981.7[#] 8	100.0 3	0.0	3/2+	M1		6.51×10^{-4}	B(M1)(W.u.)=0.147 18
3677.9	3/2−	696[@]	0.64 13	2982.0	3/2+	[E1]			B(E1)(W.u.)=0.00058 15
		1037[#] 1	24.9 6	2640.5	1/2−	M1+E2	−0.14 5		B(M1)(W.u.)=0.18 3; B(E2)(W.u.)=21 15 Mult.,δ: From (p,$\alpha\gamma$) and weighted average of −0.11 6 (t,α),(t,$\alpha\gamma$) and −0.22 10 (p,$\alpha\gamma$).
		1287[#] 1	1.65 13	2390.9	1/2+	(E1)[@]		1.21×10^{-4}	B(E1)(W.u.)=0.00023 4
		3237.2[#] 9	100.0 8	440.2	5/2+	E1		1.36×10^{-3}	B(E1)(W.u.)=0.00089 13
		3677.6	3.9 13	0.0	3/2+	[E1]			B(E1)(W.u.)=2.4×10^{-5} 9 E_γ,I_γ: From (t,α),(t,$\alpha\gamma$).
3847.9	5/2−	170[@] 1	0.72[@] 17	3677.9	3/2−				

$^{23}_{11}Na_{12}$-14

$\gamma(^{23}$Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
3847.9	5/2⁻	866[@] *1*	3.3 *3*	2982.0	3/2⁺	(E1)[@]			B(E1)(W.u.)=0.00030 *8* I_γ: Other value: 0.89 *22* (^{12}C,pγ).
		1207[@] *1*	7.36 *16*	2640.5	1/2⁻	(E2)[@]		2.06×10^{-5} *4*	B(E2)(W.u.)=29 *7* I_γ: Other value: 13 *4* (p,$\alpha\gamma$).
		1772[@] *1*	100.0 *11*	2076.2	7/2⁺	(E1)[@]		4.81×10^{-4}	B(E1)(W.u.)=0.0011 *3*
		3408[@] *1*	15.5 *15*	440.2	5/2⁺	E1+M2	−0.21 *14*	0.00140 *6*	B(E1)(W.u.)=2.2×10^{-5} *6*; B(M2)(W.u.)=0.4 *+5−3* I_γ: Other value: 32 *9* (p,$\alpha\gamma$). Mult.,δ: From (p,$\alpha\gamma$).
		3848[@] *1*	37.5 *10*	0.0	3/2⁺	(E1+M2)[@]		1.61×10^{-3} *3*	
3914.6	5/2⁺	932[@] *1*	2.9 *3*	2982.0	3/2⁺	[M1]			B(M1)(W.u.)=0.091 *21*
		1523[j@] *1*	1.38[j] *13*	2390.9	1/2⁺	[E2]		1.03×10^{-4}	B(E2)(W.u.)=28 *7*
		1838[@] *1*	11.3 *3*	2076.2	7/2⁺	M1		1.82×10^{-4}	B(M1)(W.u.)=0.046 *10* Mult.: From (t,α),(t,$\alpha\gamma$).
		3474[@] *1*	10.19 *13*	440.2	5/2⁺				
		3914[@] *1*	100.0 *4*	0.0	3/2⁺	M1+E2	+0.22 *3*	1.00×10^{-3} *2*	B(M1)(W.u.)=0.040 *9*; B(E2)(W.u.)=0.8 *3* Mult.,δ: From (t,α),(t,$\alpha\gamma$).
4429.63	1/2⁺	2038.6	9.9 *3*	2390.9	1/2⁺	[M1]		2.62×10^{-4}	B(M1)(W.u.)=1.11 *12*
		4429.2	100 *3*	0.0	3/2⁺	M1		1.16×10^{-3}	B(M1)(W.u.)=1.10 *12* Mult.: From $\sigma(E_{e'})$ in (e,e′).
4775.2	7/2⁺	860[@] *1*	8.0[@] *13*	3914.6	5/2⁺				
		2072[@] *1*	28[@] *3*	2703.8	9/2⁺				I_γ: Other value: 5.7 *15* (p,γ).
		2699[@] *1*	44.0 *18*	2076.2	7/2⁺	M1		5.37×10^{-4}	B(M1)(W.u.)>0.20 Mult.: From (t,α),(t,$\alpha\gamma$).
		4335[@] *1*	100.0 *19*	440.2	5/2⁺	M1+E2	+0.18 *2*	1.14×10^{-3}	B(M1)(W.u.)>0.10; B(E2)(W.u.)>0.93 Mult.,δ: Weighted average of data from (p,$\alpha\gamma$) and (t,α),(t,$\alpha\gamma$).
5378.56	5/2⁺	2396.4	12.4 *10*	2982.0	3/2⁺				
		3302.1	36.0[c] *17*	2076.2	7/2⁺	M1+E2	−0.19 *12*	7.79×10^{-4} *14*	B(M1)(W.u.)=0.95 *16* δ: from 1970Po08 − (t,α),(t,$\alpha\gamma$)).
		4937.8	100.0 *17*	440.2	5/2⁺	M1+E2	−0.15 *4*	1.31×10^{-3}	B(M1)(W.u.)=0.72 *11*; B(E2)(W.u.)=5 *4* δ: Unweighted average of data from −0.27 *5* (p,$\alpha\gamma$), −0.10 *7* (p,γ), and −0.16 *7* and −0.08 *4* in (t,α),(t,$\alpha\gamma$). These values are for spin 5/2.
		5377.9	22.9[d] *13*	0.0	3/2⁺	M1(+E2)	−0.02 *5*	1.43×10^{-3}	B(M1)(W.u.)=0.130 *21* Mult.,δ: Weighted average of −0.05 *5* (p,$\alpha\gamma$), −0.20 *9* (p,γ), and +0.04 *4* (t,α),(t,$\alpha\gamma$). Note other possible values in later two data sets for spin 3/2.
5534.2	11/2⁺	2830[@] *1*	100.0[@] *14*	2703.8	9/2⁺	M1+E2	+0.17 *3*	5.93×10^{-4}	B(M1)(W.u.)=0.07 *4*; B(E2)(W.u.)=1.7 *11* Mult.,δ: From (p,$\alpha\gamma$).

$\gamma(^{23}$Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
5534.2	11/2+	3458[@] 1	27.5[@] 7	2076.2	7/2+	E2		9.76×10⁻⁴	B(E2)(W.u.)=6 4 Mult.: From (^{12}C,pγ).
5741.0	5/2+	5300.1	41[d] 5	440.2	5/2+	M1+E2	−0.19 12	1.41×10⁻³ 2	B(M1)(W.u.)=0.105 24; B(E2)(W.u.)=0.9 +11−8 Mult.,δ: From (t,α),(t,$\alpha\gamma$).
		5740.2	100.0 19	0.0	3/2+	M1+E2	+0.19 3	1.52×10⁻³	B(M1)(W.u.)=0.20 3; B(E2)(W.u.)=1.5 5 Mult.,δ: Weighted average of data from (p,$\alpha\gamma$) and (p,γ).
5766.03	3/2+	1918.0	2.9 14	3847.9	5/2−	[E1]			B(E1)(W.u.)=0.34 4
		3125.3	8.6 18	2640.5	1/2−	[E1]		1.30×10⁻³	B(E1)(W.u.)=0.0029 8
		3374.9	11.3 19	2390.9	1/2+				E_γ,I_γ: From (γ,γ').
		5325.2	82 5	440.2	5/2+	M1		1.41×10⁻³	B(M1)(W.u.)=0.174 24 I_γ: Weighted average of data from (p,γ) and (γ,γ'). E_γ,I_γ: From (p,γ).
		5765.3	100 6	0.0	3/2+	M1+E2	−0.09 5	1.53×10⁻³	B(M1)(W.u.)=0.169 23; B(E2)(W.u.)=0.25 +34−20 E_γ,I_γ,Mult.,δ: From (p,γ).
5925.8	7/2+	1151[@] 1	3.53 19	4775.2	7/2+	M1+E2		1.28×10⁻⁵ 23	I_γ: Other: 6.5 22 (^{12}C,pγ). Mult.: From (^{12}C,pγ).
		2010[@] 1	12.5 6	3914.6	5/2+	M1		2.51×10⁻⁴	B(M1)(W.u.)=0.014 6 Mult.: From (^{12}C,pγ).
		3850[@] 1	25.3 24	2076.2	7/2+	M1+E2		0.00105 8	I_γ: Other: 39 4 (^{12}C,pγ). Mult.: From (^{12}C,pγ).
		5484[@] 1	44.6 17	440.2	5/2+	M1+E2	+4.4 6	1.61×10⁻³	B(M1)(W.u.)=0.00012 6; B(E2)(W.u.)=0.51 20 I_γ: Other: 52.2 22 (^{12}C,pγ). Mult.,δ: From (p,γ).
		5925[@] 1	100 2	0.0	3/2+	E2		1.73×10⁻³	B(E2)(W.u.)=0.8 4 Mult.: From (p,γ).
5965.9	3/2−	1536.2	10 4	4429.63	1/2+				
		2288[@] 1	30 10	3677.9	3/2−				I_γ: Other: 100 25 (^{12}C,pγ).
		3325[@] 1	100 20	2640.5	1/2−	(M1)		7.83×10⁻⁴	B(M1)(W.u.)>0.027 Mult.: From (^{12}C,pγ).
		3574.7	20 10	2390.9	1/2+				
		5525.0	20 8	440.2	5/2+	[E1]			B(E1)(W.u.)>4.5×10⁻⁵
		5965.0	20 8	0.0	3/2+				
6041.9	7/2−	2127.2	5.7 10	3914.6	5/2+	[E1]		7.33×10⁻⁴	B(E1)(W.u.)=0.00040 16
		2194[@] 1	100 4	3847.9	5/2−	M1+E2[h]	−0.13[h] 3	3.27×10⁻⁴	B(M1)(W.u.)=0.17 6; B(E2)(W.u.)=3.9 22 I_γ: Other: 76.3 26 (^{12}C,pγ).
		2364[@] 1	25 6	3677.9	3/2−	(E2)[@]		4.95×10⁻⁴	B(E2)(W.u.)=40 17 I_γ: Other: 100 5 (^{12}C,pγ).
		5601.0	74 4	440.2	5/2+	E1+M2[h]	+0.17[h] 6	0.00216 4	B(E1)(W.u.)=0.00028 10; B(M2)(W.u.)=1.2 9
6115.1	(11/2)+	3411[@] 1	100.0[@] 9	2703.8	9/2+	M1[@]		8.16×10⁻⁴	B(M1)(W.u.)=0.012 4

$^{23}_{11}$Na$_{12}$-16

$\gamma(^{23}$Na) (continued)

E_i(level)	J^{π}_i	E_γ[†]	I_γ[b]	E_f	J^{π}_f	Mult.[g]	δ	α[i]	Comments
6115.1	$(11/2)^+$	4038[@] *1*	30[@] *3*	2076.2	$7/2^+$	[E2]		1.18×10^{-3}	B(E2)(W.u.)=0.89 *25*
6194.6	$5/2^-$	2346.6	94 *15*	3847.9	$5/2^-$				
		2516.6	100 *21*	3677.9	$3/2^-$				
		3553.8	68 *15*	2640.5	$1/2^-$				
		6193.7	32 *15*	0.0	$3/2^+$				
6235.4	$(13/2^+)$	701[@] *1*	12[@] *6*	5534.2	$11/2^+$	(M1)			B(M1)(W.u.)=0.4 *3* Mult.,δ: D+Q in (^{12}C,pγ). RUL yields to high B(E2)(W.u.) value for M1+E2 with δ=+1.05 *70* (^{12}C,pγ) and limits the δ<0.14.
		3531[@] *1*	100.0[@] *12*	2703.8	$9/2^+$	(E2)		1.00×10^{-3}	B(E2)(W.u.)=15 *8* Mult.,δ: Q in (^{12}C,pγ) (2013Je04). However, D+Q earlier literature with δ=+1.6 *6* (p,$\alpha\gamma$) (1972Li02) and +1.05 *70* (^{12}C,pγ) (1977Ke05) for $9/2^+$; δ=−0.15 *14* (p,$\alpha\gamma$) (1972Li02) and −0.03 *15* (^{12}C,pγ) (1977Ke05) for $13/2^+$.
6305.6	$1/2^+$	3914.3[&] *5*	100	2390.9	$1/2^+$				
6354.2	$9/2^-$	312[@] *1*	0.65[@] *11*	6041.9	$7/2^-$				
		819[@] *1*	4.3[@] *11*	5534.2	$11/2^+$	(E1)[@]			B(E1)(W.u.)=0.0017 *6*
		1579[@] *1*	19.6[@] *11*	4775.2	$7/2^+$	(E1)[@]		3.33×10^{-4}	B(E1)(W.u.)=0.0011 *3*
		2506[@] *1*	100.0[@] *11*	3847.9	$5/2^-$	E2[@]		5.63×10^{-4}	B(E2)(W.u.)=39 *10*
		3650[@] *1*	50.0[@] *11*	2703.8	$9/2^+$	[E1]		1.54×10^{-3}	B(E1)(W.u.)=0.00022 *6*
		4278[@] *1*	7.4[@] *2*	2076.2	$7/2^+$	(E1)[@]		0.00179	B(E1)(W.u.)=2.1×10^{-5} *5*
6578.0	$(9/2^+,5/2^+)$	2663[@] *1*	33 *7*	3914.6	$5/2^+$				I_γ: Other: 20 *5* (^{12}C,pγ).
		3874[@] *1*	42 *9*	2703.8	$9/2^+$				I_γ: Other: 25 *5* (^{12}C,pγ).
		4501[@] *1*	100[@] *10*	2076.2	$7/2^+$	M1+E2[h]	−0.25[h] *10*	1.19×10^{-3} *2*	B(M1)(W.u.)>0.0084; B(E2)(W.u.)>0.045 I_γ: Other: 80 *7* (p,$\alpha\gamma$). δ: for 9/2 (p,γ) (1989Ba42).
		6137[@] *1*	58 *9*	440.2	$5/2^+$				I_γ: Others: 100 *10* (^{12}C,pγ), 100 *9* (p,$\alpha\gamma$).
6618.3	$(7/2,5/2)^+$	1843.0	3.07 *11*	4775.2	$7/2^+$				
		2703.5	1.21 *22*	3914.6	$5/2^+$				
		4541.6	1.21 *22*	2076.2	$7/2^+$				
		6177[@] *1*	100.0 *7*	440.2	$5/2^+$	M1+E2[h]	+0.09[h] *1*		B(M1)(W.u.)>0.12; B(E2)(W.u.)>0.13 δ: δ for J(6618)=7/2 (1989Ba42) (p,γ).
		6617.3	4.2 *6*	0.0	$3/2^+$				
6735.5	$3/2^+$	3753.2	38 *10*	2982.0	$3/2^+$				
		4658.8	71 *13*	2076.2	$7/2^+$	[E2]		1.39×10^{-3}	B(E2)(W.u.)=43 *11*
		6294.4	100 *13*	440.2	$5/2^+$				
6820.2	$5/2^-$	2973[@] *1*	100 *11*	3847.9	$5/2^-$	M1+E2[h]	−0.29[h] *9*	6.58×10^{-4} *11*	B(M1)(W.u.)>0.055; B(E2)(W.u.)>1.6 I_γ: Other: 28 *4* (^{12}C,pγ).

$^{23}_{11}$Na$_{12}$-17

Adopted Levels, Gammas (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
6820.2	5/2⁻	3141[@] 1	67 11	3677.9	3/2⁻				I_γ: Other: 100 8 (^{12}C,pγ).
6867.7	5/2⁺,3/2⁺	6426.5	100 4	440.2	5/2⁺	D+Q[h]	+0.5[h] 4		δ: δ for J(6868)=5/2 (1989Ba42) (p,γ).
		6866.6	22 4	0.0	3/2⁺				
6881.2		4177[@] 1	100	2703.8	9/2⁺				
6920.6	3/2⁻	6479.4	43 3	440.2	5/2⁺				
		6919.5	100 3	0.0	3/2⁺				
6947.4	(3/2⁺)	3032.6	30 5	3914.6	5/2⁺				
		3965.0	100 7	2982.0	3/2⁺	D[h]			
		4306.5	26 7	2640.5	1/2⁻				
		4556.0	48 7	2390.9	1/2⁺				
		6506.2	61 10	440.2	5/2⁺				
		6946.3	55 10	0.0	3/2⁺				
7055.3		4351[@] 1	100	2703.8	9/2⁺				
7070.8		3156.0	8.9[e] 10	3914.6	5/2⁺				
		7069.6	100.0 22	0.0	3/2⁺				
7081.9	3/2⁻	4441.0	36[a] 4	2640.5	1/2⁻				
		6640.7	46[a] 7	440.2	5/2⁺	[E1]			B(E1)(W.u.)=0.0028 5
		7080.7	100[a] 4	0.0	3/2⁺	[E1]			B(E1)(W.u.)=0.0052 6
7125.8	(9/2)	2350[@] 1	14[@] 4	4775.2	7/2⁺				
		4422[@] 1	100[@] 4	2703.8	9/2⁺				
		5049[@] 1	74[@] 4	2076.2	7/2⁺	D+Q[@]			
		7125		0.0	3/2⁺				E_γ: From level energy difference, recoil corrected. Placement in (γ,γ').
7133.5	3/2⁺,5/2⁺	4151.0	30 5	2982.0	3/2⁺				
		5056.7	30 7	2076.2	7/2⁺				
		6692.3	68 5	440.2	5/2⁺				
		7132.3	100 5	0.0	3/2⁺				
7185.3	(9/2⁺)	1259[@] 1	100[@] 4	5925.8	7/2⁺	D+Q[@]			
		4482[@] 1	91[@] 9	2703.8	9/2⁺				
		5108[@] 1	91[@] 4	2076.2	7/2⁺	D+Q[@]			
7268.1	13/2⁺	1033[@] 1	14[@] 3	6235.4	(13/2⁺)				
		1153[@] 1	84[@] 3	6115.1	(11/2)⁺	M1+E2[@]		1.29×10^{-5} 23	
		1734[@] 1	35[@] 3	5534.2	11/2⁺	M1+E2[@]		1.68×10^{-4} 25	
		4564[@] 1	100[@] 3	2703.8	9/2⁺	E2[@]		1.36×10^{-3}	B(E2)(W.u.)=1.8 6
7280.3	5/2⁻,7/2⁻	3432.1	66 8	3847.9	5/2⁻	M1+E2[h]	−0.2[h] 1	8.29×10^{-4} 14	B(M1)(W.u.)=0.023 16; B(E2)(W.u.)=0.5 +7−4 E_γ: Note calculated value in (p,γ) is 3428.8.
		6839[@] 1	100 8	440.2	5/2⁺	E1(+M2)[h]	+0.07[h] 6		B(E1)(W.u.)=0.00017 12; B(M2)(W.u.)=0.08 +16−7 E_γ: Note calculated value in (p,γ) is 6836.0.
7393.4	(11/2⁺)	1859[@] 1	9.8[@] 16	5534.2	11/2⁺				

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
7393.4	(11/2$^+$)	4689[@] *1*	100.0[@] *16*	2703.8	9/2$^+$	(M1+E2)[@]		0.00132 *8*	
7412.4	5/2$^+$,7/2$^+$,9/2$^+$	3497.5	53 *13*	3914.6	5/2$^+$				
		5335.5	69 *11*	2076.2	7/2$^+$				
		6971.1	100 *11*	440.2	5/2$^+$				
7451.5	5/2$^+$,3/2$^+$	3603.3	8.3 *13*	3847.9	5/2$^-$				
		5060.0	3.3 *11*	2390.9	1/2$^+$				
		7010.2	100.0 *17*	440.2	5/2$^+$	M1+E2[h]	−0.8[h] *2*		B(M1)(W.u.)>0.0094; B(E2)(W.u.)>0.70
7477.4		7036[@] *1*	100	440.2	5/2$^+$				
7488.9	1/2$^-$,3/2$^-$	3811[@] *1*	100 *16*	3677.9	3/2$^-$				I_γ: Other: 96 *8* (^{12}C,pγ).
		4848[@] *1*	44 *11*	2640.5	1/2$^-$	D[@]			I_γ: Other: 13 *4* (^{12}C,pγ).
		5097[@] *1*	78 *13*	2390.9	1/2$^+$	D[@]			I_γ: Other: 100 *4* (^{12}C,pγ).
7563.9	(5/2)$^+$	5487[@] *1*		2076.2	7/2$^+$				
		7122.5	43 *21*	440.2	5/2$^+$				
		7562.6	100 *21*	0.0	3/2$^+$				
7687.0		2911[@] *1*	83[@] *17*	4775.2	7/2$^+$				
		4983[@] *1*	100[@] *17*	2703.8	9/2$^+$	D+Q[@]			
7724.4		4741.9	33 *7*	2982.0	3/2$^+$				
		7723.0	100 *7*	0.0	3/2$^+$				
7750.6	(5/2$^-$,3/2$^-$)	4768[@] *1*	100 *4*	2982.0	3/2$^+$				
		7309.2	100 *4*	440.2	5/2$^+$				
7835.7	7/2,(5/2$^+$)	3920[@] *1*	34 *10*	3914.6	5/2$^+$				
		5131[@] *1*	38 *12*	2703.8	9/2$^+$				
		7394.2	100 *16*	440.2	5/2$^+$	D(+Q)[h]	−0.07[h] *7*		
7872.6	3/2,(5/2$^+$)	4890[@] *1*	57 *14*	2982.0	3/2$^+$				I_γ: Other: 22 *11* (^{12}C,pγ).
		5481[@] *1*	37 *9*	2390.9	1/2$^+$				I_γ: Other: 100 *11* (^{12}C,pγ).
		7431.1	100 *14*	440.2	5/2$^+$	D+Q[h]	−0.8[h] *6*		
7876.2	5/2	4027.9	51 *9*	3847.9	5/2$^-$				
		4197.9	57 *11*	3677.9	3/2$^-$				
		7874.8	100 *6*	0.0	3/2$^+$				
7891.2	5/2$^+$	5814.2	10.3[a] *17*	2076.2	7/2$^+$				
		7449.7	43 *3*	440.2	5/2$^+$	M1[h]	[h]		B(M1)(W.u.)=0.113 *11* I_γ: Other: 62 *3* (γ,γ').
		7889.8	100 *3*	0.0	3/2$^+$	M1+E2[h]	−0.06[h] *4*		B(M1)(W.u.)=0.194 *15*
7964		5887	87 *16*	2076.2	7/2$^+$				
		7523	100 *18*	440.2	5/2$^+$				
7974.0		5897[@] *1*	100	2076.2	7/2$^+$				
7991.5	(11/2)	1756[@] *1*	16.7[@] *24*	6235.4	(13/2$^+$)	D+Q[@]			
		2457[@] *1*	40[@] *5*	5534.2	11/2$^+$				

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	Comments
7991.5	(11/2)	5287[@] 1	100.0[@] 24	2703.8	9/2$^+$	D+Q[@]	
8061	5/2$^+$,7/2,9/2$^+$	5357	100 40	2703.8	9/2$^+$		
		7619	100 40	440.2	5/2$^+$		
8301.6	5/2$^-$,7/2$^-$	7860[@] 1	100	440.2	5/2$^+$		
8319.5		1701[@] 1	10[@] 3	6618.3	(7/2,5/2)$^+$		
		5615[@] 1	100[@] 11	2703.8	9/2$^+$	Q[@]	
8360.0		5968.3	13[a] 3	2390.9	1/2$^+$		
		7918.3	28.2[a] 14	440.2	5/2$^+$		
		8358.4	100[a] 4	0.0	3/2$^+$		
8417.4	3/2$^+$	5434.7	41 14	2982.0	3/2$^+$		
		6025.7	100 14	2390.9	1/2$^+$		
		8415.8	41 14	0.0	3/2$^+$		
8432.6		5728[@] 1	100	2703.8	9/2$^+$		
8475.7	3/2$^+$,5/2$^+$	8034.0	100	440.2	5/2$^+$		
8631.0		8629.3	100	0.0	3/2$^+$		
8651.2	1/2$^+$	4736[@] 1		3914.6	5/2$^+$		
		8649.5		0.0	3/2$^+$		
8665.0	1/2$^+$	5678[&] 4	5[&] 2	2982.0	3/2$^+$		
		6024[&] 3	8[&] 4	2640.5	1/2$^-$	[E1]	B(E1)(W.u.)=0.0020 11
		6272[&] 4	6[&] 4	2390.9	1/2$^+$	[M1]	B(M1)(W.u.)=0.035 24
		8666[&] 3	100[&] 2	0.0	3/2$^+$		
8721		8719[k]	100	0.0	3/2$^+$		
8798.7		4950[@] 1	11[@] 3	3847.9	5/2$^-$		
		8357[@] 1	100[@] 7	440.2	5/2$^+$	D+Q[@]	
8820.8	(9/2$^-$)	984[@] 1	9[@] 3	7835.7	7/2,(5/2$^+$)		
		2780[@] 1	42[@] 3	6041.9	7/2$^-$		
		4047[@] 1	100[@] 6	4775.2	7/2$^+$	D+Q[@]	
		6114[@] 1	82[@] 6	2703.8	9/2$^+$		
8827.9	1/2$^+$	6436[@] 1	100[&] 16	2390.9	1/2$^+$	[M1]	B(M1)(W.u.)=0.25 10
		8826.1	56[&] 16	0.0	3/2$^+$		
8945.1	(3/2$^+$)	5030[@] 1	100 5	3914.6	5/2$^+$		
		6553[@] 1	30 5	2390.9	1/2$^+$	D+Q[@]	I_γ: Other: 65 10 (^{12}C,pγ).
8946.8	(7/2$^-$)	1821[@] 1	67[@] 4	7125.8	(9/2)	D[@]	
		2592[@] 1	21[@] 4	6354.2	9/2$^-$		
		6240[@] 1	100[@] 8	2703.8	9/2$^+$	D[@]	
		6872[@] 1	25[@] 4	2076.2	7/2$^+$		
8963.9		8522[@] 1	100	440.2	5/2$^+$		

$^{23}_{11}Na_{12}$-20

Adopted Levels, Gammas (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	Comments
8975.3	3/2+,5/2+	2357.1	8.0 *16*	6618.3	(7/2,5/2)+		
		4200.3	4.1 *5*	4775.2	7/2+		
		5060.5	4.6 *14*	3914.6	5/2+		
		5297.0	6.0 *9*	3677.9	3/2−		
		5992.4	8.7 *9*	2982.0	3/2+		E_γ: Other value: 5990 (^{12}C,pγ), yields a level energy of 8972.9 *11* in least-squares fit, if ΔE=1 keV.
		6898.2	100 *3*	2076.2	7/2+		
		8533.6	90.8 *16*	440.2	5/2+		
		8973.4	13 *3*	0.0	3/2+		
9039.5	(15/2)	1771[@] *1*	16[@] *6*	7268.1	13/2+		
		2804[@] *1*	100[@] *6*	6235.4	(13/2+)	D+Q[@]	
		3505[@] *1*	16[@] *3*	5534.2	11/2+		
9042.6	(7/2,9/2)+	2222	4.9 *4*	6820.2	5/2−		
		2687	3.3 *4*	6354.2	9/2−		
		3000	5.7 *4*	6041.9	7/2−		
		3115	7.9 *4*	5925.8	7/2+		
		5128	4.0 *9*	3914.6	5/2+		
		5194	29.3 *11*	3847.9	5/2−		
		6337	24.0 *11*	2703.8	9/2+		
		6965[@] *1*	41.2 *13*	2076.2	7/2+		I_γ: Other value: 100 *5* (^{12}C,pγ).
		8601[@] *1*	100.0 *20*	440.2	5/2+		I_γ: Other value: 20 *5* (^{12}C,pγ).
9101.5	(13/2+)	1110[@] *1*	40[@] *10*	7991.5	(11/2)	D+Q[@]	
		1708[@] *1*	90[@] *10*	7393.4	(11/2+)	D+Q[@]	
		2866[@] *1*	80[@] *10*	6235.4	(13/2+)		
		2986[@] *1*	90[@] *10*	6115.1	(11/2)+		
		6397[@] *1*	100[@] *20*	2703.8	9/2+	Q[@]	
9172.8		6468[@] *1*	100	2703.8	9/2+		
9210.4	(11/2+)	1523[j@] *1*	2.1[j@] *3*	7687.0			
		1817[@] *1*	2.55[@] *20*	7393.4	(11/2+)		
		1943[@] *1*	5.9[@] *20*	7268.1	13/2+		
		2025[@] *1*	100[@] *6*	7185.3	(9/2+)	D+Q[@]	
		2632[@] *1*	11.8[@] *20*	6578.0	(9/2+,5/2+)		
		3095[@] *1*	35[@] *4*	6115.1	(11/2)+		
		3284[@] *1*	13.7[@] *20*	5925.8	7/2+		
9211.0	3/2−	1338	2.0 *4*	7872.6	3/2,(5/2+)		
		1723	4.8 *5*	7488.9	1/2−,3/2−		
		2129	12.6 *9*	7081.9	3/2−		
		2290	5.6 *6*	6920.6	3/2−		
		2343	8.3 *8*	6867.7	5/2+,3/2+		

$^{23}_{11}Na_{12}$-21

Adopted Levels, Gammas (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[b]	E_f	J_f^π	Mult.[g]	δ	Comments
9211.0	3/2⁻	2903	10.3 *7*	6305.6	1/2⁺			
		3016	12.3 *9*	6194.6	5/2⁻			
		3247	76 *4*	5965.9	3/2⁻			
		3469	8.6 *7*	5741.0	5/2⁺			
		4781	13.9 *9*	4429.63	1/2⁺			
		5297	100 *5*	3914.6	5/2⁺	D[@]		E_γ: Other value: 5292 (^{12}C,pγ) (uncertainty of 1 keV is an estimate – might be higher) yields level energy of 9207.1 keV, however authors (2013Je04) attribution of 5292γ from 9211-keV level indicate that 9207 and 9211 keV levels are same. Mult.: From (^{12}C,pγ).
		5363	11.0 *8*	3847.9	5/2⁻			
		5533	5.5 *7*	3677.9	3/2⁻			
		6571	14.6 *10*	2640.5	1/2⁻			
		6820	6.5 *6*	2390.9	1/2⁺			
		7135[k]	5.7 *5*	2076.2	7/2⁺			E_γ: γ-ray branch to 2076.2-keV level reported in 2017Ke01 (p,γ), adopted spin-parity 7/2⁺ for 2076.2 keV level implies an (M2) transition. Placement should be considered with caution.
		8771	13.0 *9*	440.2	5/2⁺			
		9211	13.9 *10*	0.0	3/2⁺			
9212.9		6230[@] *1*	100	2982.0	3/2⁺			E_γ: Comparable γ-ray placed from 9211-keV level in (p,γ). See footnote for 9212.9-keV level.
9252.10	1/2⁺	2170	4.93 *22*	7081.9	3/2⁻			
		2331.4	5.81 *22*	6920.6	3/2⁻			
		3485.8	6.65 *22*	5766.03	3/2⁺			
		4821.9	4.04 *22*	4429.63	1/2⁺			
		5336.8	0.89 *22*	3914.6	5/2⁺			
		5573.5	11.6 *4*	3677.9	3/2⁻			
		6269.2	75.8 *12*	2982.0	3/2⁺			
		6611.0	19.8 *4*	2640.5	1/2⁻			
		6860.1	9.7 *3*	2390.9	1/2⁺			
		9250.1	100.0 *17*	0.0	3/2⁺			
9285.4	3/2⁺,5/2⁺	7208[@] *1*	100	2076.2	7/2⁺			
9292.7		2674[@] *1*	2.9[@] *7*	6618.3	(7/2,5/2)⁺			
		6588[@] *1*	100[@] *14*	2703.8	9/2⁺			
9325.8	(9/2⁺,13/2⁺)	6621[@] *1*	100	2703.8	9/2⁺			
9396.4	7/2⁻	978.9	0.83	8417.4	3/2⁺			
		1520.1	92	7876.2	5/2	D+Q[h]	+0.08[h] *7*	
		1645.8	11	7750.6	(5/2⁻,3/2⁻)			
		1830.1	13	7563.9	(5/2)⁺	D+Q[h]	+0.13[h] *7*	
		1944.8	8.3	7451.5	5/2⁺,3/2⁺			

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	Comments
9396.4	7/2⁻	1983.9	42	7412.4	5/2⁺,7/2⁺,9/2⁺	D+Q[h]	[h]	
		2116.1	83	7280.3	5/2⁻,7/2⁻	D(+Q)	−0.04 *6*	
		2211.7	17	7185.3	(9/2⁺)			
		2576.6	100	6820.2	5/2⁻	D+Q	+0.06 *2*	
		2818.4	37	6578.0	(9/2⁺,5/2⁺)			
		3041.7	17	6354.2	9/2⁻	D+Q	+0.24 *7*	
		3201.6	62	6194.6	5/2⁻	D+Q	−0.11 *2*	
		3353.9	81	6041.9	7/2⁻	D+Q	+0.03 *6*	
		3654.3	83	5741.0	5/2⁺	D(+Q)	+0.02 *2*	
		4621.3	5.8	4775.2	7/2⁺			
		5481.5	23	3914.6	5/2⁺			
		5547.6	100	3847.9	5/2⁻	D(+Q)	+0.02 *2*	
		6691.9	39	2703.8	9/2⁺			
		8954.5[@]	25	440.2	5/2⁺	D+Q[h]	+2.6[h] *7*	E_γ: Consideration of 8957 *1* from (^{12}C,pγ) in least squares fit yields level energy of 9399.1 *11*, significantly different than literature values. Evaluators adopted level energy from (p,γ).
9401.0		5486[@] *1*	50[@] *25*	3914.6	5/2⁺			
		5722[@] *1*	100[@] *25*	3677.9	3/2⁻			
		6418[@] *1*	18[@] *5*	2982.0	3/2⁺			
9404.8	1/2	1680.3	0.58 *4*	7724.4				
		3638.5	0.54 *4*	5766.03	3/2⁺			
		4974.6	4.47 *13*	4429.63	1/2⁺			
		5726.1	10.0 *3*	3677.9	3/2⁻			
		6421.8	10.3 *5*	2982.0	3/2⁺			
		6763.2	3.82 *13*	2640.5	1/2⁻			
		8962.7	1.97 *13*	440.2	5/2⁺			
		9402.7	100.0 *9*	0.0	3/2⁺			
9426.1	3/2⁻	1937.1		7488.9	1/2⁻,3/2⁻	D+Q[h]	+0.098[h] *9*	
		2344.1		7081.9	3/2⁻	D(+Q)[h]	+0.11[h] *15*	
		2605.7		6820.2	5/2⁻	D+Q[h]	+0.18[h] *4*	δ: or <−8.
		2690.4		6735.5	3/2⁺	D(+Q)[h]	+0.04[h] *5*	
		3120.3		6305.6	1/2⁺	D(+Q)[h]	−0.01[h] *3*	δ: or −1.7 *2*.
		3459.9		5965.9	3/2⁻	D(+Q)[h]	+0.01[h] *5*	
		3659.8		5766.03	3/2⁺	D+Q[h]	−0.18[h] *6*	
		4995.9		4429.63	1/2⁺	D(+Q)[h]	+0.005[h] *10*	
		5510.8		3914.6	5/2⁺	D+Q[h]	−0.07[h] *2*	
		5577.5		3847.9	5/2⁻	D+Q[h]	−0.28[h] *2*	
		6784.5		2640.5	1/2⁻	D+Q[h]	+0.25[h] *4*	
		7034.0		2390.9	1/2⁺	D+Q[h]	+0.022[h] *4*	

$^{23}_{11}Na_{12}$-23

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E$_i$(level)	J$^\pi_i$	E$_\gamma$[†]	I$_\gamma$[b]	E$_f$	J$^\pi_f$	Mult.[g]	δ	α[i]	Comments
9426.1	3/2$^-$	8984.0		440.2	5/2$^+$	D+Q[h]	+0.40[h] *5*		δ: or +6 *2*.
		9424.0		0.0	3/2$^+$	D+Q[h]	+0.35[h] *3*		δ: or +1.5 *2*.
9487.7	3/2	3181.9	4.4	6305.6	1/2$^+$				
		3292.9	1.4	6194.6	5/2$^-$				
		3521.5	3.1	5965.9	3/2$^-$				
		3721.3	5.6	5766.03	3/2$^+$				
		4108.7	3.3	5378.56	5/2$^+$				
		5057.5	5.8	4429.63	1/2$^+$				
		5572.4	9.2	3914.6	5/2$^+$				
		5809.0	2.5	3677.9	3/2$^-$				
		6504.7	6.9	2982.0	3/2$^+$				
		6846.1	50	2640.5	1/2$^-$				
		7095.6	2.2	2390.9	1/2$^+$				
		9045.6	100	440.2	5/2$^+$	D+Q[h]	−1.2[h] *+2−8*		
		9485.6	83	0.0	3/2$^+$	D+Q[h]	+0.36[h] *10*		δ: or +1.7 *5*.
9541.5	(13/2$^+$)	4007[@] *1*	100	5534.2	11/2$^+$	D+Q[@]			
9608.2	3/2$^+$	1735.5	0.7	7872.6	3/2,(5/2$^+$)				
		1883.7	1.2	7724.4					
		2119.2	1.4	7488.9	1/2$^-$,3/2$^-$				
		2214.7	0.2	7393.4	(11/2$^+$)				
		2537.2	1.6	7070.8					
		2660.6	2.8	6947.4	(3/2$^+$)				
		2787.8	0.9	6820.2	5/2$^-$				
		2872.5	0.5	6735.5	3/2$^+$				
		3302.4	0.5	6305.6	1/2$^+$				
		3642.0	0.2	5965.9	3/2$^-$				
		3841.8	1.4	5766.03	3/2$^+$				
		3866.8	5.1	5741.0	5/2$^+$	D+Q[h]	−0.38[h] *14*		
		4229.2	2.1	5378.56	5/2$^+$				
		5177.9	1.2	4429.63	1/2$^+$				
		5692.8	42	3914.6	5/2$^+$	D+Q[h]	+0.13[h] *4*		
		5759.5	4.2	3847.9	5/2$^-$				
		6625.2	4.2	2982.0	3/2$^+$				
		6966.6	4.2	2640.5	1/2$^-$				
		7216.1	1.9	2390.9	1/2$^+$	D+Q[h]	+0.20[h] *2*		
		9166.0	100	440.2	5/2$^+$	D+Q[h]	+0.32[h] *4*		
		9606.1	56	0.0	3/2$^+$	D+Q[h]	+0.40[h] *10*		
9626	1/2$^+$	9624	100	0.0	3/2$^+$				
9628.3	11/2$^-$	3274[@] *1*	100[@] *9*	6354.2	9/2$^-$	(M1+E2)[@]		0.00083 *7*	
		3586[@] *1*	71[@] *6*	6041.9	7/2$^-$	(E2)[@]		1.03×10^{-3}	B(E2)(W.u.)=36 *19*

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	Comments
9652.2	(3/2+,5/2+)	2784.3	3.3	6867.7	5/2+,3/2+			
		4876.4	41	4775.2	7/2+			
		5736.8	2.2	3914.6	5/2+			
		5803.5	1.5	3847.9	5/2−			
		5973.5	6.5	3677.9	3/2−			
		7260.1	1.7	2390.9	1/2+			
		7574.7	2.2	2076.2	7/2+			
		9210.0	100	440.2	5/2+			
		9650.0	59	0.0	3/2+			
9655.6	(1/2+)	4879.8[k]	11	4775.2	7/2+			E_γ: Placement from 1973Me11 (p,γ), consider with caution − ΔJ=3, if J^π=(1/2+).
		5225.3	2.7	4429.63	1/2+			
		5740.2	1.4	3914.6	5/2+			
		5976.9	64	3677.9	3/2−			
		6672.6	1.8	2982.0	3/2+			
		7014.0	8.6	2640.5	1/2−			
		7263.5	1.4	2390.9	1/2+			
		9213.4	36	440.2	5/2+			
		9653.4	100	0.0	3/2+			
9674.1	3/2+,5/2+	1782.8	3.6	7891.2	5/2+			
		2806.2	28	6867.7	5/2+,3/2+			
		3479.2	6.1	6194.6	5/2−			
		3907.7	9.7	5766.03	3/2+			
		5758.7	21	3914.6	5/2+			
		5825.4	3.9	3847.9	5/2−			
		5995.4	9.7	3677.9	3/2−			
		6691.0	21	2982.0	3/2+			
		7282.0	3.0	2390.9	1/2+			
		7596.6	58	2076.2	7/2+			
		9231.9	100	440.2	5/2+	D+Q[h]	−0.11[h] *7*	δ: or −2.1 *12*.
		9671.9	39	0.0	3/2+	D+Q[h]	−3.7[h] *5*	
9682.7	(3/2+)	1381.0	1.8	8301.6	5/2−,7/2−			
		2118.7	21	7563.9	(5/2)+			
		2231.1	16	7451.5	5/2+,3/2+			
		2600.6	8.9	7081.9	3/2−			
		4906.9	13	4775.2	7/2+			
		5767.3	11	3914.6	5/2+			
		5834.0	89	3847.9	5/2−			
		6003.9	30	3677.9	3/2−			
		6699.6	54	2982.0	3/2+			
		7605.2	5.0	2076.2	7/2+			
		9240.5	8.6	440.2	5/2+	D(+Q)[h]	−1.2[h] *+15−11*	

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[b]	E_f	J_f^π	Mult.[g]	δ	Comments
9682.7	(3/2$^+$)	9680.5	100	0.0	3/2$^+$	D+Q[h]	−0.36[h] *10*	δ: or −5.7 *+57−20*.
9700.9	3/2$^+$	1809.6	0.6	7891.2	5/2$^+$			
		1950.2	0.6	7750.6	(5/2$^-$,3/2$^-$)			
		1976.4	0.4	7724.4				
		2965.2	0.8	6735.5	3/2$^+$			
		3959.5	4.0	5741.0	5/2$^+$			
		5270.6	0.6	4429.63	1/2$^+$			
		5785.5	4.2	3914.6	5/2$^+$	D+Q[h]	+0.16[h] *11*	
		6022.2	5.2	3677.9	3/2$^-$	D+Q[h]	+0.35[h] *9*	
		6717.8	8.1	2982.0	3/2$^+$			
		7059.2	17	2640.5	1/2$^-$	D+Q[h]	−0.58[h] *7*	
		7308.8	1.5	2390.9	1/2$^+$			
		7623.3	3.1	2076.2	7/2$^+$			
		9258.7	62	440.2	5/2$^+$	D+Q[h]	−0.18[h] *6*	
		9698.7	100	0.0	3/2$^+$	D+Q[h]	+0.14[h] *4*	
9732.53	7/2	1256.8	7.0	8475.7	3/2$^+$,5/2$^+$			
		1430.9	4.5	8301.6	5/2$^-$,7/2$^-$			
		1671.5	3.0	8061	5/2$^+$,7/2,9/2$^+$			
		1856.3	6.0	7876.2	5/2			
		1896.8	3.0	7835.7	7/2,(5/2$^+$)			
		1981.8	5.0	7750.6	(5/2$^-$,3/2$^-$)	D(+Q)[h]	+0.02[h] *4*	
		2320.0	1.0	7412.4	5/2$^+$,7/2$^+$,9/2$^+$			
		2452.1	3.0	7280.3	5/2$^-$,7/2$^-$			
		2912.1	6.0	6820.2	5/2$^-$	D+Q[h]	−0.11[h] *4*	
		3154.3	14	6578.0	(9/2$^+$,5/2$^+$)	D(+Q)[h]	−0.01[h] *3*	
		3537.6	7.5	6194.6	5/2$^-$	D+Q[h]	−3.4[h] *7*	
		3690.3	70	6041.9	7/2$^-$	D+Q[h]	+0.05[h] *4*	
		3991.2	18	5741.0	5/2$^+$	D(+Q)[h]	0.00[h] *3*	
		4353.5	20	5378.56	5/2$^+$	D(+Q)[h]	+0.02[h] *3*	
		5817.5	21	3914.6	5/2$^+$	D+Q[h]	−0.12[h] *5*	
		5883.8	95	3847.9	5/2$^-$	D+Q[h]	−0.05[h] *2*	
		7027.6	85	2703.8	9/2$^+$	D(+Q)[h]	−0.02[h] *2*	
		7655.0	34	2076.2	7/2$^+$	D+Q[h]	+0.118[h] *5*	
		9290.3	100	440.2	5/2$^+$	D+Q[h]	+0.033[h] *7*	
9755.5	3/2$^+$	5325.2	1.0	4429.63	1/2$^+$			
		5840.1	7.1	3914.6	5/2$^+$			
		5906.8	14	3847.9	5/2$^-$			
		6076.7	17	3677.9	3/2$^-$			
		7113.8	100	2640.5	1/2$^-$			

$^{23}_{11}Na_{12}$-26

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
9755.5	3/2$^+$	7363.3	1.4	2390.9	1/2$^+$				
		9313.3	13	440.2	5/2$^+$				
		9753.3	16	0.0	3/2$^+$				
9802.9	(15/2$^+$)	2535[@] *1*	71[@] *5*	7268.1	13/2$^+$	(M1+E2)[@]		0.00052 *6*	
		3568[@] *1*	100[@] *5*	6235.4	(13/2$^+$)	(M1+E2)[@]		0.00095 *8*	
		4269[@] *1*	29[@] *5*	5534.2	11/2$^+$	E2[@]		1.27×10^{-3}	B(E2)(W.u.)=3.5 *14*
9815.7	5/2$^+$	1514.0	0.3	8301.6	5/2$^-$,7/2$^-$				
		1851.6	4.7	7964					
		1924.4	0.9	7891.2	5/2$^+$				
		1943.0	1.6	7872.6	3/2,(5/2$^+$)				
		2403.2	2.2	7412.4	5/2$^+$,7/2$^+$,9/2$^+$				
		2682.0	2.8	7133.5	3/2$^+$,5/2$^+$				
		2744.7	9.4	7070.8					
		2868.1	11	6947.4	(3/2$^+$)				
		3080.0	2.2	6735.5	3/2$^+$				
		3197.2	1.6	6618.3	(7/2,5/2)$^+$				
		3889.6	1.6	5925.8	7/2$^+$				
		4049.3	24	5766.03	3/2$^+$	D+Q	−0.039 *13*		δ: From (p,γ).
		4074.3	5.0	5741.0	5/2$^+$				
		5039.9	4.4	4775.2	7/2$^+$				
		5385.4	7.5	4429.63	1/2$^+$				
		5900.3	15	3914.6	5/2$^+$				
		5967.0	0.6	3847.9	5/2$^-$				
		6832.6	100	2982.0	3/2$^+$				
		7110.7	21	2703.8	9/2$^+$				
		7423.5	1.9	2390.9	1/2$^+$				
		7738.1	50	2076.2	7/2$^+$				
		9373.5	23	440.2	5/2$^+$				
		9813.5	20	0.0	3/2$^+$				
9835.4	3/2$^+$	1944.1	3.8	7891.2	5/2$^+$				
		2701.7	5.0	7133.5	3/2$^+$,5/2$^+$				
		2764.4	0.8	7070.8					
		3099.7	3.5	6735.5	3/2$^+$				
		3640.5	11	6194.6	5/2$^-$				
		4094.0	4.0	5741.0	5/2$^+$				
		4456.4	5.5	5378.56	5/2$^+$				
		5405.1	12	4429.63	1/2$^+$				
		5920.0	30	3914.6	5/2$^+$				
		5986.7	8.5	3847.9	5/2$^-$				
		6156.6	0.5	3677.9	3/2$^-$				
		6852.3	0.5	2982.0	3/2$^+$				
		7443.2	30	2390.9	1/2$^+$				
		9393.1	35	440.2	5/2$^+$				

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]
9835.4	3/2+	9833.1	100	0.0	3/2+			
9850.1	1/2+	5419.8	11	4429.63	1/2+			
		6171.3	33	3677.9	3/2−			
		6867.0	6.7	2982.0	3/2+			
		7208.4	97	2640.5	1/2−			
		7457.9	100	2390.9	1/2+			
		9407.8	0.9	440.2	5/2+			
		9847.8	55	0.0	3/2+			
9875.6		3833[@] *1*	100[@] *2*	6041.9	7/2−			
		7171[@] *1*	100[@] *2*	2703.8	9/2+			
9890.9	3/2	4124.5	8.7	5766.03	3/2+			
		4511.9	8.7	5378.56	5/2+			
		5975.5	42	3914.6	5/2+			
		6042.2	24	3847.9	5/2−			
		6212.1	33	3677.9	3/2−			
		7249.2	92	2640.5	1/2−			
		7498.7	34	2390.9	1/2+			
		9448.6	75	440.2	5/2+			
		9888.6	100	0.0	3/2+			
9917.5	(3/2+,5/2,7/2+)	3049.6	13	6867.7	5/2+,3/2+			
		5141.7	18	4775.2	7/2+			
		6002[@] *1*	100	3914.6	5/2+			
		6068.7	55	3847.9	5/2−			
		9475.2	55	440.2	5/2+			
		9915.2	10	0.0	3/2+			
9924.3	(3/2,7/2)	9482[@] *1*	100	440.2	5/2+			
9964.6	(9/2,13/2)	4430[@] *1*	100	5534.2	11/2+	D+Q[@]		
9988.2	11/2−	3946[@] *1*	100	6041.9	7/2−	Q[@]		
10003.2	1/2−	4036.9	5.5	5965.9	3/2−			
		4236.8	23	5766.03	3/2+			
		5572.8	6.4	4429.63	1/2+			
		6324.4	7.4	3677.9	3/2−			
		7020.0	4.0	2982.0	3/2+			
		7361.4	100	2640.5	1/2−			
		7611.0	26	2390.9	1/2+			
		10000.9	40	0.0	3/2+			
10017.4	5/2+	1386.4	0.3	8631.0				
		1599.9	0.9	8417.4	3/2+	M1+E2[h]	+0.37[h] *4*	1.03×10^{-4} *2*
		2141.1	0.9	7876.2	5/2	D+Q[h]	−0.09[h] *7*	
		2565.7	1.8	7451.5	5/2+,3/2+	M1+E2[h]	−0.49[h] *3*	5.03×10^{-4} *8*
		2740.1	0.9	7280.3	5/2−,7/2−			

$^{23}_{11}Na_{12}$-28

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
10017.4	5/2+	2883.7	0.6	7133.5	3/2+,5/2+				
		3096.6	0.9	6920.6	3/2−				
		3281.6	0.6	6735.5	3/2+				
		3398.8	11	6618.3	(7/2,5/2)+	M1(+E2)[h]	0.00[h] *1*	8.11×10^{-4}	
		3975.1	0.3	6041.9	7/2−				
		4250.9	0.9	5766.03	3/2+	M1+E2[h]	−0.15[h] *4*	1.10×10^{-3}	
		4276.0	1.2	5741.0	5/2+				
		4638.3	2.1	5378.56	5/2+	M1+E2[h]	−0.05[h] *4*	1.22×10^{-3}	δ: or +1.3 *2*.
		5241.6	0.9	4775.2	7/2+				
		6101.9	56	3914.6	5/2+	M1+E2[h]	+0.05[h] *2*		
		6168.6	15	3847.9	5/2−	E1(+M2)[h]	0.00[h] *2*		
		6338.6	35	3677.9	3/2−	E1+M2[h]	−0.020[h] *6*		
		7034.2	100	2982.0	3/2+	M1+E2[h]	−0.032[h] *5*		
		7312.4	0.3	2703.8	9/2+				
		7625.1	1.2	2390.9	1/2+				
		7939.7	15	2076.2	7/2+	M1+E2[h]	−0.276[h] *14*		
		9575.1	44	440.2	5/2+	M1+E2[h]	−0.207[h] *13*		
		10015.1	4.7	0.0	3/2+	M1+E2[h]	−0.126[h] *11*		
10033.8		1087[@] *1*	20[@] *10*	8946.8	(7/2−)				
		5258[@] *1*	100[@] *20*	4775.2	7/2+				
10036.4		9594[@] *1*	100	440.2	5/2+				
10049.1		6200.3	73	3847.9	5/2−				
		7971.4	55	2076.2	7/2+				
		9606.7	100	440.2	5/2+				
10070.9	(5/2,7/2)	7993.2	100	2076.2	7/2+				
		9628.5	64	440.2	5/2+				
		10068.5	14	0.0	3/2+				
10075.9	3/2,5/2	3255.5	13	6820.2	5/2−				
		4033.6	23	6041.9	7/2−				
		4109.6	6.4	5965.9	3/2−				
		4334.5	10	5741.0	5/2+				
		5300.0	82	4775.2	7/2+				
		6227.1	73	3847.9	5/2−				
		6397.0	18	3677.9	3/2−				
		7092.7	68	2982.0	3/2+				
		7434.1	4.1	2640.5	1/2−				
		7998.2	100	2076.2	7/2+				
		9633.5	30	440.2	5/2+				
		10073.5	26	0.0	3/2+				
10085.3	1/2+	3137.7	15	6947.4	(3/2+)				

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
10085.3	1/2$^+$	3164.5	26	6920.6	3/2$^-$				
		3349.5	18	6735.5	3/2$^+$				
		3779.4	100	6305.6	1/2$^+$				
		4318.8	85	5766.03	3/2$^+$				
		5654.9	12	4429.63	1/2$^+$				
		6406.4	24	3677.9	3/2$^-$				
		7102.1	5.8	2982.0	3/2$^+$				
		7693.0	18	2390.9	1/2$^+$				
		9642.9	27	440.2	5/2$^+$				
		10082.9	54	0.0	3/2$^+$				
10114.8	1/2$^+$	4148.5	5.6	5965.9	3/2$^-$				
		4348.3	9.7	5766.03	3/2$^+$				
		7131.6	100	2982.0	3/2$^+$				
		7722.5	2.1	2390.9	1/2$^+$				
		10112.4	12	0.0	3/2$^+$				
10125.9	5/2	4083.6	11	6041.9	7/2$^-$				
		4159.6	7.9	5965.9	3/2$^-$				
		4384.5	33	5741.0	5/2$^+$				
		4746.8	11	5378.56	5/2$^+$				
		6210.4	15	3914.6	5/2$^+$				
		6277.1	20	3847.9	5/2$^-$				
		6447.0	88	3677.9	3/2$^-$				
		7142.7	10	2982.0	3/2$^+$				
		8048.2	100	2076.2	7/2$^+$				
		9683.5	71	440.2	5/2$^+$				
		10123.5	50	0.0	3/2$^+$				
10156.4		9714[@] *1*	100	440.2	5/2$^+$				
10169.6	5/2$^+$	1693.8	1.3	8475.7	3/2$^+$,5/2$^+$				
		2108.5	2.2	8061	5/2$^+$,7/2,9/2$^+$				
		2296.9	5.6	7872.6	3/2,(5/2$^+$)	D+Q[h]	+0.09[h] *3*		
		2333.8	3.8	7835.7	7/2,(5/2$^+$)	D(+Q)[h]	0.00[h] *3*		
		2889.1	1.8	7280.3	5/2$^-$,7/2$^-$				
		3301.6	15	6867.7	5/2$^+$,3/2$^+$				
		3433.8	1.1	6735.5	3/2$^+$				
		3974.6	2.0	6194.6	5/2$^-$	E1[h]		1.67×10^{-3}	
		4127.3	2.4	6041.9	7/2$^-$	E1[h]		1.73×10^{-3}	
		4243.4	4.2	5925.8	7/2$^+$	M1+E2[h]	+0.18[h] *4*	1.10×10^{-3}	δ: or >−4.
		4428.1	5.8	5741.0	5/2$^+$	M1+E2[h]	−0.41[h] *8*	1.18×10^{-3} *2*	δ: or +2.7 *7*.
		4790.5	15	5378.56	5/2$^+$				
		5393.7	24	4775.2	7/2$^+$	M1+E2[h]	+0.30[h] *2*	1.44×10^{-3}	
		6254.1	1.3	3914.6	5/2$^+$				

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]
10169.6	5/2$^+$	6320.8	1.8	3847.9	5/2$^-$			
		7186.4	100	2982.0	3/2$^+$	M1+E2[h]	+0.14[h] *2*	
		7464.5	4.4	2703.8	9/2$^+$	E2(+M3)[h]	+0.03[h] *5*	
		8091.9	3.3	2076.2	7/2$^+$	M1+E2[h]	+0.11[h] *3*	
		9727.2	18	440.2	5/2$^+$	M1+E2[h]	+1.33[h] *9*	
		10167.2	8.9	0.0	3/2$^+$	M1+E2[h]	−3.4[h] *19*	
10212.9		1266[@] *1*	100	8946.8	(7/2$^-$)			
10231.7	5/2$^+$	1755.9	0.7	8475.7	3/2$^+$,5/2$^+$			
		1814.2	2.9	8417.4	3/2$^+$			
		1930.0	0.7	8301.6	5/2$^-$,7/2$^-$			
		2667.6	1.3	7563.9	(5/2)$^+$			
		2819.1	1.1	7412.4	5/2$^+$,7/2$^+$,9/2$^+$			
		3098.0	4.7	7133.5	3/2$^+$,5/2$^+$			
		3284.0	2.0	6947.4	(3/2$^+$)			
		3363.7	2.7	6867.7	5/2$^+$,3/2$^+$	M1+E2[h]	+0.12[h] *10*	8.00×10^{-4}
		3613.1	8.2	6618.3	(7/2,5/2)$^+$	M1+E2[h]	−0.03[h] *2*	8.89×10^{-4}
		4189.4	8.2	6041.9	7/2$^-$	E1[h]		1.76×10^{-3}
		4305.5	40	5925.8	7/2$^+$	M1+E2[h]	+0.04[h] *2*	1.12×10^{-3}
		4465.2	1.3	5766.03	3/2$^+$			
		4490.2	0.7	5741.0	5/2$^+$			
		6316.2	24	3914.6	5/2$^+$			
		6382.9	0.7	3847.9	5/2$^-$			
		6552.8	10	3677.9	3/2$^-$	E1[h]		
		7839.4	8.0	2390.9	1/2$^+$	E2[h]		
		9789.3	100	440.2	5/2$^+$	M1+E2[h]	+0.30[h] *3*	
		10229.3	4.7	0.0	3/2$^+$	M1+E2[h]	+0.03[h] *2*	
10237.8		8160[@] *1*	100	2076.2	7/2$^+$			
10243.7	1/2$^+$	2519.1	14	7724.4				
		4477.2	12	5766.03	3/2$^+$			
		5813.3	4	4429.63	1/2$^+$			
		6564.8	100	3677.9	3/2$^-$			
		7260.5	10	2982.0	3/2$^+$			
		7601.9	12	2640.5	1/2$^-$			
		7851.4	38	2390.9	1/2$^+$			
		9801.3	10	440.2	5/2$^+$			
10281.5	3/2$^+$	3147.8 *12*	3.1	7133.5	3/2$^+$,5/2$^+$			
		4315.2 *9*	6.2	5965.9	3/2$^-$			
		4515.0 *6*	16	5766.03	3/2$^+$			
		4902.4 *6*	3.1	5378.56	5/2$^+$			
		5505.6 *6*	3.3	4775.2	7/2$^+$			

Adopted Levels, Gammas (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[b]	E_f	J_f^π	Mult.[g]	δ	Comments
10281.5	3/2+	6366.0 *6*	100	3914.6	5/2+			
		7298.3 *6*	11	2982.0	3/2+			
		7639.6 *6*	14	2640.5	1/2−			
		7889.2 *6*	36	2390.9	1/2+			
		9839.0 *6*	38	440.2	5/2+			
		10279.0 *6*	25	0.0	3/2+			
10318.0	3/2−	5887.6	41	4429.63	1/2+	D[h]		
		6469.1	13	3847.9	5/2−			
		6639.1	8.2	3677.9	3/2−			
		7334.7	25	2982.0	3/2+	D+Q[h]	+1.3[h] *7*	
		7676.1	59	2640.5	1/2−	D+Q[h]	−0.58[h] *27*	
		7925.6	3.5	2390.9	1/2+			
		9875.5	100	440.2	5/2+	D+Q[h]	+0.12[h] *6*	
		10315.5	44	0.0	3/2+			
10333.8		8256[@] *1*	100	2076.2	7/2+			
10338.7	(1/2−)	3417.8	9.1	6920.6	3/2−			
		3518.2	2.7	6820.2	5/2−			
		4032.7	11	6305.6	1/2+			
		4372.4	4.2	5965.9	3/2−			
		6659.8	15	3677.9	3/2−			
		7355.4	88	2982.0	3/2+			
		7696.8	18	2640.5	1/2−			
		7946.3	45	2390.9	1/2+			
		9896.2[k]	10	440.2	5/2+			E_γ: Placement from (p,γ) should be considered with caution. If J^π=1/2−, would be an [M2] transition to 5/2+.
		10336.2	100	0.0	3/2+			
10346.1	5/2+	4303.8	4.1	6041.9	7/2−			
		4579.6	12	5766.03	3/2+			
		4604.6	8.3	5741.0	5/2+			
		4967.0	5.5	5378.56	5/2+			
		5570.2	6.6	4775.2	7/2+			
		6430.5	27	3914.6	5/2+	D+Q[h]	−0.10[h] *7*	
		6497.2	2.4	3847.9	5/2−			
		6667.2	5.2	3677.9	3/2−			
		7362.8	13	2982.0	3/2+	D(+Q)[h]	−0.09[h] *10*	
		7953.7	12	2390.9	1/2+			
		8268.3	52	2076.2	7/2+	D+Q[h]	−0.06[h] *2*	
		9903.6	97	440.2	5/2+	D+Q[h]	+0.21[h] *8*	
		10343.6	100	0.0	3/2+	D+Q[h]	−0.27[h] *5*	
10353.8	3/2+	2462.5	5.0	7891.2	5/2+			
		3618.0	1.5	6735.5	3/2+			

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ†	I_γ b	E_f	J^π_f	Mult.g	δ
10353.8	3/2+	4587.3	9.4	5766.03	3/2+		
		4612.3	5.9	5741.0	5/2+		
		4974.7	10	5378.56	5/2+		
		5923.4	4.1	4429.63	1/2+		
		6438.2	2.6	3914.6	5/2+		
		6504.9	88	3847.9	5/2−		
		6674.9	24	3677.9	3/2−		
		7370.5	12	2982.0	3/2+		
		7711.9	100	2640.5	1/2−		
		7961.4	8.2	2390.9	1/2+		
		8276.0	7.6	2076.2	7/2+		
		9911.3	11	440.2	5/2+		
		10351.3	4.4	0.0	3/2+		
10354.0	13/2−	2362@ *1*	7.8@ *20*	7991.5	(11/2)		
		2960@ *1*	2.2@ *6*	7393.4	(11/2+)		
		3999@ *1*	100@ *4*	6354.2	9/2−	Q@	
		4820@ *1*	12@ *2*	5534.2	11/2+	D@	
10404.8	(11/2−)	4169@ *1*	100	6235.4	(13/2+)	(D)@	
10408.8		8331@ *1*	100	2076.2	7/2+		
10438.5	5/2+	2021.0	9.2	8417.4	3/2+		
		3025.9	5.8	7412.4	5/2+,7/2+,9/2+		
		3819.9	9.4	6618.3	(7/2,5/2)+		
		5059.3	3.3	5378.56	5/2+		
		6522.9	25	3914.6	5/2+	D+Qh	+0.50h *10*
		6759.5	1.4	3677.9	3/2−		
		7455.2	100	2982.0	3/2+		
		8360.7	26	2076.2	7/2+	D+Qh	+0.09h *3*
		9996@ *1*	56	440.2	5/2+	D+Qh	−0.22h *10*
		10436.0	42	0.0	3/2+	D+Qh	+0.24h *8*
10448.7		1972.9	17	8475.7	3/2+,5/2+		
		2557.3	7.9	7891.2	5/2+		
		4406.4	16	6041.9	7/2−		
		6533.1	48	3914.6	5/2+		
		6599.8	100	3847.9	5/2−		
		7743.5	48	2703.8	9/2+		
		8370.9	55	2076.2	7/2+		
		10006.2	7.9	440.2	5/2+		
		10446.2	2.4	0.0	3/2+		
10478.8	3/2+	2754.2	7.4	7724.4			
		3658.2	4.2	6820.2	5/2−		
		4712.3	10	5766.03	3/2+		

Adopted Levels, Gammas (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]
10478.8	3/2+	4737.3	45	5741.0	5/2+			
		5099.6	100	5378.56	5/2+			
		6563.2	35	3914.6	5/2+			
		6629.9	7.7	3847.9	5/2−			
		7836.9	4.5	2640.5	1/2−			
		8086.4	10	2390.9	1/2+			
		10036.3	11	440.2	5/2+			
		10476.2	87	0.0	3/2+			
10501.9	3/2−	4760.4	1.3	5741.0	5/2+			
		6071.4	1.9	4429.63	1/2+			
		6653.0	13	3847.9	5/2−			
		6822.9	9.1	3677.9	3/2−			
		7518.6	3.8	2982.0	3/2+			
		7860.0	3.2	2640.5	1/2−			
		8109.5	9.1	2390.9	1/2+			
		10059.4	47	440.2	5/2+			
		10499.3	100	0.0	3/2+			
10507.8	1/2+	3425.6	20	7081.9	3/2−			
		3586.9	14	6920.6	3/2−			
		4201.8	6.2	6305.6	1/2+			
		4541.4	9.7	5965.9	3/2−			
		4741.2	11	5766.03	3/2+			
		6077.3	31	4429.63	1/2+			
		6828.8	30	3677.9	3/2−			
		7524.5	38	2982.0	3/2+			
		7865.9	100	2640.5	1/2−			
		8115.4	34	2390.9	1/2+			
		10065.2	11	440.2	5/2+			
		10505.2	38	0.0	3/2+			
10519.1	5/2+	1888.0	1.75	8631.0				
		2101.6	4.25	8417.4	3/2+	M1[h]		2.88×10^{-4}
		2159.0	0.5	8360.0				
		2627.7	9.5	7891.2	5/2+	M1[h]		5.07×10^{-4}
		2683.2	1.75	7835.7	7/2,(5/2+)	D[h]		
		2955.0	0.75	7563.9	(5/2)+			
		3067.4	2	7451.5	5/2+,3/2+	M1+E2[h]	−0.52[h] *7*	7.13×10^{-4} *12*
		3106.5	0.75	7412.4	5/2+,7/2+,9/2+			
		3385.3	5.75	7133.5	3/2+,5/2+			
		3571.4	1.75	6947.4	(3/2+)	M1+E2[h]	−0.06[h] *3*	8.75×10^{-4}
		3598.2	1.75	6920.6	3/2−			
		3651.1	4.75	6867.7	5/2+,3/2+	M1[h]		9.03×10^{-4}
		3698.6	1.25	6820.2	5/2−	(E1)[h]		1.56×10^{-3}

$\gamma(^{23}Na)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[b]	E_f	J_f^π	Mult.[g]	δ	α[i]	Comments
10519.1	5/2$^+$	3783.3	1.25	6735.5	3/2$^+$				
		3900.4	4.5	6618.3	(7/2,5/2)$^+$	M1+E2[h]	+0.06[h] *4*	9.90×10^{-4}	
		4213.1	0.5	6305.6	1/2$^+$				
		4552.7	1	5965.9	3/2$^-$				
		4752.5	6.5	5766.03	3/2$^+$	M1+E2[h]	+0.17[h] *2*	1.26×10^{-3}	
		4777.6	3.8	5741.0	5/2$^+$	(M1)[h]		1.27×10^{-3}	
		5139.9	1.5	5378.56	5/2$^+$				
		6088.6	1	4429.63	1/2$^+$				
		6840.1	5.25	3677.9	3/2$^-$	(E1)[h]			
		7535.8	8.75	2982.0	3/2$^+$	(M1)[h]			
		7813.9	2	2703.8	9/2$^+$				
		8126.7	6	2390.9	1/2$^+$	(E2)[h]			
		8441.2	10.5	2076.2	7/2$^+$	M1+E2[h]	+0.43[h] *2*		δ: or +3.0 *2*.
		10076.5	62.5	440.2	5/2$^+$	M1+E2[h]	−0.19[h] *3*		
		10516.5	100	0.0	3/2$^+$	M1+E2[h]	−0.13[h] *2*		
10534.1		3613.2	15	6920.6	3/2$^-$				
		5758.1	11	4775.2	7/2$^+$				
		6855.1	15	3677.9	3/2$^-$				
		7550.8	3.3	2982.0	3/2$^+$				
		8141.7	9.5	2390.9	1/2$^+$				
		8456.2	7.1	2076.2	7/2$^+$				
		10091.5	20	440.2	5/2$^+$				
		10531.5	100	0.0	3/2$^+$				
10549.2	5/2$^+$	2657.8	6.0	7891.2	5/2$^+$				
		2824.6	6.5	7724.4					
		4582.8	14	5965.9	3/2$^-$				
		4807.7	7.0	5741.0	5/2$^+$				
		5170.0	16	5378.56	5/2$^+$				
		6118.7	70	4429.63	1/2$^+$				
		6633.6	75	3914.6	5/2$^+$				
		6870.2	4.0	3677.9	3/2$^-$				
		7565.9	95	2982.0	3/2$^+$				
		8156.8	46	2390.9	1/2$^+$				
		8471.3	17	2076.2	7/2$^+$	D+Q[h]	−0.07[h] *6*		
		10106.6	42	440.2	5/2$^+$	D+Q[h]	−0.19[h] *8*		
		10546.6	100	0.0	3/2$^+$	D+Q[h]	+0.19[h] *6*		
10574.6	3/2$^-$	3754.1	9.5	6820.2	5/2$^-$				
		5195.4	4.0	5378.56	5/2$^+$				
		6144.1	7.0	4429.63	1/2$^+$				
		6659.0	7.0	3914.6	5/2$^+$				

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Mult.[g]	δ	α[i]	Comments
10574.6	$3/2^-$	6725.6	61	3847.9	$5/2^-$				
		6895.6	9.5	3677.9	$3/2^-$				
		7591.2	5.7	2982.0	$3/2^+$				
		7932.6	4.3	2640.5	$1/2^-$				
		8182.1	19	2390.9	$1/2^+$				
		10132.0	100	440.2	$5/2^+$				
10590.7	$(13/2^-)$	2599[@] *1*	33[@] *8*	7991.5	(11/2)				
		3322[@] *1*	17[@] *8*	7268.1	$13/2^+$				
		4236[@] *1*	42[@] *8*	6354.2	$9/2^-$				
		4355[@] *1*	42[@] *8*	6235.4	$(13/2^+)$	D+Q[@]			
		5056[@] *1*	100[@] *17*	5534.2	$11/2^+$	D[@]			
10616.9	$5/2^+,3/2^+$	3748.9	8.9	6867.7	$5/2^+,3/2^+$				
		4850.3	11	5766.03	$3/2^+$				
		6701.3	16	3914.6	$5/2^+$	D[h]			
		6937.9	30	3677.9	$3/2^-$	D+Q[h]	−0.6[h] *5*		
		8224.4	5.6	2390.9	$1/2^+$				
		8539.0	8.1	2076.2	$7/2^+$				
		10174.3	100	440.2	$5/2^+$	D[h]			
		10614.3	6.1	0.0	$3/2^+$				
10698.0	(7/2,11/2)	4343[@] *1*	21[@] *5*	6354.2	$9/2^-$	D+Q[@]			
		7993[@] *1*	100[@] *11*	2703.8	$9/2^+$	(D)[@]			
10759.8		4524[@] *1*	100	6235.4	$(13/2^+)$				
10798.0		8720[@] *1*	100	2076.2	$7/2^+$				
10860.9		8782[@] *1*	100[@] *38*	2076.2	$7/2^+$				
		10419[@] *1*	23[@] *8*	440.2	$5/2^+$				
10923.0		8845[@] *1*	100	2076.2	$7/2^+$				
11073.7	$(17/2^+)$	2034[@] *1*	100[@] *25*	9039.5	(15/2)	D+Q[@]			
		4838[@] *1*	50[@] *13*	6235.4	$(13/2^+)$	(E2)[@]		1.44×10^{-3}	B(E2)(W.u.)=0.53 *20*
11271.9	$(11/2^-)$	2325[@] *1*	33[@] *17*	8946.8	$(7/2^-)$				
		5036[@] *1*	100[@] *17*	6235.4	$(13/2^+)$	(E1)[@]		0.00203	B(E1)(W.u.)=0.00039 *12*
11424.7	(11/2)	1070[@] *1*	100[@] *17*	10354.0	$13/2^-$	D[@]			
		9347[@] *1*	7[@] *3*	2076.2	$7/2^+$				
11538.8	$(15/2^+)$	4270[@] *1*	100[@] *50*	7268.1	$13/2^+$				
		6004[@] *1*	100[@] *50*	5534.2	$11/2^+$				
11651.6	$(13/2^+)$	2441[@] *1*	100[@] *29*	9210.4	$(11/2^+)$				
		4466[@] *1*	29[@] *14*	7185.3	$(9/2^+)$				
12013.5		9935[@] *1*	100	2076.2	$7/2^+$				

Adopted Levels, Gammas (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[b]	E_f	J^π_f	Comments
12122		9138	50[f] *9*	2982.0	3/2$^+$	
		9480	38[f] *12*	2640.5	1/2$^-$	
		9729	100[f] *26*	2390.9	1/2$^+$	
		11679	21[f] *9*	440.2	5/2$^+$	
		12119	85[f] *21*	0.0	3/2$^+$	
12184	(3/2)$^+$	8268	13[f] *4*	3914.6	5/2$^+$	
		8334	7[f] *2*	3847.9	5/2$^-$	
		8504	19[f] *4*	3677.9	3/2$^-$	
		9200	11[f] *2*	2982.0	3/2$^+$	
		10106	20[f] *4*	2076.2	7/2$^+$	
		11741	15[f] *4*	440.2	5/2$^+$	
		12181	100[f] *7*	0.0	3/2$^+$	
12593.1		2792[@]	50[@]	9802.9	(15/2$^+$)	
		5323.6[@] *19*	100[@]	7268.1	13/2$^+$	
		6355[@]	50[@]	6235.4	(13/2$^+$)	
25400		23311		2076.2	7/2$^+$	
		24945		440.2	5/2$^+$	E_γ: Unresolved.
		25385		0.0	3/2$^+$	E_γ: Unresolved.

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

‡ Weighted average of data in (^{12}C,pγ), (d,nγ), and (p,p′γ).

\# Weighted average of data in (^{12}C,pγ) and (p,p′γ).

@ From (^{12}C,pγ).

& From (d,nγ).

a From (γ,γ′).

b From (p,γ), except otherwise noted.

c In good agreement with weighted average of all available data.

d Weighted average of data from (p,γ), (γ,γ′), (p,αγ), and (t,α),(t,αγ).

e Weighted average of data from (p,γ) and (γ,γ′).

f From ^{19}F(α,γ).

g From (p,p′γ) and RUL, except otherwise noted.

h From (p,γ).

i Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies,

$^{23}_{11}Na_{12}$-37

$\gamma(^{23}Na)$ (continued)

assigned multipolarities, and mixing ratios, unless otherwise specified.

[j] Multiply placed with intensity suitably divided.

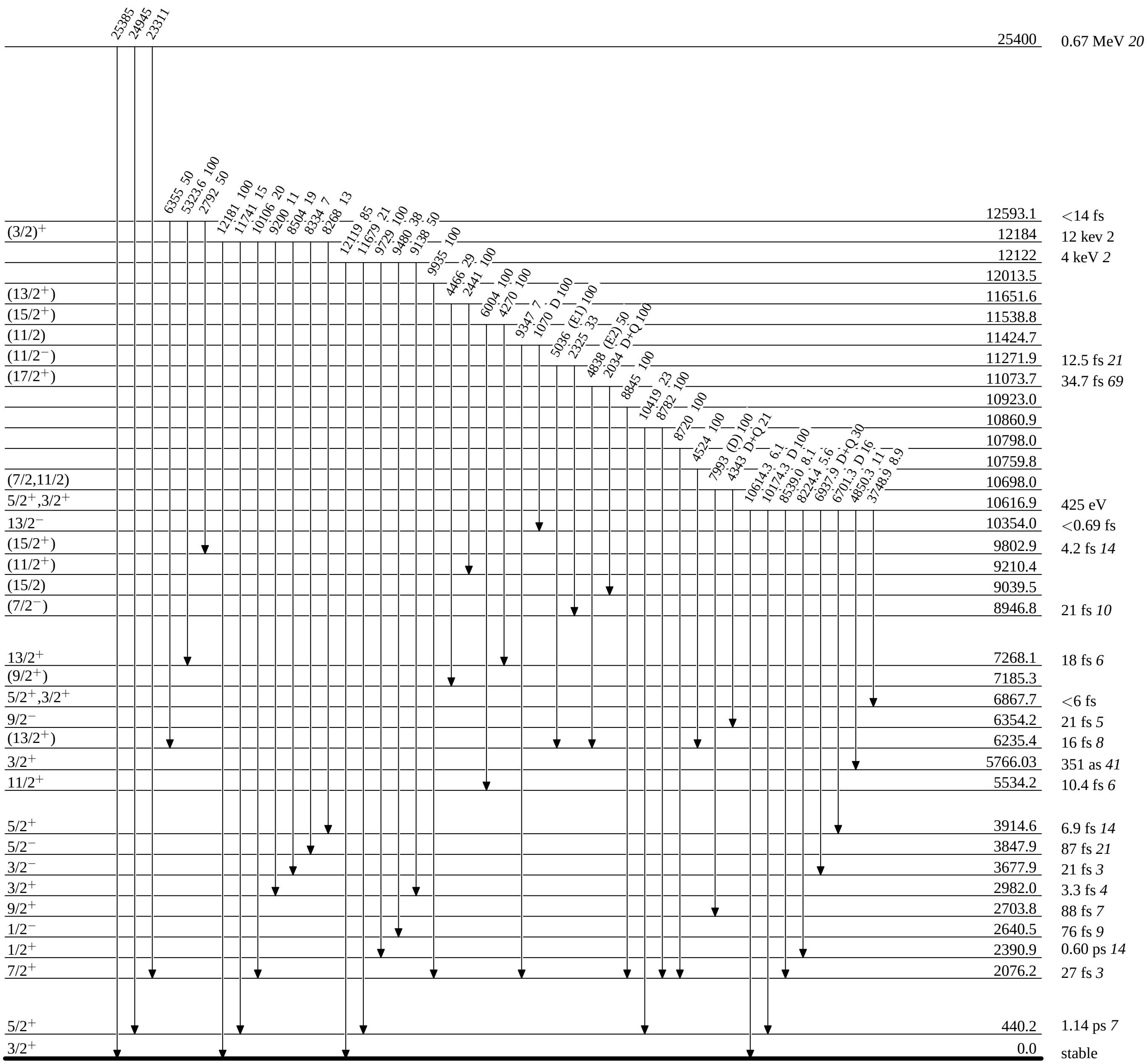
[k] Placement of transition in the level scheme is uncertain.

$^{23}_{11}Na_{12}$-38

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

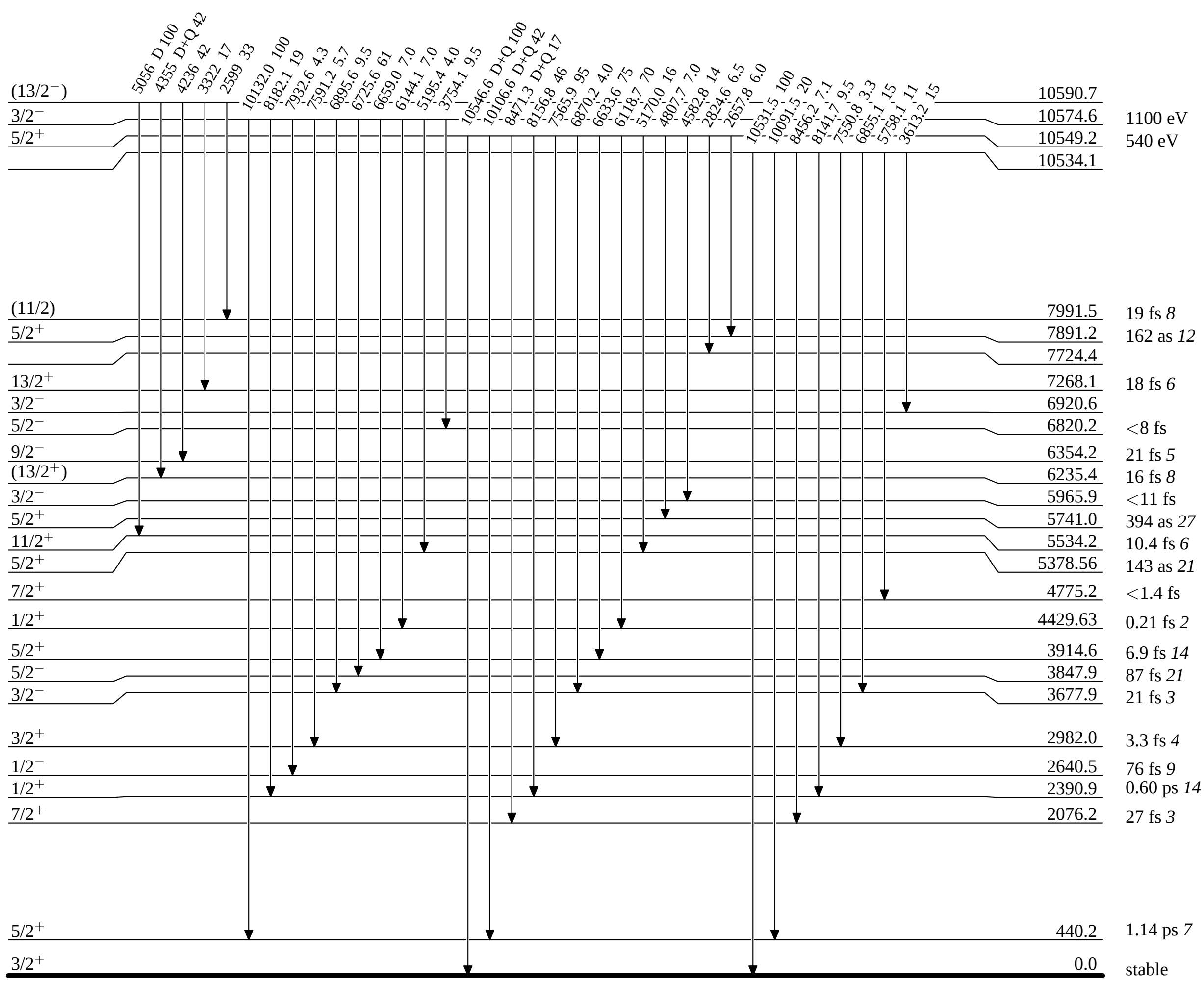


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

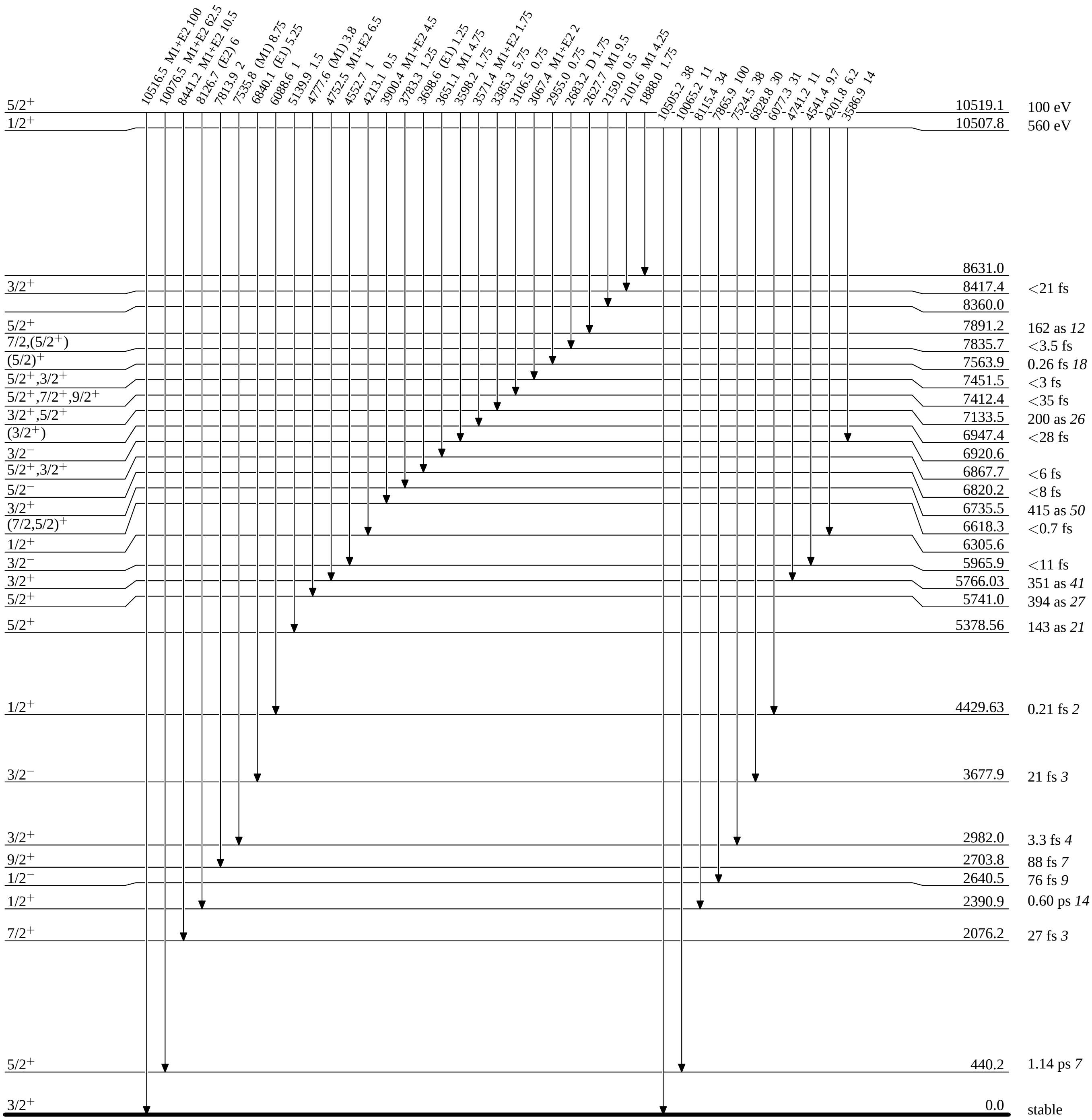


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

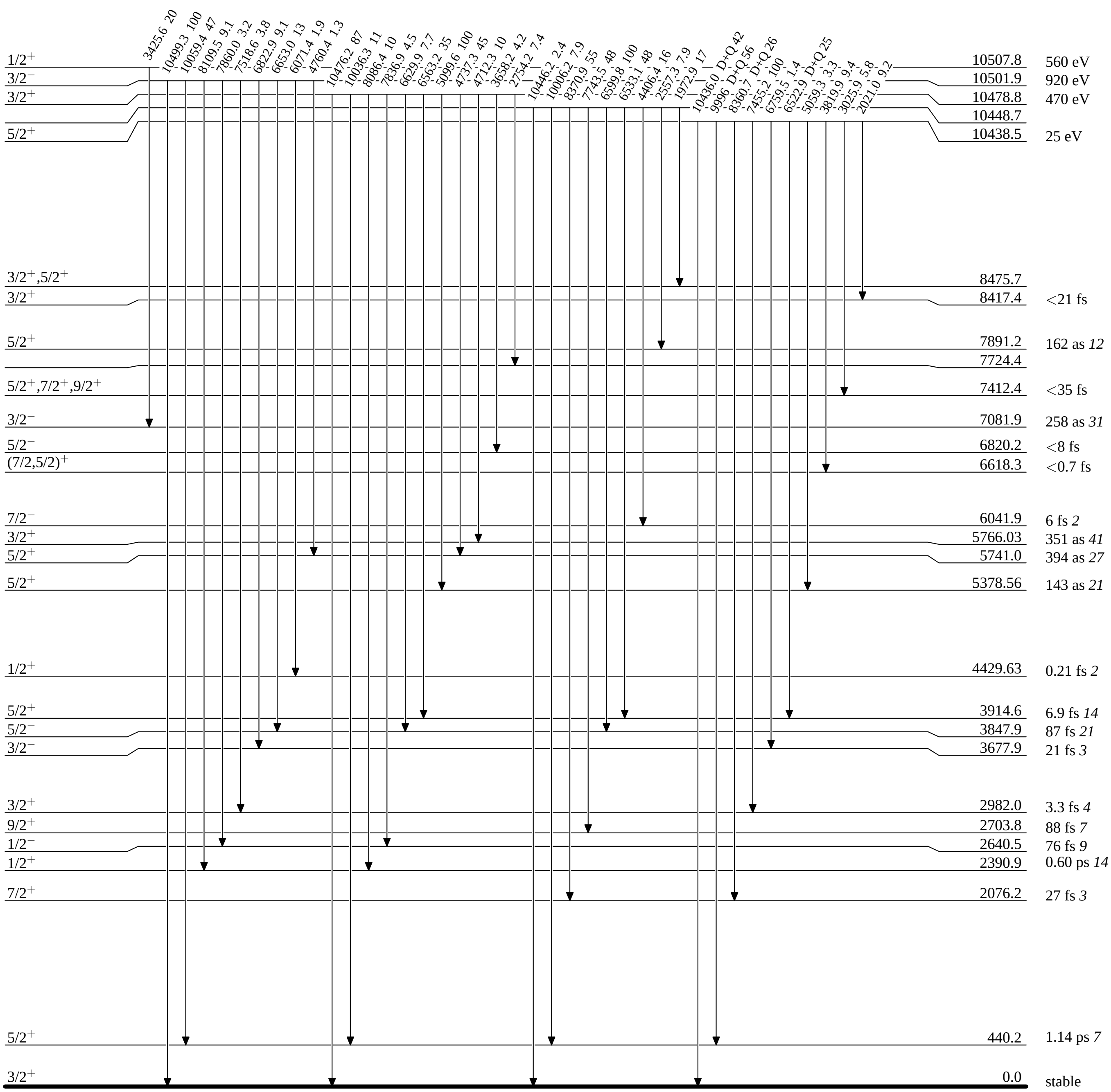


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{23}_{11}Na_{12}$

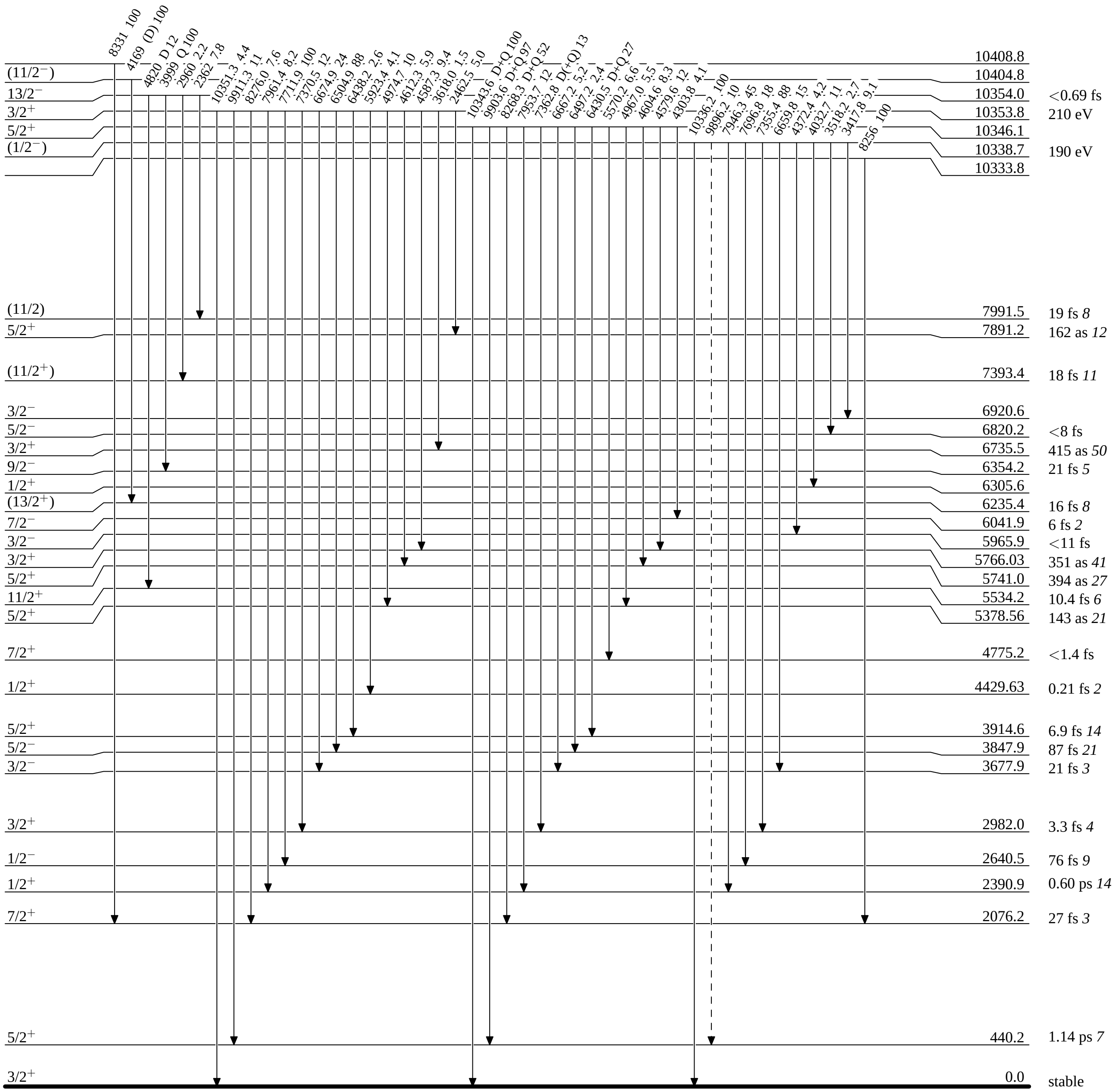
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

γ Decay (Uncertain)

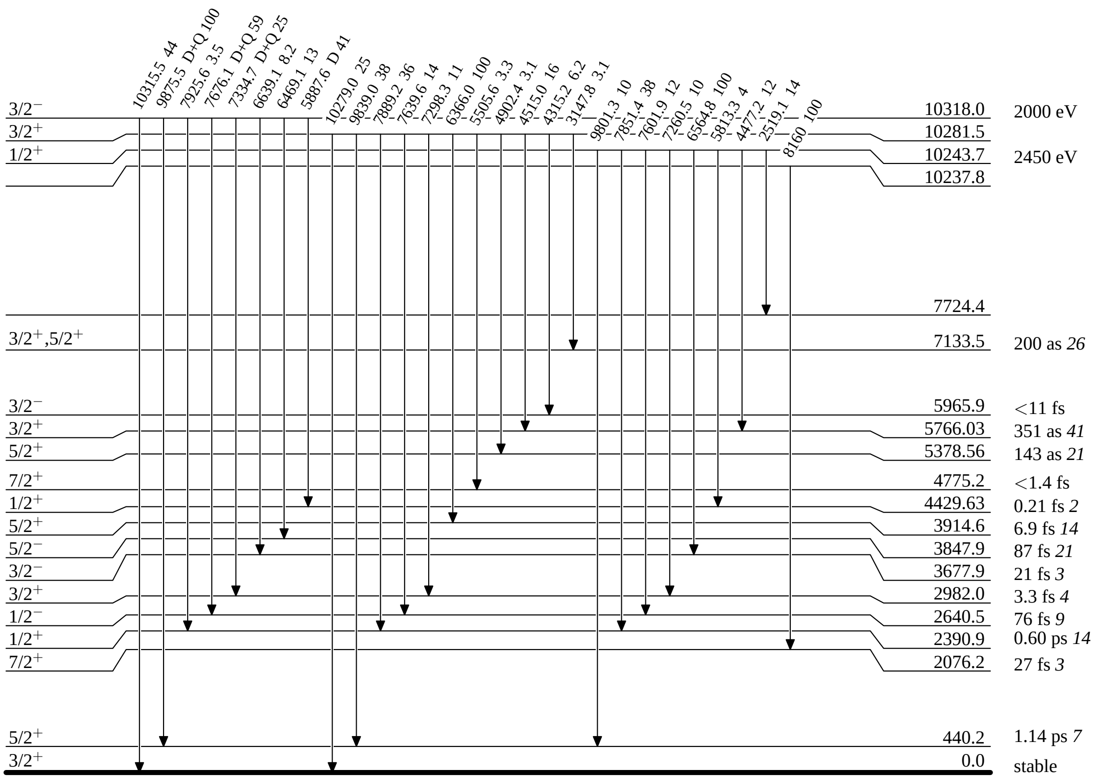


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

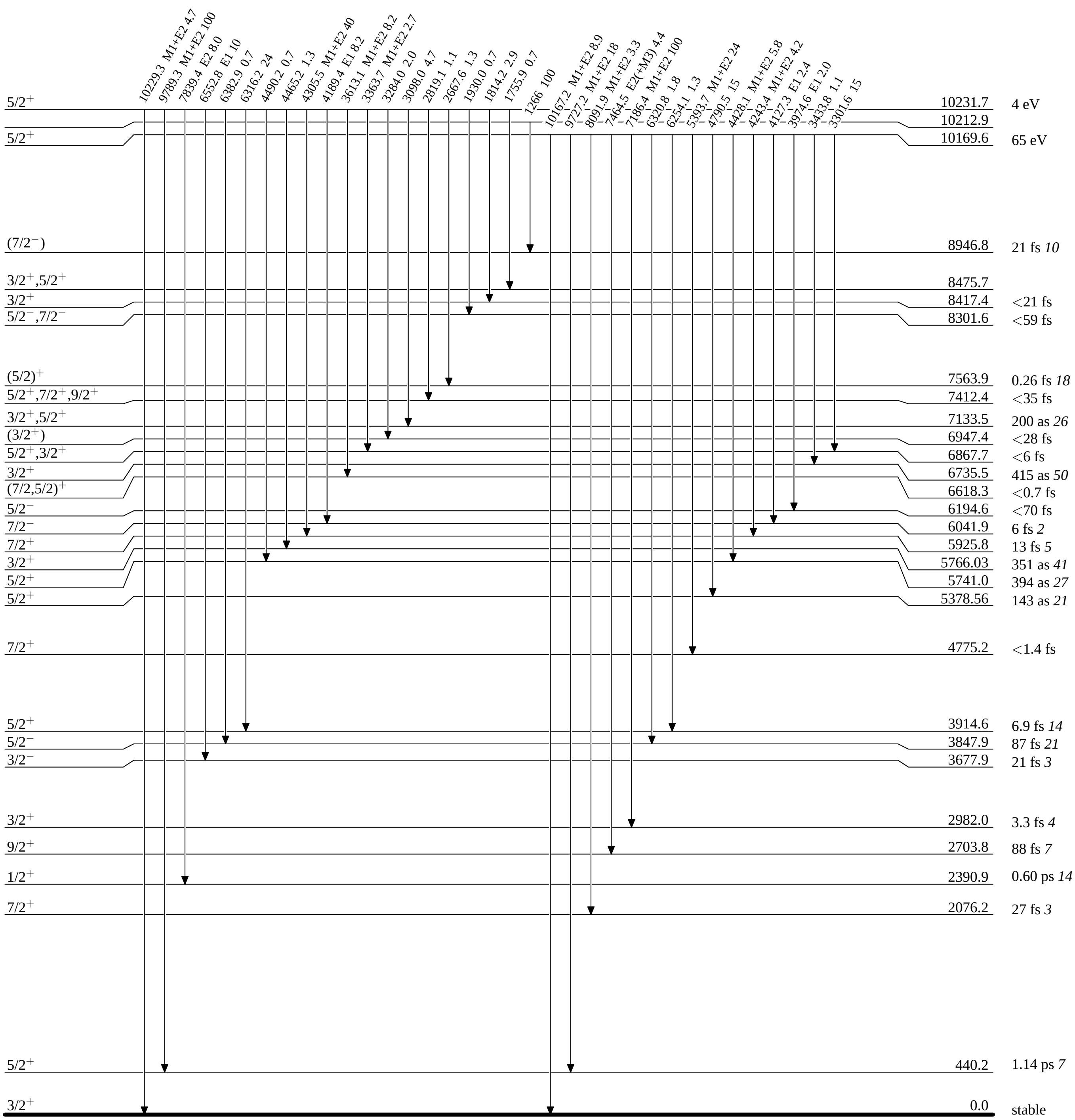


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

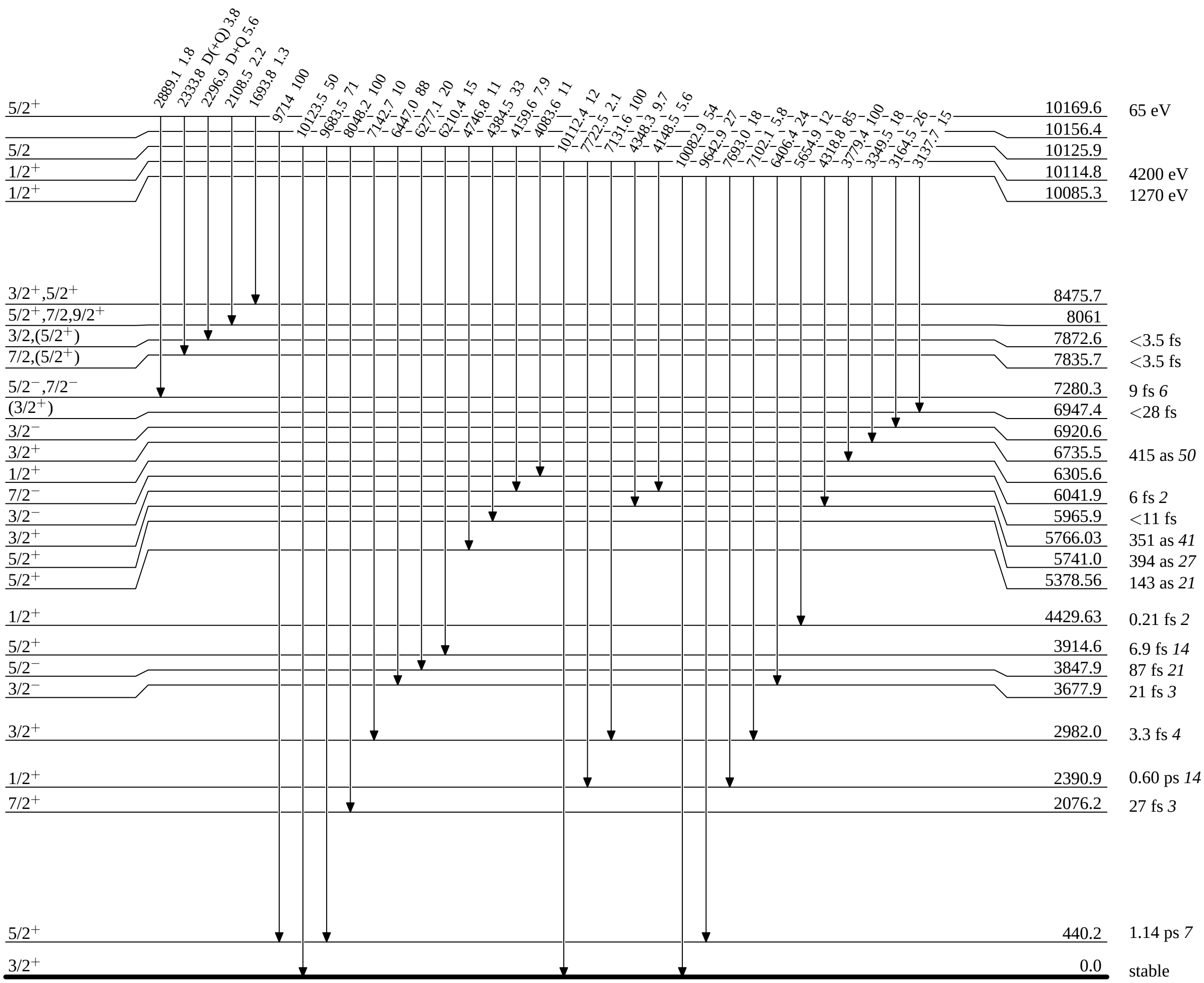


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

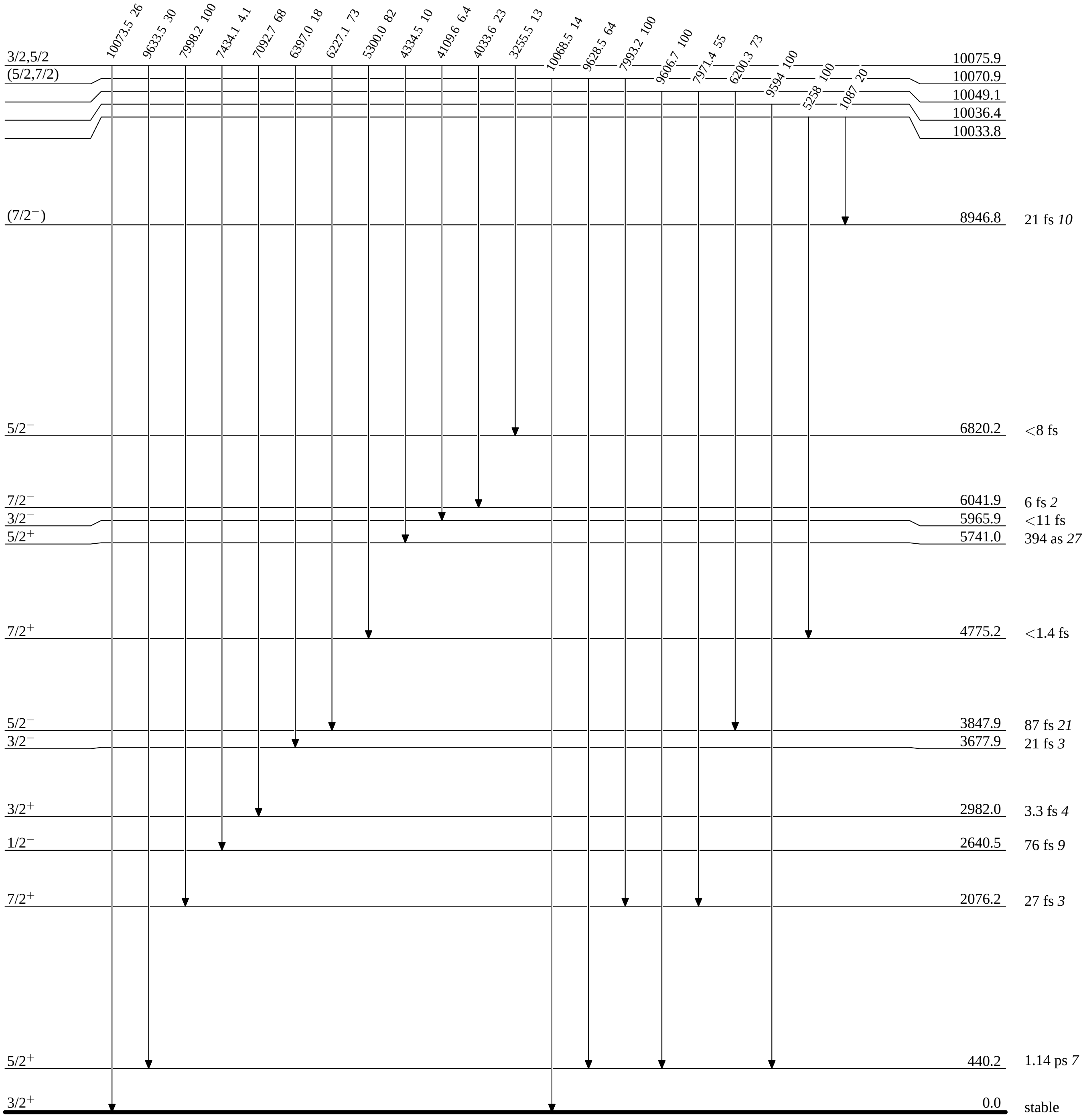


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

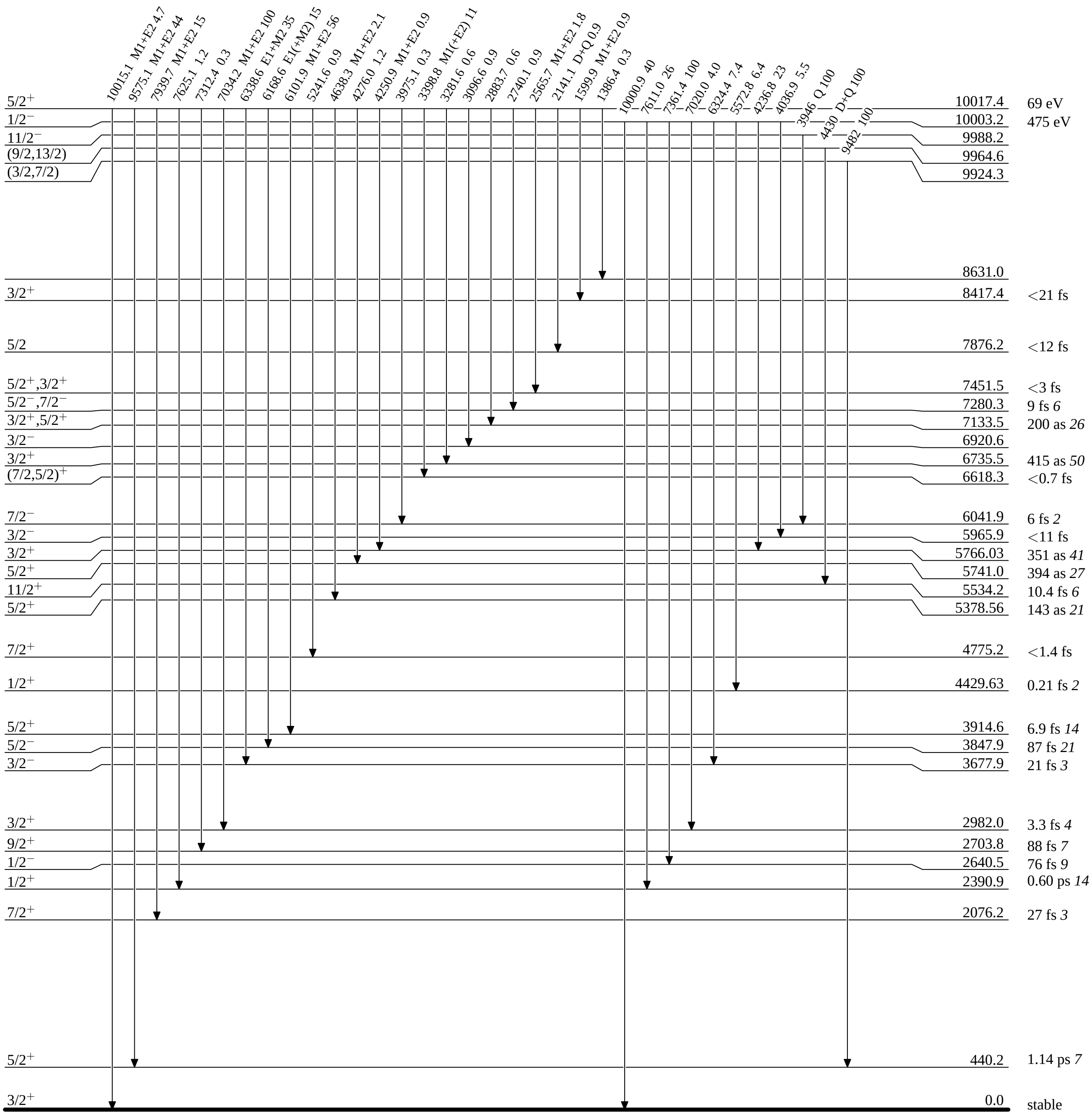


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

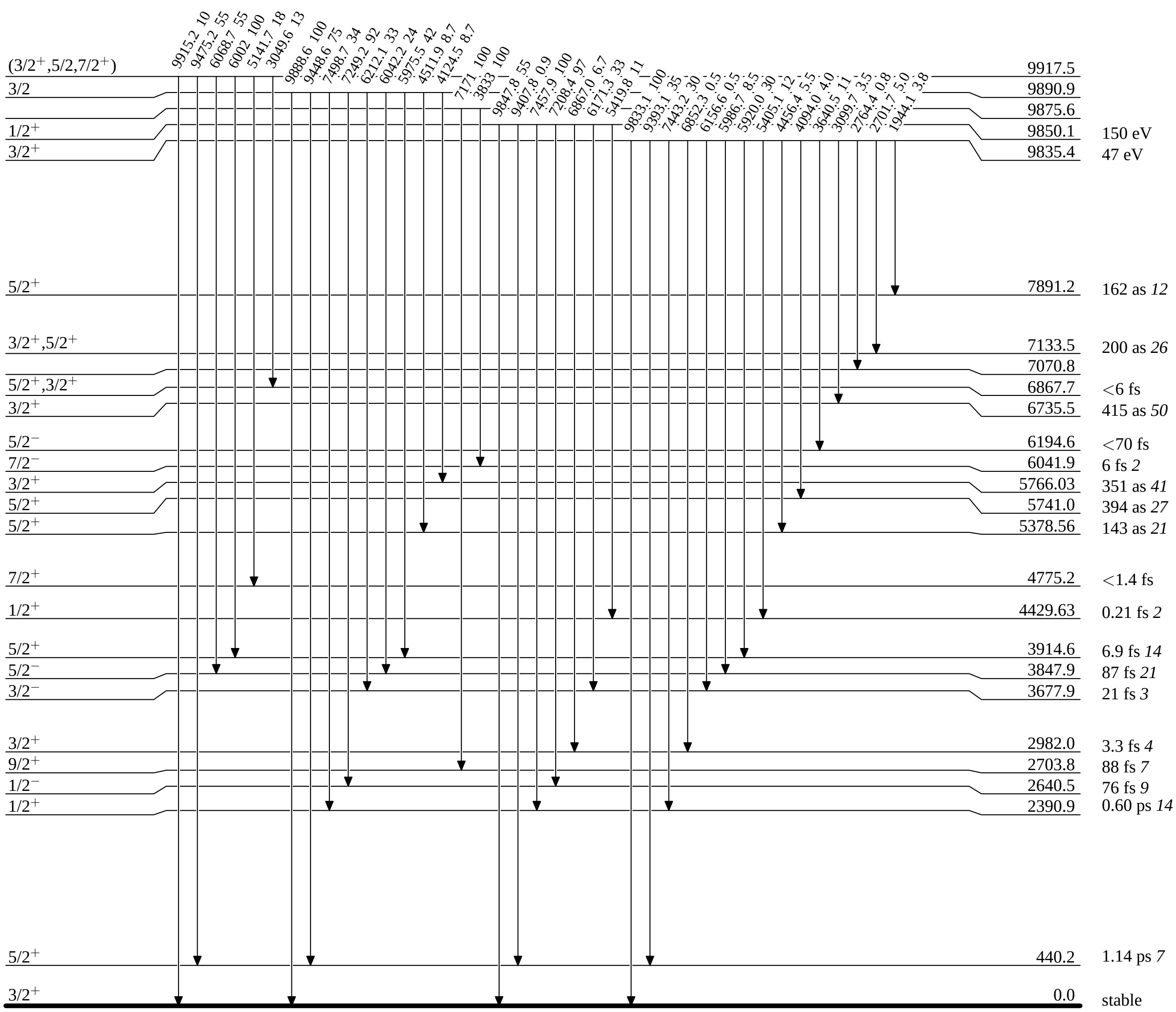


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

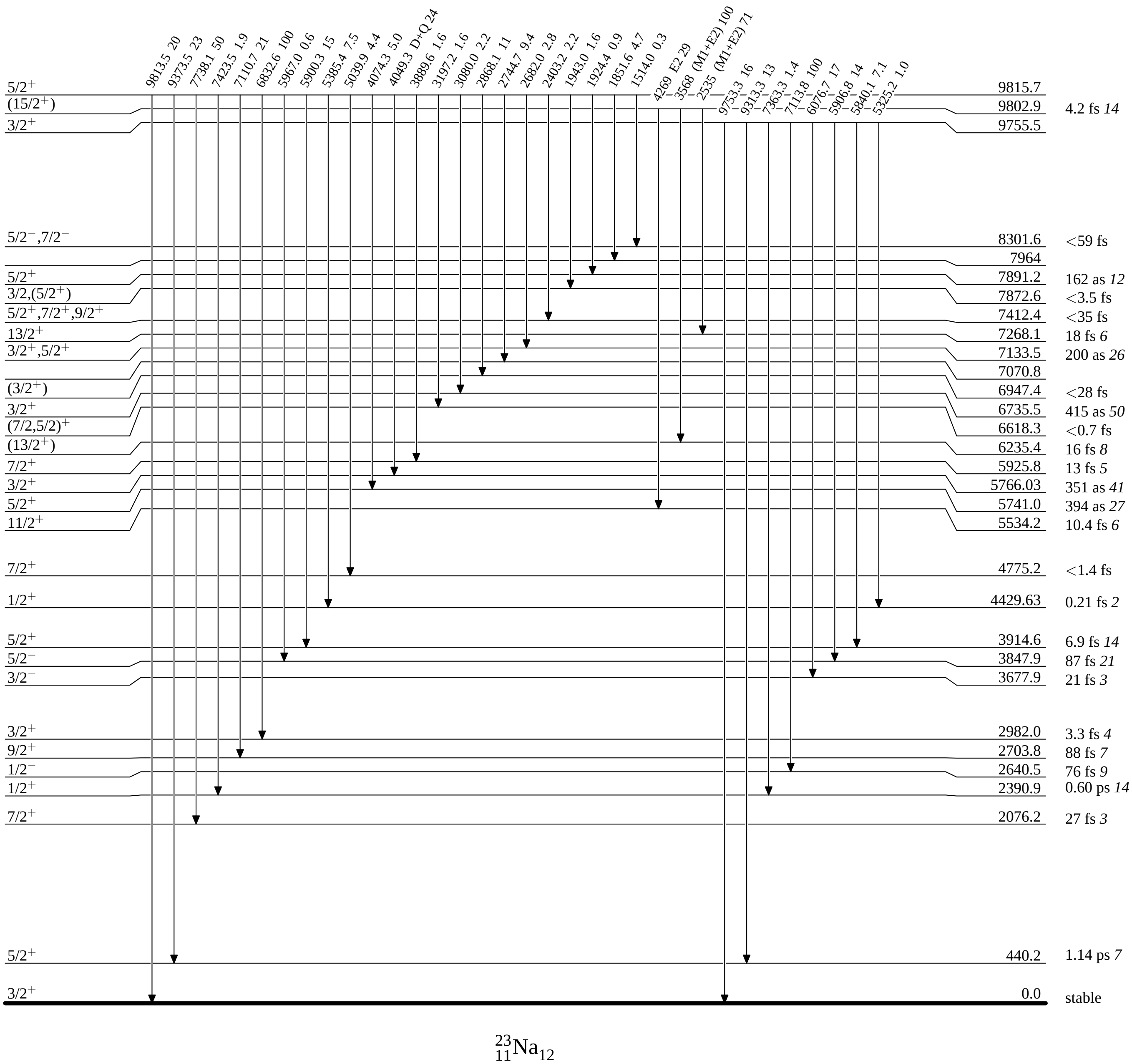


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

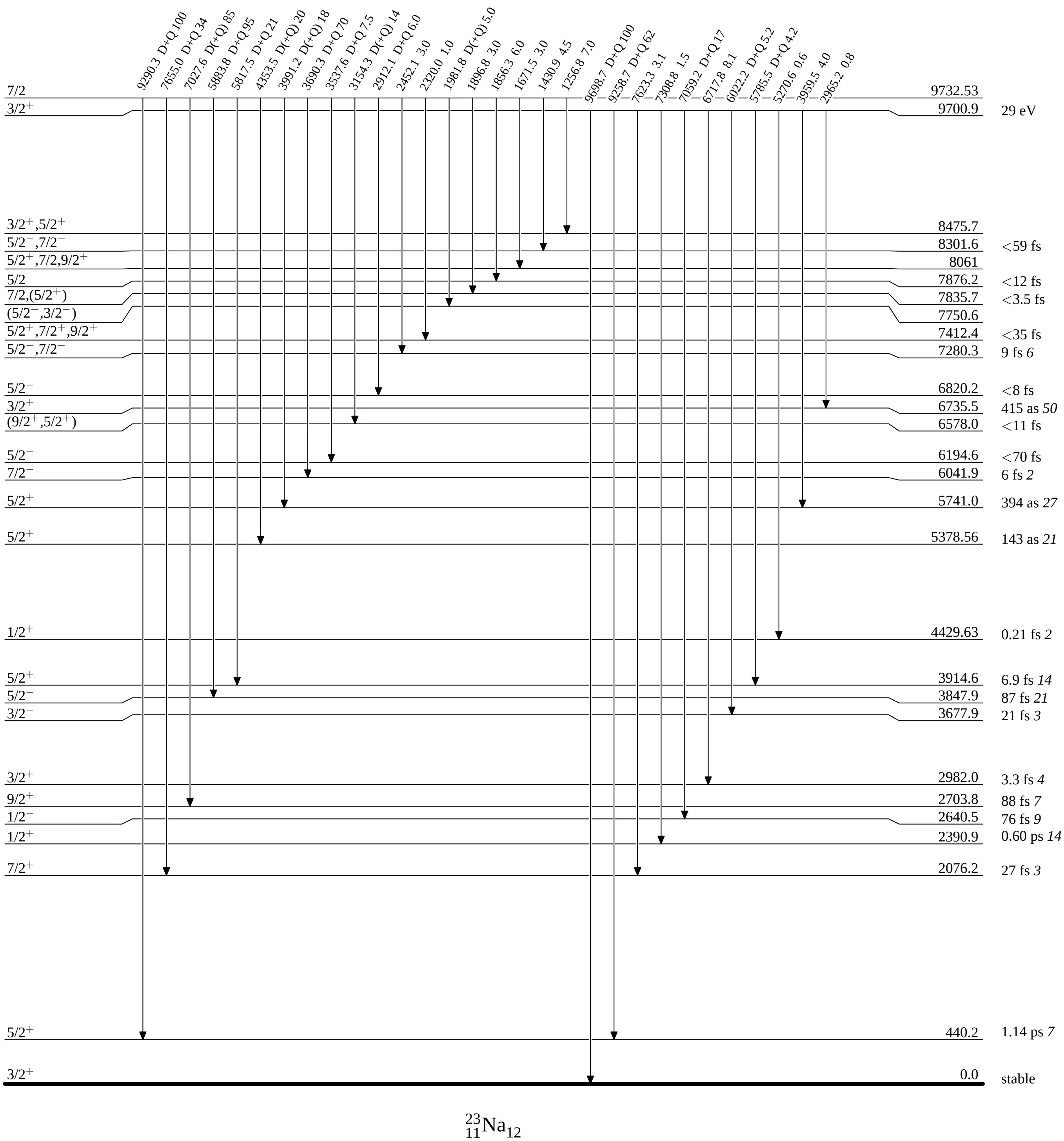
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

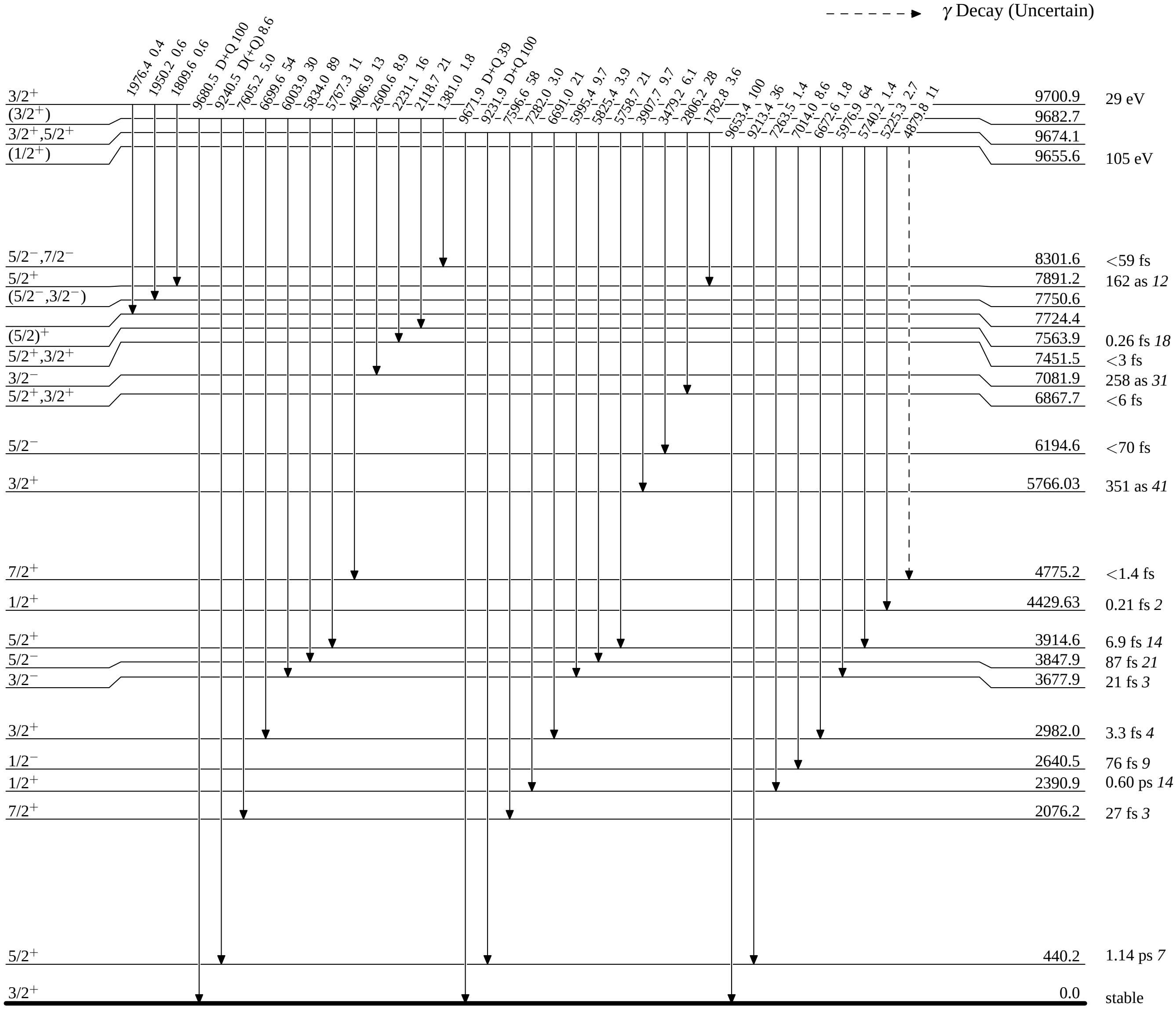
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

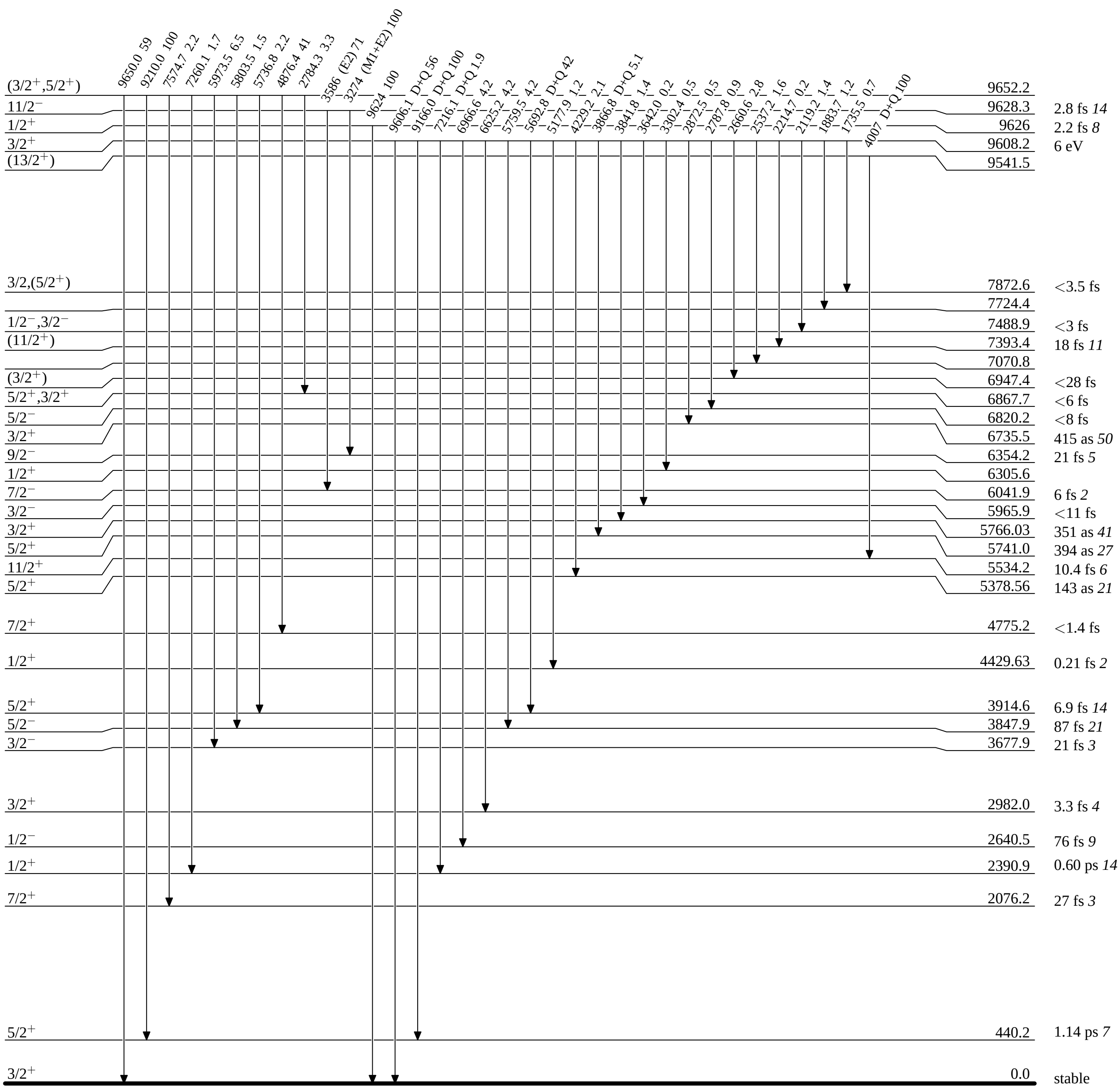


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

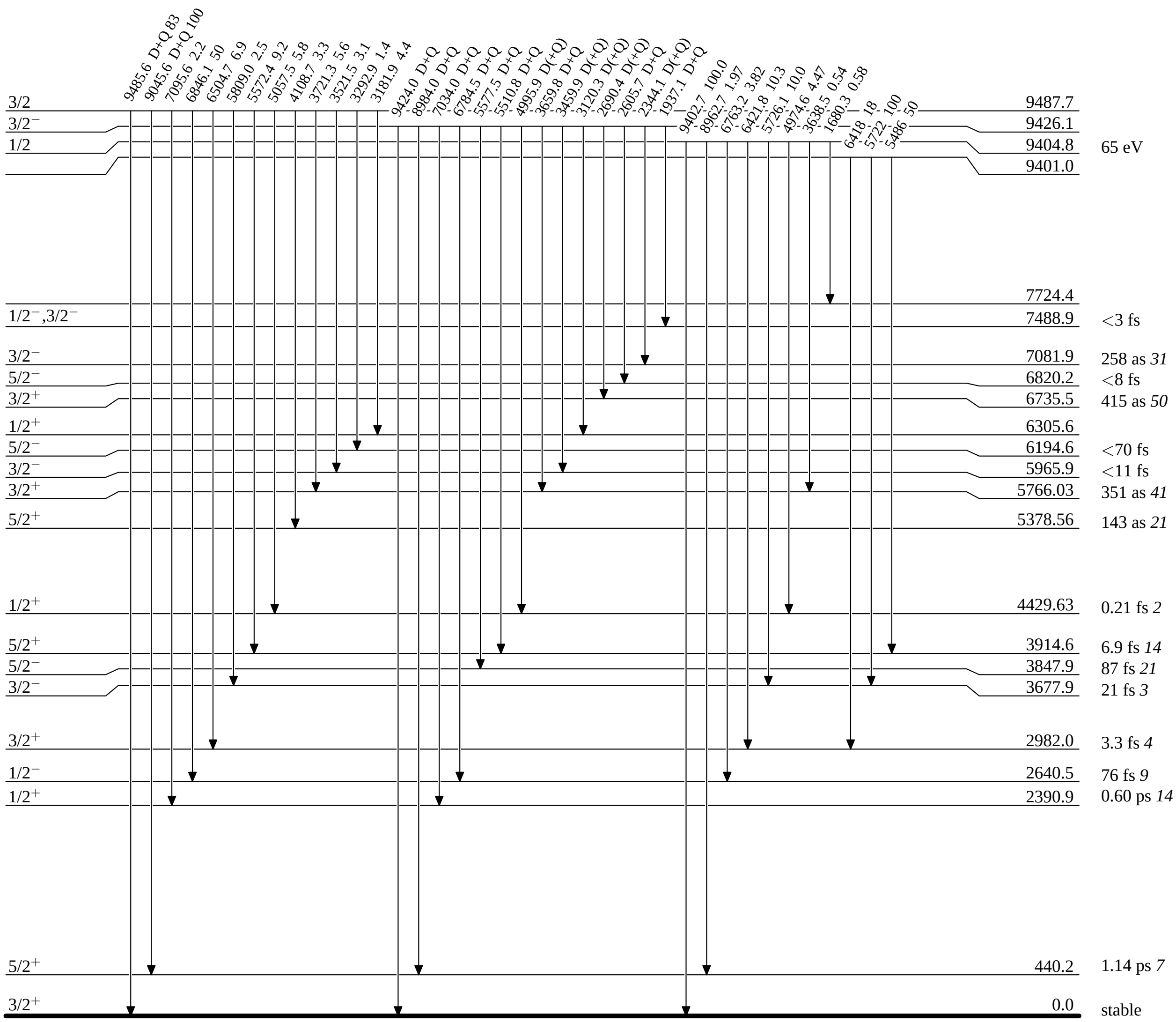
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

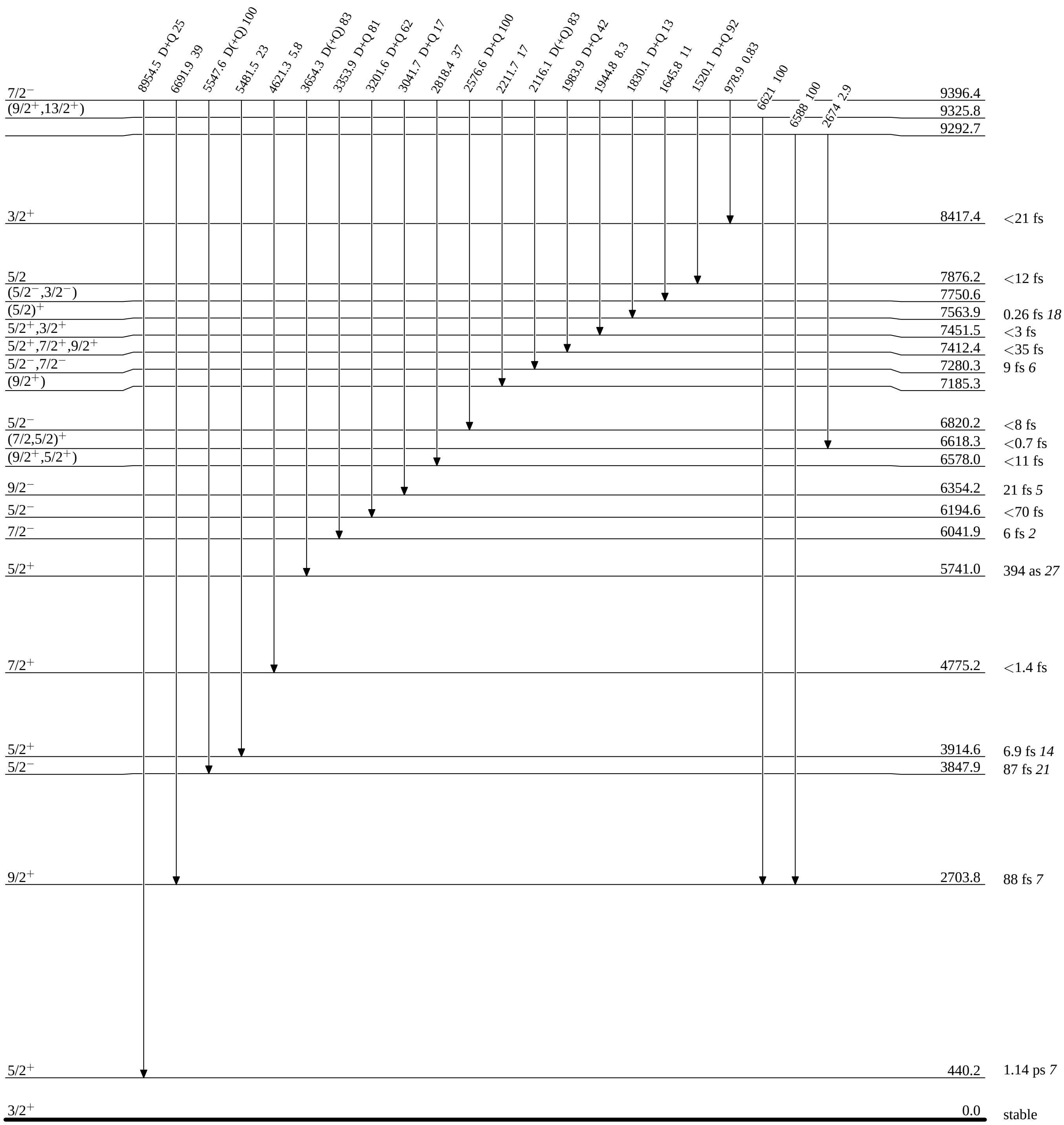


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

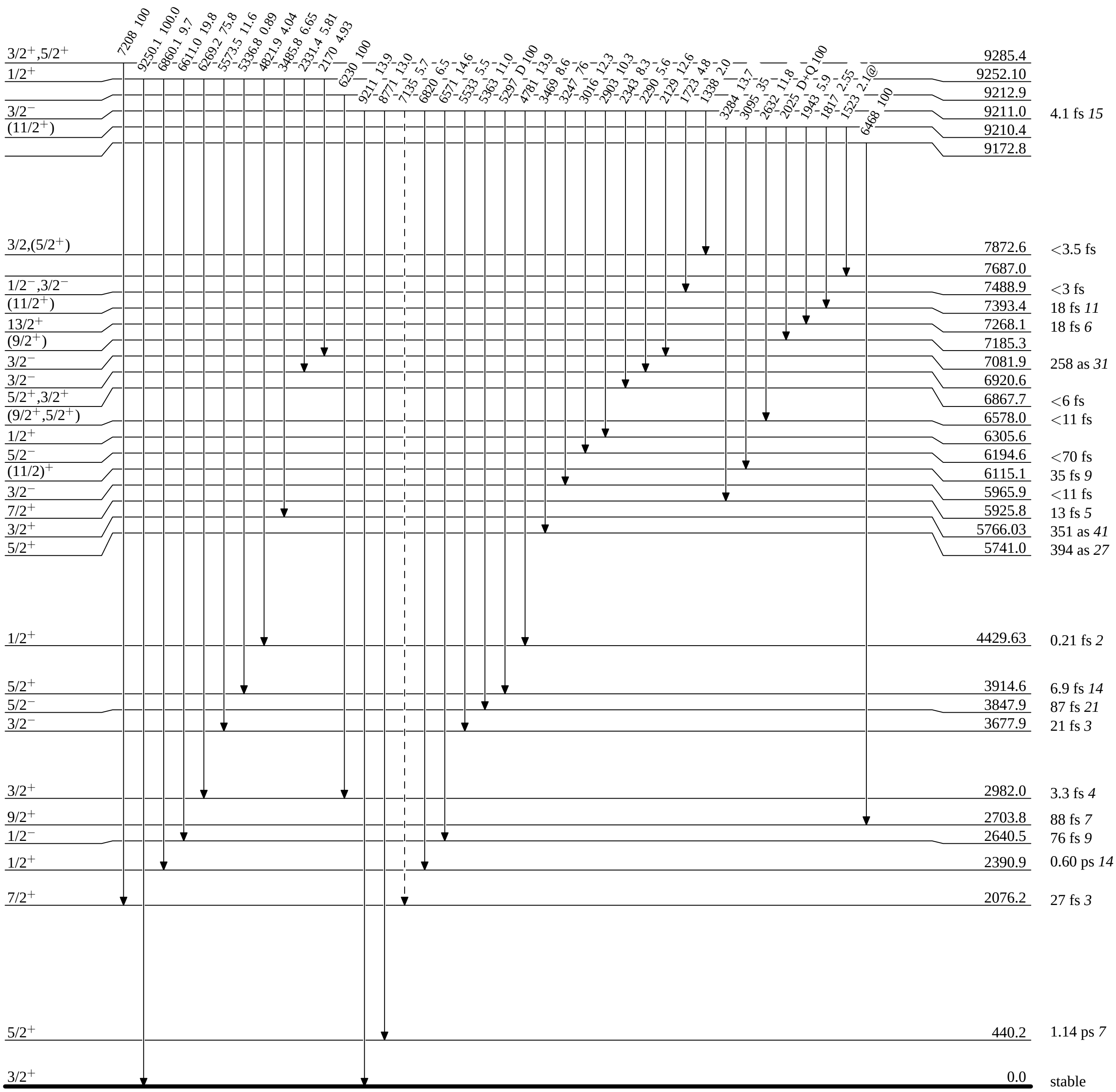


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

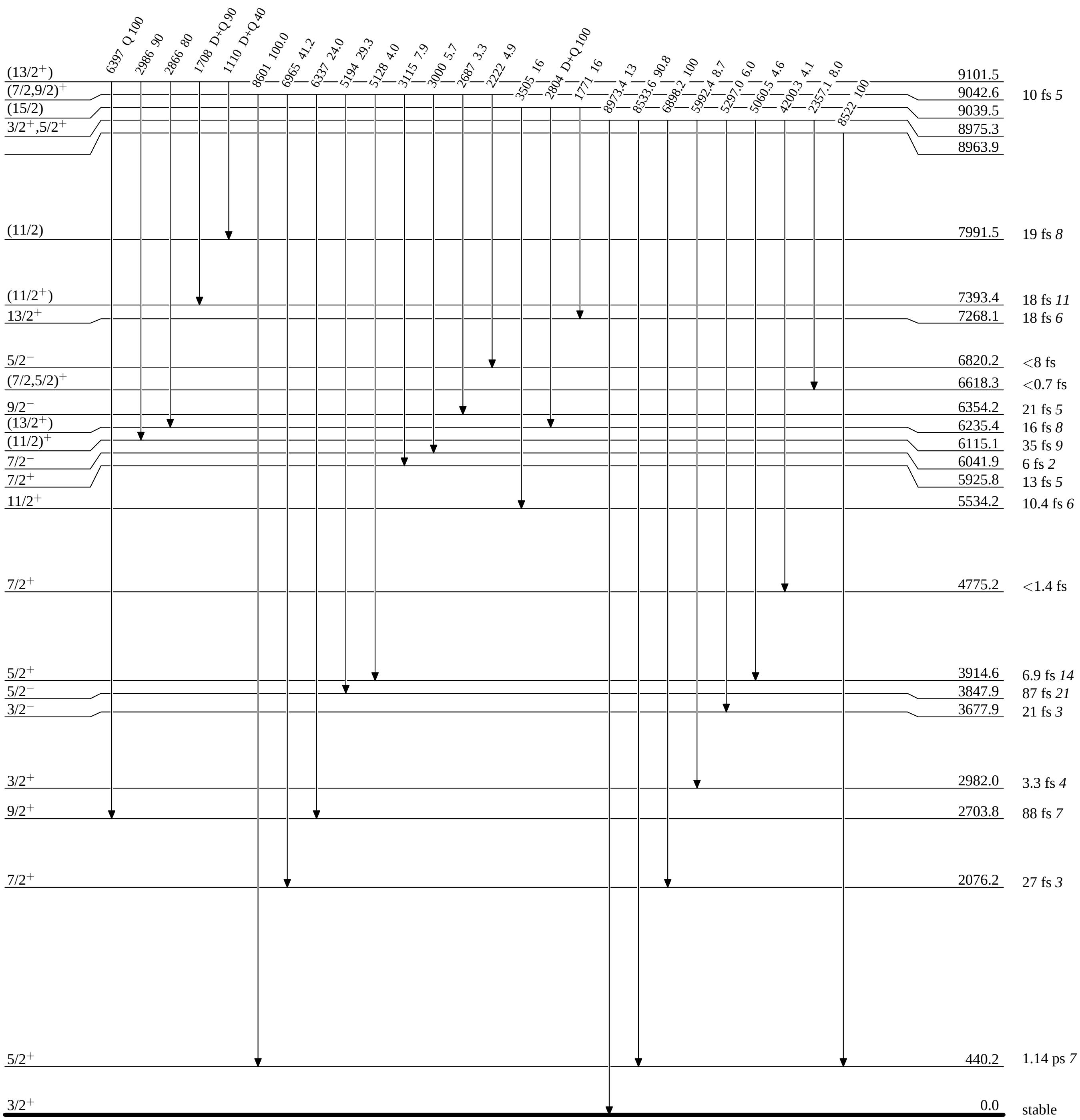


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

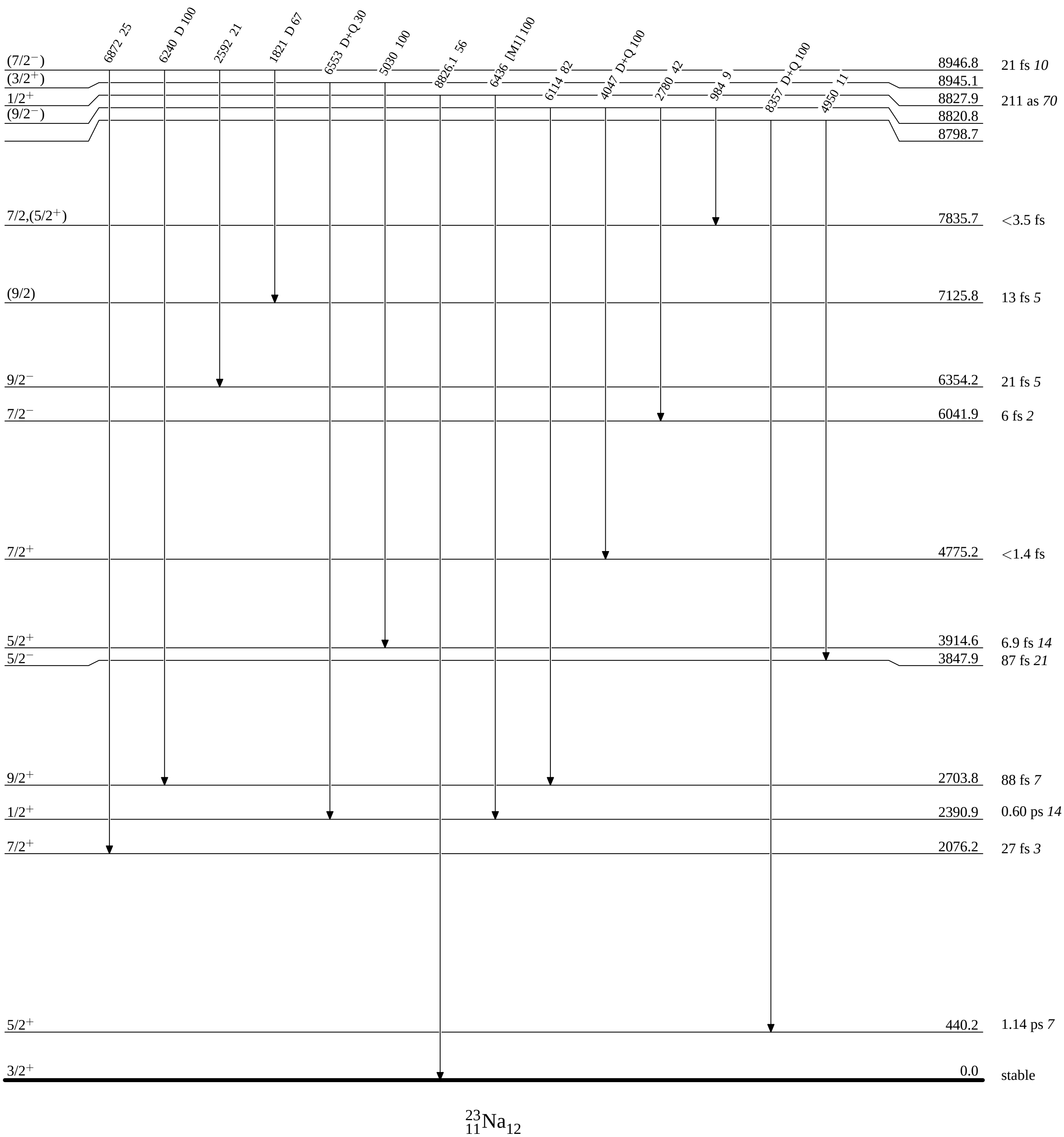


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided



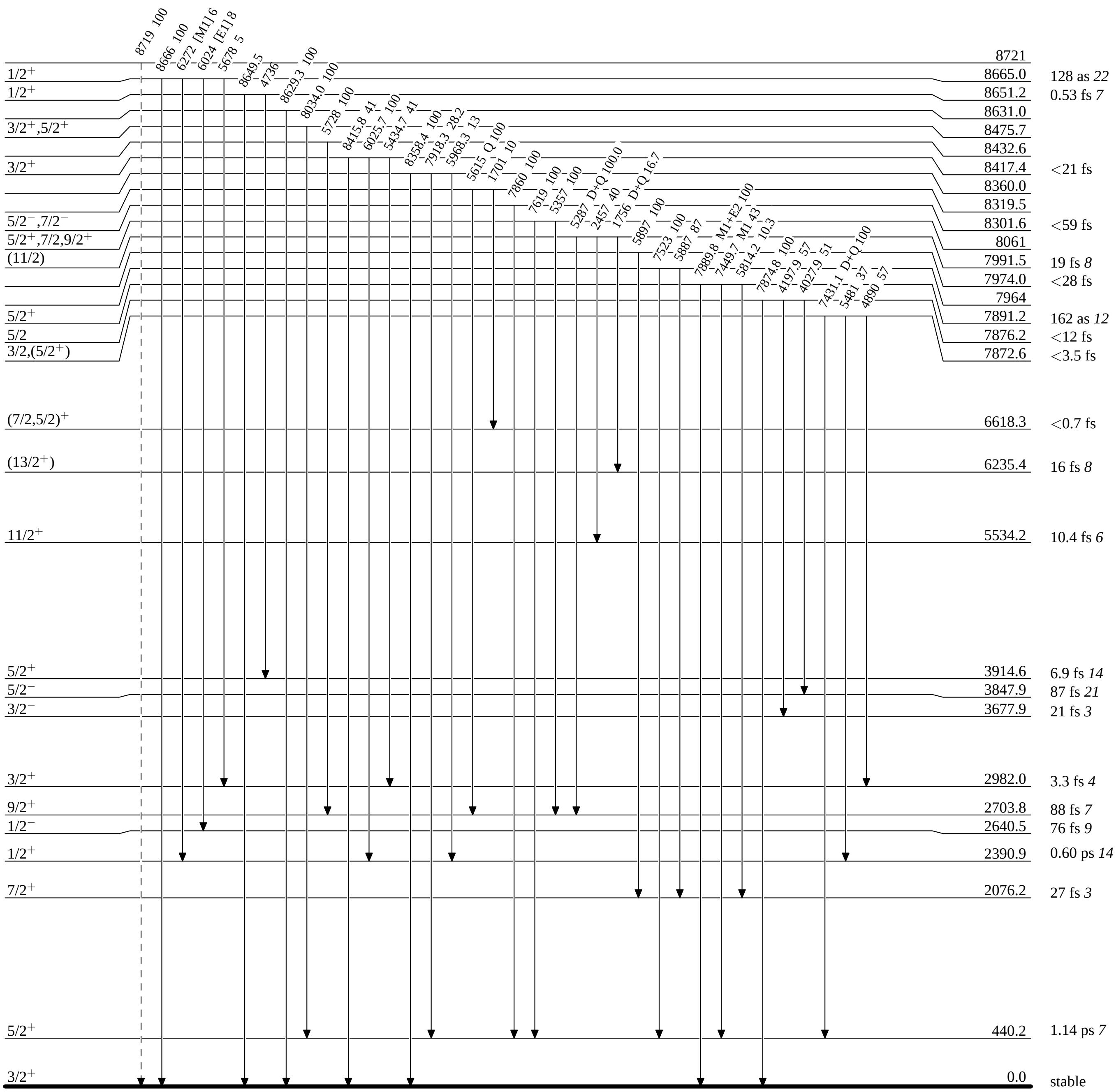
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

Legend

γ Decay (Uncertain)

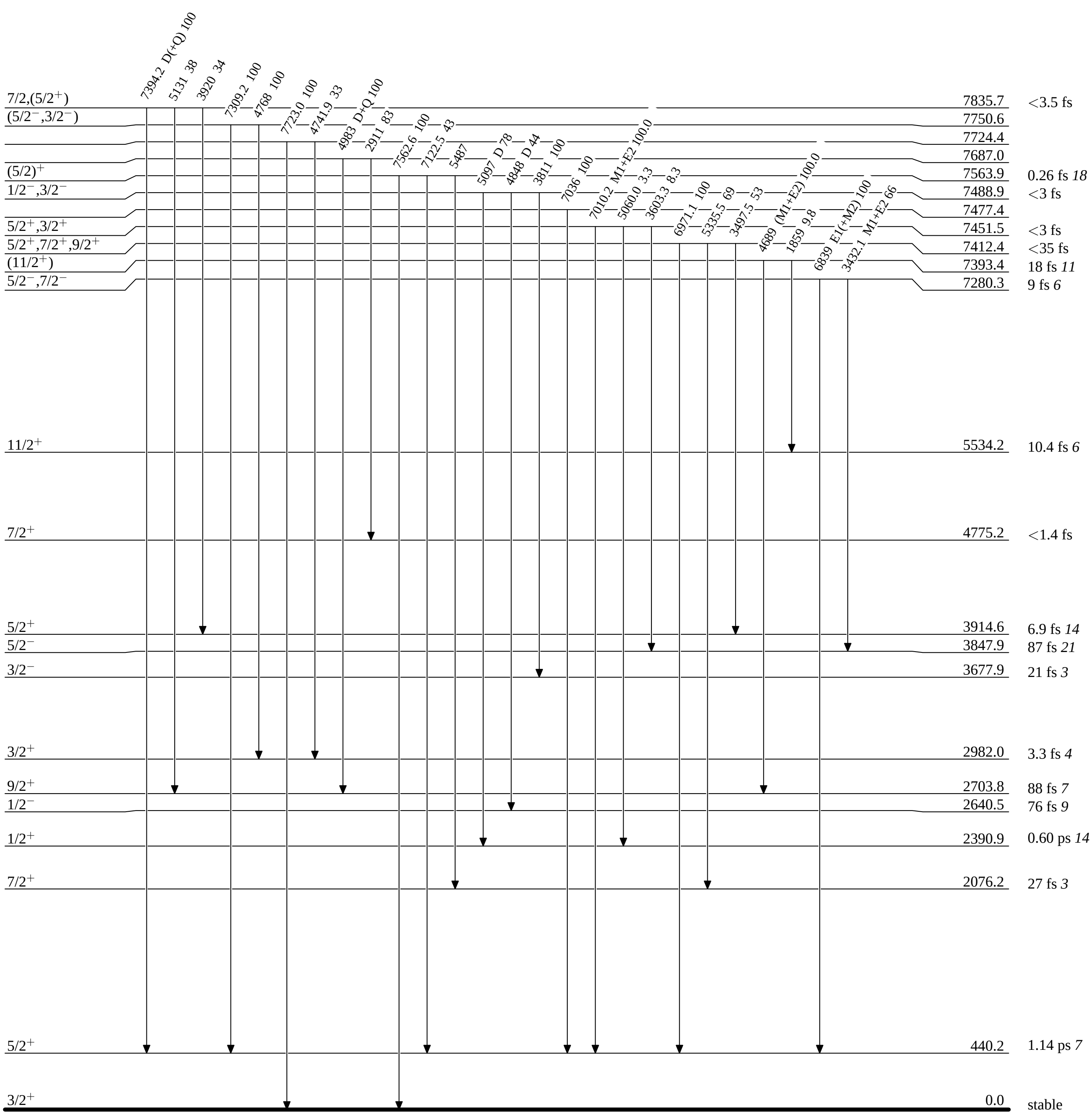


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

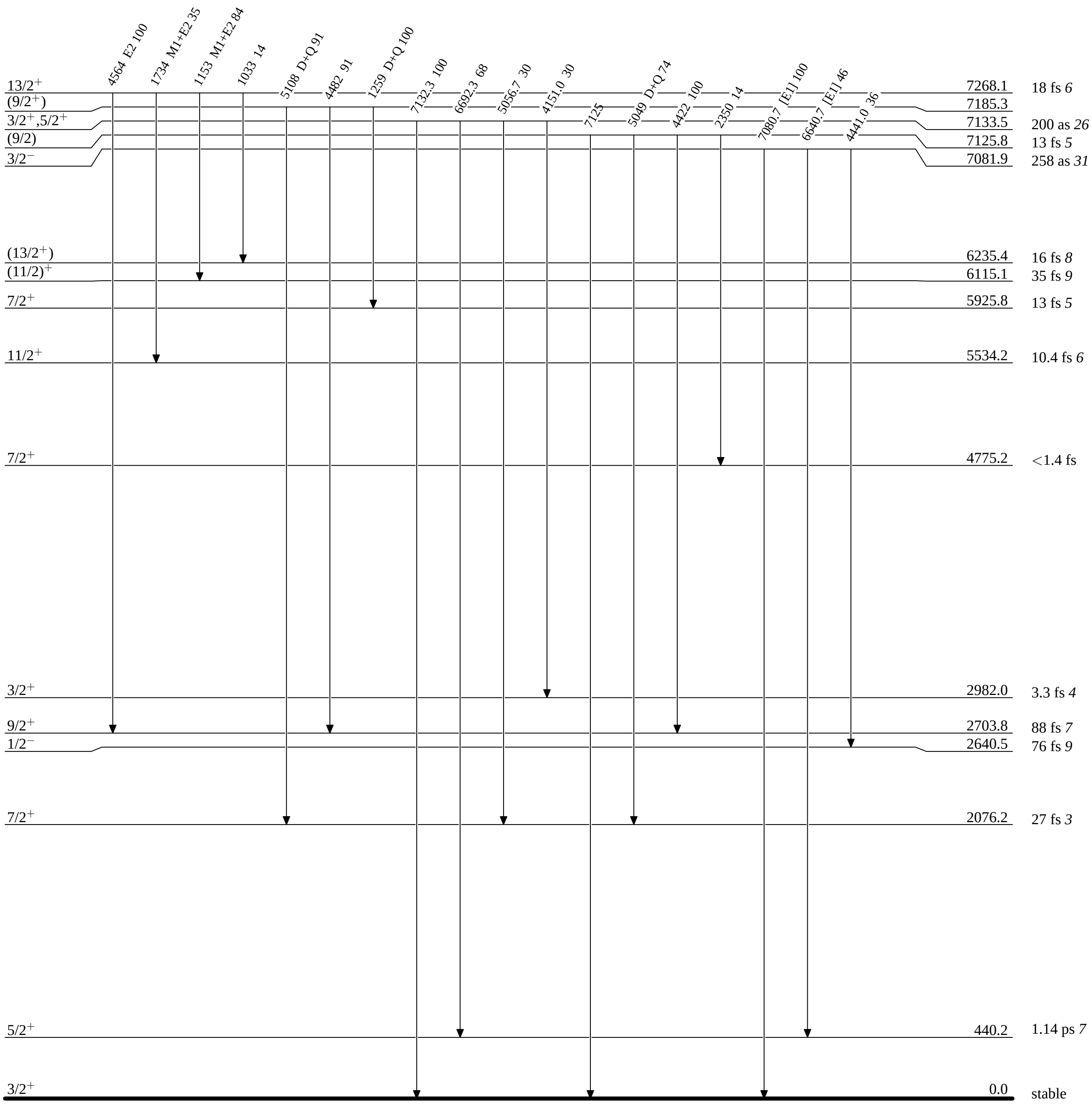


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

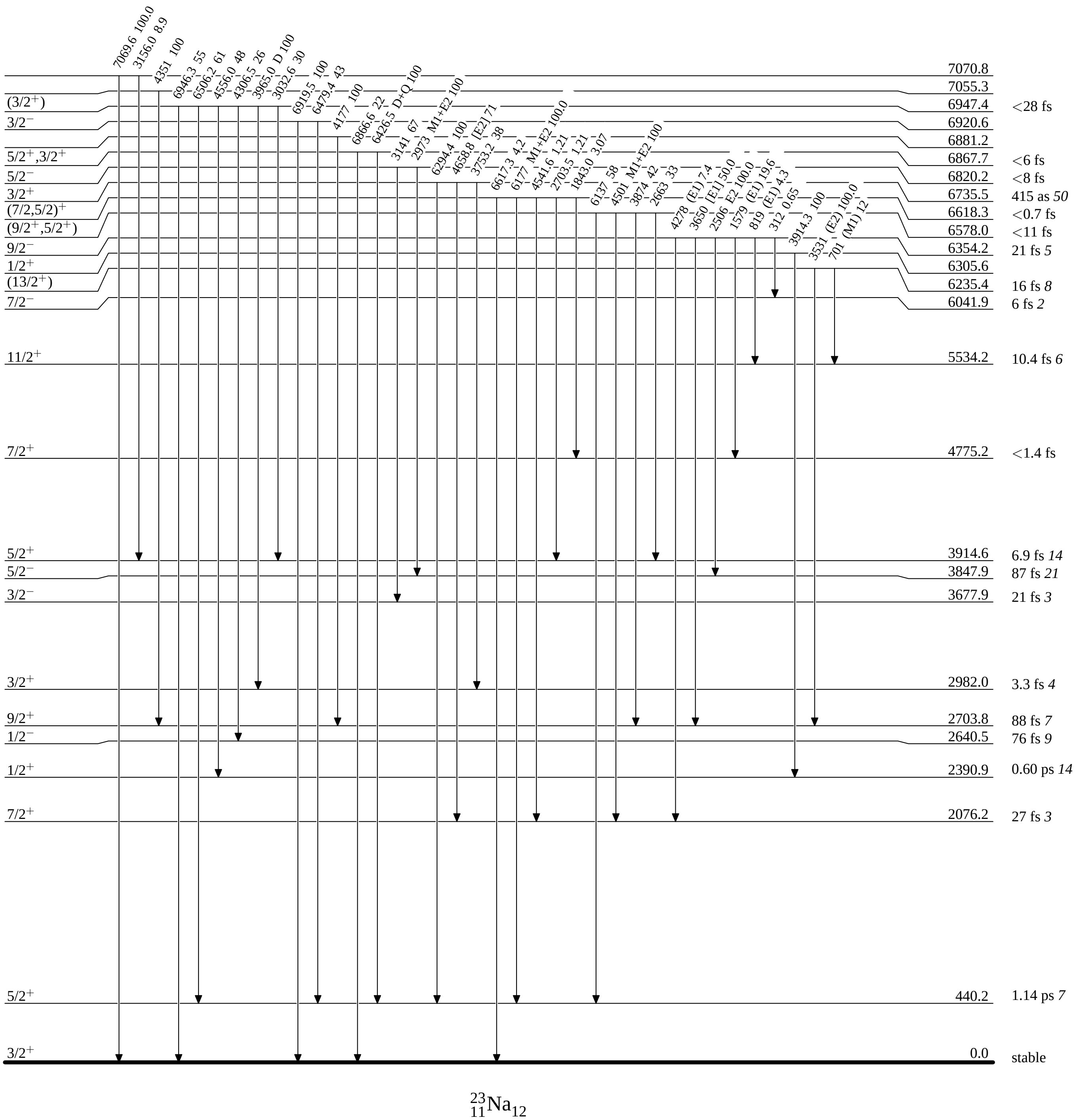


$^{23}_{11}Na_{12}$

Adopted Levels, Gammas

Level Scheme (continued)

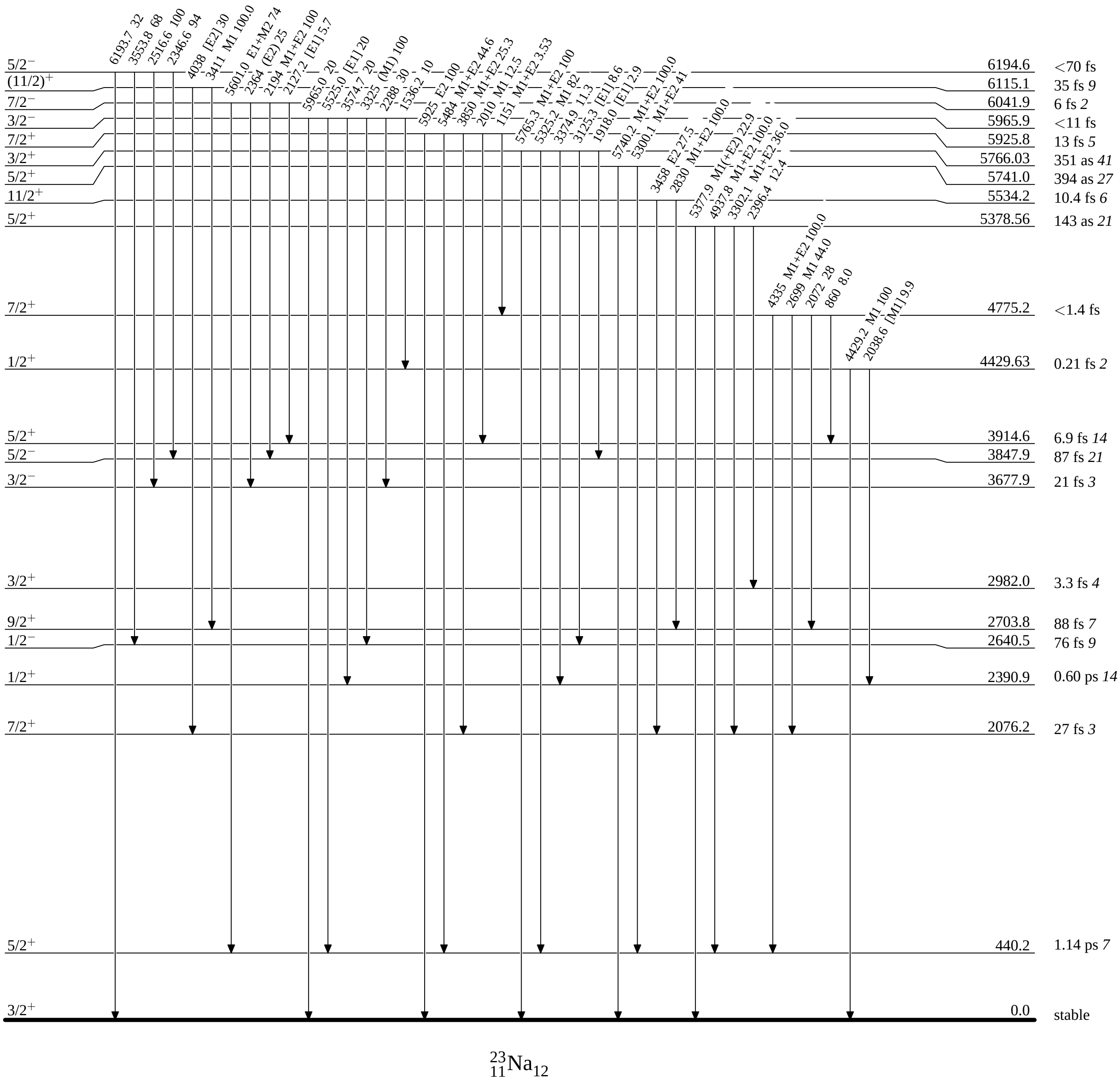
Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided



Adopted Levels, Gammas

Level Scheme (continued)

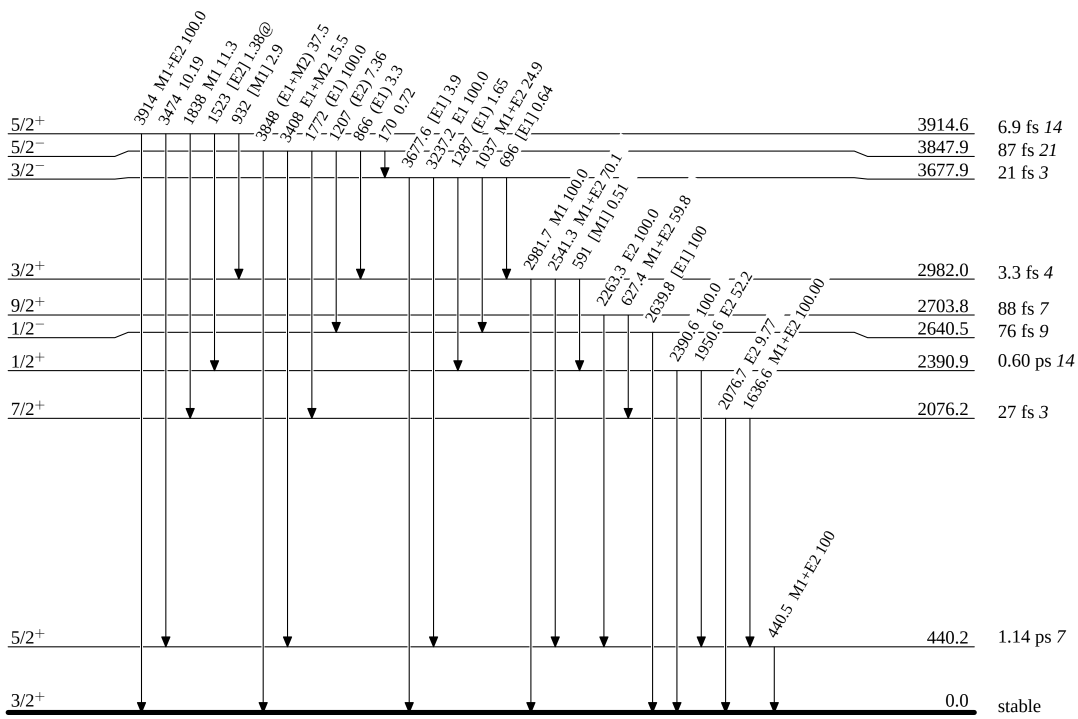
Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided



Adopted Levels, Gammas

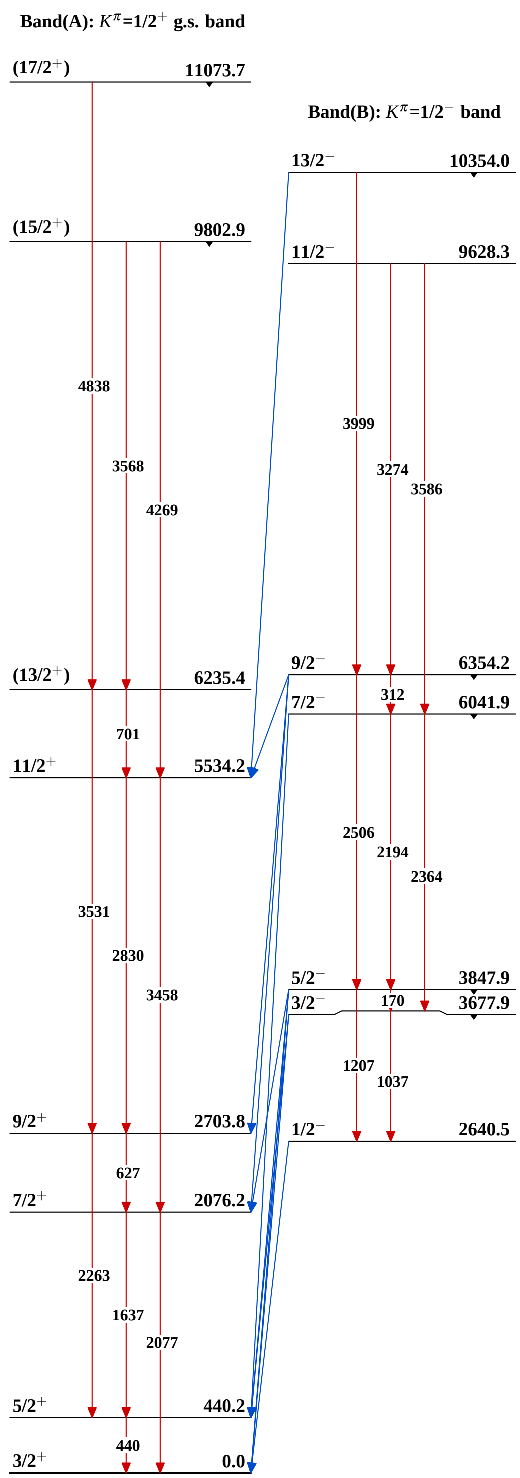
Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided



$^{23}_{11}Na_{12}$

Adopted Levels, Gammas



$^{23}_{11}Na_{12}$

^{23}Ne β^- decay 1974Al03,1963Ca06,1957Pe12

Parent: ^{23}Ne: E=0.0; J$^\pi$=5/2$^+$; $T_{1/2}$=37.25 s *10*; Q(β^-)=4375.80 *10*; %β^- decay=100

Other references: 1972Ch41, 1968Mo03, 1965La10, 1940Po01.

1974Al03: ^{23}Ne was produced via ^{22}Ne(d,p) reaction, E(d)=3.0 MeV. ~0.4 atm of Ne target in a gas cell was bombarded for 10 sec, gas was expanded through the trap to the cylindrical counting cell, internal dimension of 7.5 cm diameter and 2 cm height. 70 cm^3 Ge(Li) detector, NE102 plastic scintillator. Measured Eγ, Iγ, ^{23}Ne half-life; Deduced beta feeding to excited states from γ-ray intensity balance, log *ft* values.

1963Ca06: ^{23}Ne was produced via ^{23}Na(n,p) reaction by bombarding 100 g of sodium aluminum silicate in the core of the Oak Ridge research reactor. Emanating ^{23}Ne was swept continuously by water vapor to the laboratory; vapor removed and contamination purged ^{23}Ne gas was allowed to decay in a source volume; some of the ions formed following β decay emerged from the volume as a beam, were analyzed by electrostatic and magnetic analyzer in tandem. Measured recoil energy spectrum from 100 to 500 eV; deduce electron-neutrino angular correlation coefficient; assuming *V-A* (Vector-Axial vector) interaction is valid – deduced g.s. and 1st excited state β feeding in ^{23}Na.

1957Pe12: ^{23}Ne was produced via ^{23}Na(d,2p) reaction by bombarding NaCl powdered target, E_d=22 MeV. Active gases were swept by flow of helium to a source chamber of small volume at 100 ft away from the target. Contaminating activities were removed by activated coconut charcoal trap cooled with LN_2. β particles were detected by a stilbene crystal, γ radiation was detected by two NaI(Tl) crystals. Measured Eγ, Iγ, γ-γ coincidence, Eβ spectrum; deduced β feeding to g.s. and excited states.

1972Ch41: Source from ^{22}Ne(d,p), E=2.5 MeV, beam chopper, 99.5% enriched ^{23}Ne gas target cell (dimension not mentioned). 200 cycles of irradiation and counting. 25.5 cm^3 Ge(Li) detector. Measured Eγ, Iγ, deduced log *ft*, decay scheme. Some of the reported γ in 1965La10 were not observed.

1968Mo03: Source from ^{22}Ne(n,γ), E=thermal, in a circulating volume. 10 and 30 cm^3 Ge(Li), NaI(Tl) detectors. Measured Eγ, Iγ, $\gamma\gamma$ coincidence. Deduced decay scheme. Some of the reported γ in 1965La10 were not observed.

1965La10: Source from ^{22}Ne(n,γ), E=thermal, in a large volume cell (dimension not mentioned). NaI(Tl) and anthracene crystal. Measured Eγ, Iγ, $\gamma\gamma$-coin, and Eβ. Proposed level scheme. Nine γ rays were placed from seven excited states. Four of the γ rays and four levels were not confirmed in later studies.

1940Po01: ^{23}Ne produced in ^{22}Ne(d,p), E(d)=2.6 MeV. Measured Eβ and half-life 43 s *3* of ^{23}Ne and β-endpoint energy=4.1 MeV.

Sum of decay energies of this dataset is 4378 keV *42*, as compared to Q(β^-)=4375.80 keV *10* (2017Wa10) for ^{23}Ne β^- decay.

^{23}Na Levels

E(level)†	J$^\pi$	$T_{1/2}$
0.0	3/2$^+$	stable
440.3 *9*	5/2$^+$	
2076.9 *7*	7/2$^+$	
2981.8 *7*	3/2$^+$	

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

β^- radiations

E(decay)	E(level)	Iβ^-†‡	Log *ft*	Comments
(1394.0 *7*)	2981.8	0.065 *4*	6.13 *3*	
(2298.9 *7*)	2076.9	1.10 *6*	5.82 *2*	E(decay),Iβ^-: Eβ=2.4 × 10^3 *1* (1957Pe12). Iβ=1.00 *15* (1957Pe12).
(3935.5 *9*)	440.3	31.9 *10*	5.38 *2*	E(decay),Iβ^-: Eβ=3950 *50* (1957Pe12). Iβ=32 *1* (1963Ca06) and 32 *3* (1957Pe12).
(4375.80 *10*)	0.0	67 *1*	5.27 *1*	E(decay): 4383 *8* (1963Ca06) and 4390 *50* (1957Pe12). Iβ^-: 67 *1* (1963Ca06) and 67 *3* (1957Pe12).

† From γ-ray intensity balance.
‡ Absolute intensity per 100 decays.

^{23}Ne β^- decay 1974Al03,1963Ca06,1957Pe12 (continued)

$\gamma(^{23}Na)$

Iγ normalization: From Σ I(γ+ce) to g.s.=33 *1* (100 − 67 *1* (1963Ca06)), assuming 1% statistical uncertainty for the 440γ.

E_γ †	I_γ ‡#	E_i(level)	J^π_i	E_f	J^π_f	Mult.†	δ†	α@	Comments
440.5 *6*	100	440.3	5/2$^+$	0.0	3/2$^+$	M1+E2	+0.065 *5*	5.45×10^{-5} *8*	%Iγ=32.9 *10* E_γ: 440 (1974Al03), 440.0 *6* (1968Mo03). I_γ: 33.0 (1974Al03).
1636.6 *8*	3.03 *12*	2076.9	7/2$^+$	440.3	5/2$^+$	M1+E2	+0.19 *1*	1.12×10^{-4}	%Iγ=1.00 *5* E_γ: 1636 (1974Al03). I_γ: 1.00 *4* (1974Al03).
2076.7 *8*	0.306 *18*	2076.9	7/2$^+$	0.0	3/2$^+$	E2(+M3)	−0.14 *14*	3.50×10^{-4} *15*	%Iγ=0.101 *7* E_γ: 2076 (1974Al03). I_γ: 0.101 *6* (1974Al03).
2541.3 *9*	0.082 *6*	2981.8	3/2$^+$	440.3	5/2$^+$	M1+E2	−0.09 *3*	4.73×10^{-4}	%Iγ=0.0269 *22* E_γ: 2542 (1974Al03). I_γ: 0.027 *2* (1974Al03).
2981.7 *8*	0.115 *6*	2981.8	3/2$^+$	0.0	3/2$^+$	M1		6.51×10^{-4}	%Iγ=0.0378 *23* E_γ: 2982 (1974Al03). I_γ: 0.038 *2* (1974Al03).

† From Adopted Gammas. γ-ray energy reported in 1974Al03 is listed in comments section.

‡ 1974Al03 present Iγ relative to Iγ(440)=33 (listed in comments). Evaluators present Iγ relative to Iγ(440)=100. The uncertainties of Iγ (1974Al03) are statistical only. A larger systematic uncertainty can be expected for the cylindrical gas cell (diameter 7.5 cm and height 2 cm) counting geometry. However, the recommend uncertainty of the absolute γ-ray emission probability is expected to be valid due to the unique feature of the decay scheme as Iγ(1+α)(440) represents 99.6% of ΣIγ(1+α) to the g.s. from excited states and the β branching to the g.s. and 1st excited state dominate the total Iβ, (67+32)=99%, that yields the same uncertainties as %Iβ=67 *3*, 32 *3* (1957Pe12), 67 *1*, 32 *1* (1963Ca06), for the g.s. and 1st excited states, respectively. As a result, the uncertainty of the Iγ(440) can be considered equivalent to ΔIβ(1st excited state at 440).

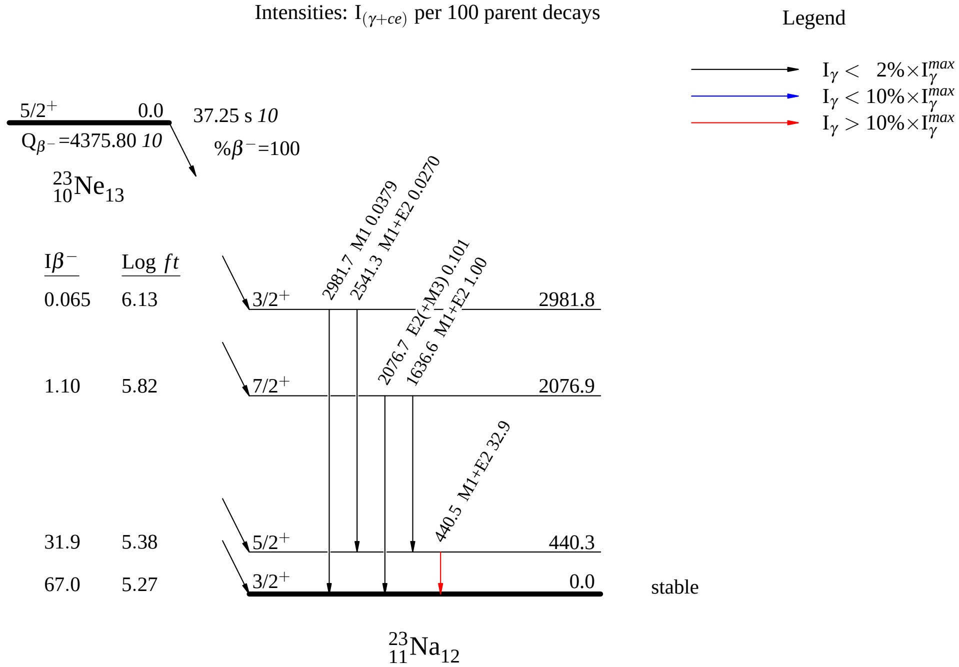
For absolute intensity per 100 decays, multiply by 0.329 *10*.

@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

^{23}Ne β^- decay 1974Al03,1963Ca06,1957Pe12

Decay Scheme

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



^{23}Mg ε decay 2017Ma18,1974Ma41

Parent: ^{23}Mg: E=0.0; J^π=3/2$^+$; $T_{1/2}$=11.3046 s *45*; Q(ε)=4056.179 *32*; %ε+%β^+ decay=100

^{23}Mg-Q(ε): From 2017Wa10 (2016-ame). Measured value: 4056.182 *32* (2019Ka30).

Others: 1960Ta14, 1968Go05, 1971De05, 1974Al03, 1977Az01.

2017Ma18: ^{23}Mg was produced from ^{23}Na(p,n) reaction, E=15,30 MeV; After mass separation, ^{23}Mg nuclides (contaminated only by ^{23}Na) were transported to the yield station and deposited on a Mylar tape (50 μm thickness and 1.25 cm width) for β particle and γ ray detection by plastic scintillator and HPGe detectors. The plastic scintillator was read out by two photomultipliers (PMs). The coincidence signals of these PMs were used to count the β+ particles and to trigger the data acquisition of the HPGe detector. Measured ^{23}Mg half-life from β(t), 440γ absolute emission probability, and deduced super-allowed β-transition branch g.s. to g.s. from feedings of ^{23}Na excited states.

1974Ma41: ^{23}Mg produced from ^{23}Na(p,n), Ep=10 MeV, reaction. Measured γ-ray branching, beta feedings.

^{23}Na Levels

E(level)†	J^π†	$T_{1/2}$
0.0	3/2$^+$	stable
440.2 *4*	5/2$^+$	
2390.9 *3*	1/2$^+$	

† From Adopted Levels.

ε,β^+ radiations

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
(1665.3 *3*)	2390.9	0.006 *1*	0.0006 *1*	4.97 *7*	0.007 *1*	I(ε+β^+) − from 1974Ma41.
(3616.0 *4*)	440.2	7.84 *11*	0.00927 *16*	4.434 *6*	7.85 *11*	I(ε+β^+) − from γ intensity balance.
(4056.18 *3*)	0.0	92.08 *11*	0.0681 *7*	3.6675 *6*	92.15 *11*	Deduced by the evaluators (100 − g.s. feeding branch of 440.5γ. Other: 92.08 *14* (2017Ma18 − considering literature and their measured data).

† Absolute intensity per 100 decays.

γ(^{23}Na)

E_γ†	I_γ#	E_i(level)	J^π_i	E_f	J^π_f	Comments
440.5 *6*	7.85 *11*	440.2	5/2$^+$	0.0	3/2$^+$	I_γ: Weighted average of 8.6 *3* (1968Go05), 8.1 *4* (1974Ma41), 7.79 *15* (1977Az01), and 7.805 *81* (2017Ma18). Other values: 9.1 *5* (1960Ta14), 9.1 *4* (1974Al03) − discrepant data omitted in the wt. average. 6 *3* (for rough check in 1971De05).
1950.6 *4*	0.0025‡ *7*	2390.9	1/2$^+$	440.2	5/2$^+$	
2390.6 *4*	0.0044‡ *7*	2390.9	1/2$^+$	0.0	3/2$^+$	

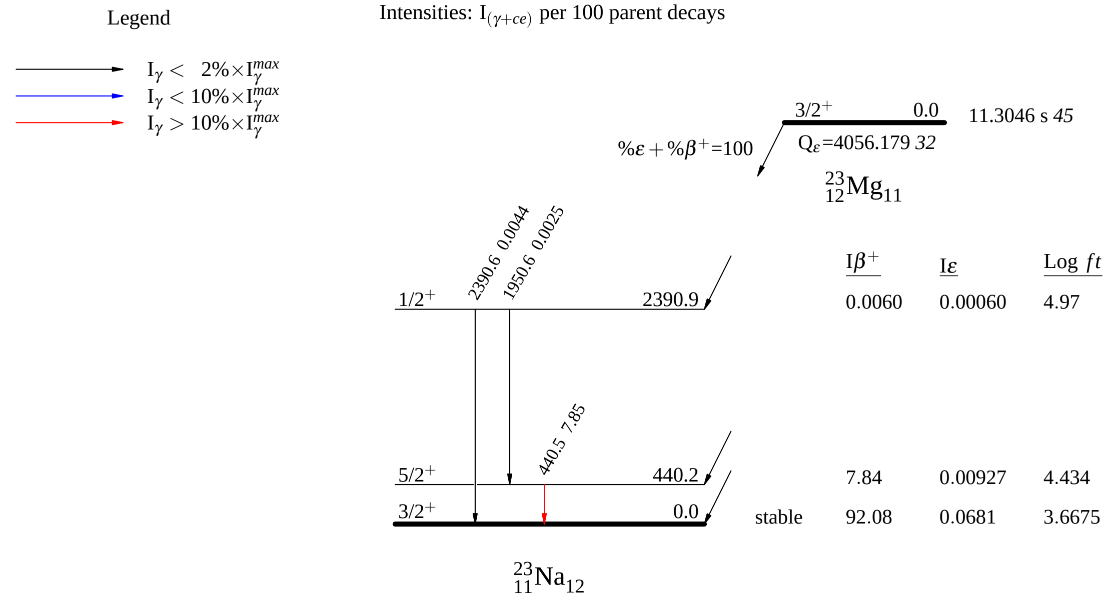
† From Adopted Gammas.

‡ From ε feeding and adopted γ-ray branching intensities.

Absolute intensity per 100 decays.

^{23}Mg ε decay 2017Ma18,1974Ma41

Decay Scheme



^{24}Al β^+p decay 1994Ba54

Parent: ^{24}Al: E=0.0; $J^\pi=4^+$; $T_{1/2}$=2.053 s *4*; Q(β^+p)=2192.02 *23*; %β^+p decay=0.0012 *3*
^{24}Al-%β^+p decay: Measured by 1994Ba54.
1994Ba54: ^{24}Al was produced from ^{24}Mg(p,n) reaction using pulsed proton beam, E=28.5 and 20 MeV; 99.8% enriched ^{24}Mg target (thickness 1.9 mg/cm^2); Recoil products were collected using a helium-jet system to the counting chamber and deposited onto a tape in the center of a low-energy proton detector ball; the detector consists of six individual gas-ΔE, gas-ΔE, Si-E triple telescopes; measured Ep spectrum; deduced β delayed proton branch of ^{24}Al.

^{23}Na Levels

E(level)	J^π
0.0	3/2$^+$

Delayed Protons (^{23}Na)

E(p)	E(^{23}Na)	Comments
7.0×10^2 *40*	0.0	E(p): From a range of 300 – 1100 keV in spectrum.

^{7}Li(^{16}O,γ) 1969Fe05

Other: 1986No05.

E= 12-32 MeV; γ rays were measured by NaI detector. Resolution ~5.5% for 25 MeV γ-ray energy. Measured σ(E;Eγ,θ); Deduced resonance level, level-width. Also studied ^{11}B(^{12}C,γ) reaction at 90° – only weak structure of ^{23}Na was observed.

^{23}Na Levels

E(level)†	Γ	Comments
0.0		
440		
2076		
25400	0.67 MeV *20*	E(level): From 1969Fe05. σ_{peak}=2.4 μb *7*. (2J+1)Γ_γ~0.5 keV.

† From Adopted Levels, except where otherwise noted.

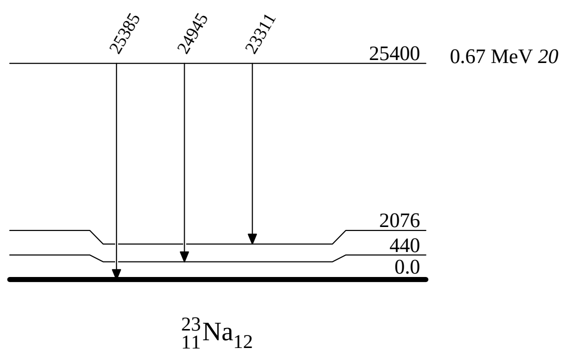
γ(^{23}Na)

E_γ†	E_i(level)	E_f
23311	25400	2076
24945‡	25400	440
25385‡	25400	0.0

† From level energy difference, recoil energy subtracted.
‡ Unresolved.

^{7}Li(^{16}O,γ) 1969Fe05

Level Scheme



^{11}B(^{16}O,α) 1975Go25

Target: Self-supporting, 95% enriched ^{11}B (thickness 30 μg/cm^2); Projectile: ^{16}O ions from Oak Ridge tandem accelerator, E=41.6-45.4 MeV; Enge split-pole magnetic spectrometer, position-sensitive proportional counter; Measured σ(E, E$_\alpha$, (θ)); Deduced excited level energies, spin and parity. FWHM 140 − 160 keV.

^{23}Na Levels

Many levels in adopted dataset for doublet 8.94 and 9.041 MeV in 1975Go25 – not listed by the evaluators in this dataset.
<dσ/dΩ> in units of mb/sr in comments section.

E(level)[†]	J$^\pi$[@]	Comments
0.0		<dσ/dΩ> = 0.047 (at 10°), 0.032 (22°), and 0.024 (36°) (c.m.).
440		<dσ/dΩ> = 0.097 (at 10°), 0.055 (22°), and 0.043 (36°) (c.m.).
2076		<dσ/dΩ> = 0.123 (at 10°), 0.072 (22°), and 0.046 (36°) (c.m.).
2391		<dσ/dΩ> = 0.038 (at 10°), 0.017 (22°), and 0.012 (36°) (c.m.).
2672		E(level): Average of 2640.5 and 2703.8, unresolved doublet in 1975Go25. <dσ/dΩ> = 0.021 (at 10°), 0.131 (22°), and 0.096 (36°) (c.m.).
2982		<dσ/dΩ> = 0.058 (at 10°), 0.04 (22°), and 0.016 (36°) (c.m.).
3678		<dσ/dΩ> = 0.040 (at 10°), 0.023 (22°), and 0.013 (36°) (c.m.).
3881		E(level): Average of 3847.9 and 3914.6, unresolved doublet in 1975Go25. <dσ/dΩ> = 0.178 (at 10°), 0.09 (22°), and 0.056 (36°) (c.m.).
4775		<dσ/dΩ> = 0.145 (at 10°), 0.09 (22°), and 0.044 (36°) (c.m.).
5534		<dσ/dΩ> = 0.176 (at 10°), 0.14 (22°), and 0.101 (36°) (c.m.).
5754		E(level): Average of 5741.0 and 5766.03, unresolved doublet in 1975Go25. <dσ/dΩ> = 0.076 (at 10°), 0.054 (22°), and 0.025 (36°) (c.m.).
6004		E(level): Average of 5965.9 and 6041.9, unresolved doublet in 1975Go25. <dσ/dΩ> = 0.131 (at 10°), 0.07 (22°), and 0.035 (36°) (c.m.). J$^\pi$: (1/2$^-$) proposed by 1975Go25 for 6041.9 keV level of the doublet.
6298[#]		E(level): Average of 6235.4, 6305.6 and 6354.2, unresolved multiplet (1975Go25 present as quadruplet). However, 1978En02 evaluation did not list 6263 keV *14* level reported in 1971Kr04, possible doublet of first two. <dσ/dΩ> = 0.321 (at 10°), 0.21 (22°), and 0.14 (36°) (c.m.).
6644[#]		E(level): Average of 6578.0, 6618.3 and 6735.5, unresolved triplet in 1975Go25. <dσ/dΩ> = 0.071 (at 10°), 0.04 (22°), and 0.025 (36°) (c.m.).
6844		E(level): Average of 6820.2 and 6867.7, unresolved doublet in 1975Go25. <dσ/dΩ> = 0.107 (at 10°), 0.06 (22°), and 0.03 (36°) (c.m.).
7109[#]		E(level): Average of 7070.8, 7081.9, 7133.5 and 7150, unresolved quadruplet in 1975Go25. <dσ/dΩ> = 0.228 (at 10°), 0.127 (22°), and 0.11 (36°) (c.m.).
7416[#]		E(level): Average of 7385, 7412.4 and 7451.5, unresolved triplet in 1975Go25. <dσ/dΩ> = 0.209 (at 10°), 0.164 (22°), and 0.1 (36°) (c.m.). J$^\pi$: (1/2$^+$) proposed by 1975Go25 for 7412 keV level of the triplet.
8311		E(level): Average of 8301.6 and 8319.5, unresolved doublet in 1975Go25. <dσ/dΩ> = 0.234 (at 10°), 0.103 (22°), and 0.08 (36°) (c.m.).
8512[#]		E(level): Average of 8475.7, 8503 and 8558, unresolved triplet in 1975Go25. <dσ/dΩ> = 0.180 (at 10°), 0.180 (22°), and 0.08 (36°) (c.m.).
9840[‡] *60*	(3/2$^+$)[‡]	<dσ/dΩ> = 0.400 (at 10°), 0.24 (22°), and 0.24 (36°) (c.m.).
10300[‡#] *60*		<dσ/dΩ> = 0.222 (at 10°), 0.172 (22°), and 0.13 (36°) (c.m.).
10900[‡#] *60*	(1/2$^+$)[‡]	<dσ/dΩ> = 0.239 (at 10°), 0.12 (22°), and 0.1 (36°) (c.m.).
11280[‡#] *60*		<dσ/dΩ> = 0.348 (at 10°), 0.24 (22°), and 0.24 (36°) (c.m.).
11580[‡#] *60*	(1/2$^-$)[‡]	<dσ/dΩ> = 0.29 (at 10°), 0.173 (22°), and 0.14 (36°) (c.m.).
13150[‡] *60*	(1/2$^+$)[‡]	<dσ/dΩ> = 0.176 (at 10°), 0.168 (22°), and 0.13 (36°) (c.m.).
13820[‡] *60*	(1/2$^+$)[‡]	<dσ/dΩ> = 0.300 (at 10°), 0.207 (22°), and 0.15 (36°) (c.m.).
14240[‡] *60*	(3/2$^+$)[‡]	<dσ/dΩ> = 0.25 (at 10°), 0.19 (22°), and 0.16 (36°) (c.m.).
14700[‡] *60*	(3/2$^+$)[‡]	<dσ/dΩ> = 0.51 (at 10°), 0.33 (22°), and 0.30 (36°) (c.m.).

Continued on next page (footnotes at end of table)

^{11}B(^{16}O,α) 1975Go25 (continued)

^{23}Na Levels (continued)

† From Adopted Levels (value rounded to nearest keV), except where otherwise note. 1975Go25 quote excited levels below 9840 keV from literature. Many unresolved multiplet.
‡ From 1975Go25.
# Multiplet for three or more levels – not referenced in Adopted Levels.
@ From 1975Go25 based on $\sigma(\theta)$.

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02

Other references: 2018Ji01,2017Mu04,2007Sp03,2006Ba64,2006Ag08,
2005Bb06,2005Je06,1990Ti02,1984FO12,1981Zy01,1980An08,1980Ke15,
1977Ev02,1977Ke02,1976Ba05,1976Ba53,1975Jo03,1975Ke07,1975Gr25,
1975Co14,1975Co10,1974Vo02,1974Va01,1974Ke16,1973Fr07,1972Fr01, 1973Wa26.

2013Je04: E(^{12}C)=16, 22 MeV provided by the ATLAS accelerator at ANL. Target=160 μg/cm^2 ^{12}C. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma(\theta)$(DCO), $T_{1/2}$ using the Gammasphere array and the fractional Doppler shift technique. Deduced levels, J, π, multipolarity, bands. Comparison with shell-model calculations.

1977Ke05: ^{12}C(^{12}C,p) E=38.82 MeV. Measured p$\gamma(\theta$,t), DSA.

1979Lu02: ^{12}C(^{12}C,p) E=14.3 MeV. Measured Eγ, Ep, pγ coincidence.

1990Ti02: ^{12}C(^{12}C,p) E=15-24 MeV. Measured DSA. coincidence.

1984Fo12: ^{12}C(^{12}C,p) E=39 MeV. Magnetic spectrometer $\sigma(\theta)$, $\sigma(E_p)$.

1976Ba05: ^{12}C(^{12}C,p) E=38.6 MeV. Measures p$\gamma(\theta)$, DSA.

1975Jo03, 1972Fr01: ^{12}C(^{12}C,p) E=28.2 MeV. Measures p$\gamma(\theta)$, linear polarization.

1973Wa26: ^{12}C(^{12}C,p) E=19 MeV. Measured Eγ, DSA.

^{23}Na Levels

E(level)[†]	J$^\pi$[@]	$T_{1/2}$[&]	σ(tot)[a]	Comments
0.0[b]	3/2$^+$		82 *6*	
439.82[b] *15*	5/2$^+$	1.22 ps *7*	83 *7*	$T_{1/2}$: From mean lifetime of 1.76 ps *10*: weighted average of 1.80 ps *11* (1990Ti02) and 1.63 ps *20* (1973Wa26).
2075.9[b] *4*	7/2$^+$		126 *7*	
2391.1 *5*	1/2$^+$		46 *4*	
2640.5[c] *6*	1/2$^-$		54 *5*	E(level): Other: 2657 *7* (1984Fo12).
2703.2[b] *4*	9/2$^+$	0.092 ps *8*	124 *6*	$T_{1/2}$: From mean lifetime of 0.133 ps *12*: weighted average of 0.139 ps *10* (1990Ti02) and 0.11 ps *2* (1973Wa26).
2982.1 *5*	3/2$^+$		85 *6*	
3677.8[c] *5*	3/2$^-$		62 *5*	
3847.8[c] *4*	5/2$^-$		101 *6*	E(level): Other: 3859 *5* (1984Fo12).
3914.5 *4*	5/2$^+$		95 *6*	
4417[‡] *10*			40 *5*	
4774.8 *5*	7/2$^+$			
5384[‡] *5*			70 *5*	
5533.7[b] *5*	11/2$^+$	10.4 fs *55*	380 *12*	J$^\pi$: From 1975Jo03, based on particle γ-ray linear polarization and angular correlation measurements of 3458γ. $T_{1/2}$: From mean lifetime of 15 fs *8*: Weighted average of 20 fs *12* (1977Ke05), and 12 fs *8* (1973Fr07).
5754[‡#] *6*			65 *5*	
5925.5 *5*	7/2$^+$		119 *6*	E(level): Other: 5943 *7* (doublet) (1984Fo12).
5965.9 *9*	3/2$^-$			
6041.5[c] *6*	7/2$^-$		102 *6*	E(level): Other: 6032 *5* (1984Fo12).
6114.6 *6*	11/2$^+$	35 fs *9*	1103 *20*	$T_{1/2}$: From τ=50 fs *13*: weighted average of 39 fs *13* (1977Ke05) and 75 fs *20* (1973Fr07).
6234.7[b] *6*	13/2$^+$	16 fs *8*	345 *10*	E(level): Other: 6229 *4* (doublet) (1984Fo12). $T_{1/2}$: From mean lifetime of 23 fs *12*: Weighted average of 19 fs *18* (1977Ke05) and 24 fs *12* (1973Fr07).
6353.8[c] *5*	9/2$^-$	21 fs *5*	24.5 *8*	J$^\pi$: Q γ to 5/2$^-$, RUL (1973Fr07 – (^{12}C,pγ)), and band assignment. $T_{1/2}$: From mean lifetime of 30 fs *7* (1972Fr01).
6577.6 *6*	9/2$^+$		82 *6*	E(level): Other: 6582 *7* (1984Fo12).
6617.9 *8*	(7/2$^+$)		84 *5*	E(level): Other: 6610 *8* (1984Fo12).
6730[‡] *7*			51 *4*	
6820.0 *8*	5/2$^-$		55 *4*	E(level): Other: 6825 *8* (1984Fo12).

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$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[@]	$T_{1/2}$[&]	σ(tot)[a]	Comments
6880.6 *11*	(7/2,11/2)		83 *5*	E(level): Other: 6874 *6* (1984Fo12).
6936[‡#] *6*			110 *6*	
7054.7 *11*	(5/2,13/2)		151 *7*	E(level): Other: 7075 *4* (doublet) (1984Fo12).
7125.3 *6*	$9/2^+$		185 *8*	E(level): Other: 7119 *5* (1984Fo12).
7184.9 *6*	$9/2^+$		122 *6*	E(level): Other: 7176 *8* (doublet) (1984Fo12).
7267.7 *6*	$13/2^+$	18 fs *6*	835 *17*	E(level): Other: 7272 *3* (doublet) (1984Fo12). $T_{1/2}$: From mean lifetime of 26 fs *8* (1977Ke05). Other: <21 fs (τ <30 fs (1973Fr07)).
7279.9 *11*	(1/2,9/2)			
7393.0 *6*	$11/2^+$	<18 fs	655 *15*	E(level): Other: 7398 *4* (doublet) (1984Fo12). $T_{1/2}$: From <21 fs (τ <30 fs (1973Fr07)).
7477.0 *11*	(1/2,9/2)			
7489.0 *7*	$3/2^-$			
7563.6 *11*	(5/2,9/2)		121 *6*	E(level): Other: 7566 *3* (1984Fo12).
7686.6 *7*	$9/2^+$		218 *8*	E(level): Other: 7697 (1984Fo12).
7750.6 *11*	$5/2^+$			
7835.3 *7*	$7/2^+$			
7872.7 *8*	$3/2^+$		344 *10*	E(level): Other: 7863 *6* (1984Fo12).
7973.7 *11*	(3/2,11/2)	<28 fs		$T_{1/2}$: From mean lifetime <40 fs (1973Fr07).
7991.0 *6*	$11/2^+$		274 *10*	E(level): Other: 7987 *6* (1984Fo12).
8068[‡#] *4*			112 *6*	
8301.3 *11*	$(7/2^-)$	<59 fs		$T_{1/2}$: From mean lifetime <85 fs (1973Fr07).
8318.9 *9*	$9/2^+$		532 *13*	E(level): Other: 8326 *4* (1984Fo12).
8432.0 *11*	(5/2,13/2)			
8483[‡#] *4*			212 *8*	
8651.0 *11*	(3/2,7/2)		249 *9*	E(level): Other: 8633 *5* (1984Fo12).
8722[‡#] *12*			95 *6*	
8798.4 *8*	$(3/2,7/2)^+$			
8820.3 *7*	$9/2^-$			
8828.1 *11*	$1/2^+$		300 *9*	E(level): Other: 8839 *15* (1984Fo12).
8945.1 *8*	$(3/2^+)$			
8946.4 *6*	$7/2^-$	21 fs *10*		$T_{1/2}$: From mean lifetime 30 fs *15* (1973Fr07).
8963.5 *11*	(1/2,9/2)		344 *10*	E(level): Other: 8965 *9* (1984Fo12).
8972.9 *11*	$5/2^+$			
9039.0 *7*	$15/2^+$			
9042.3 *8*	$(7/2,9/2)^+$	10 fs *5*	1550 *30*	E(level): Others: 9051 *7* (1984Fo12). $T_{1/2}$: From mean lifetime of 15 fs *7*: Weighted average of 19 fs *10* (1977Ke05) and 11 fs *+8−9* (1976Ba05). Other: <21 fs (1973Fr07).
9101.0 *6*	$13/2^+$			
9172.2 *11*	(7/2,11/2)			
9207.1 *11*	$3/2^-$			
9210.0 *6*	$11/2^+$			
9213.0 *11*	(1/2,5/2)			
9285.1 *11*	(5/2,9/2)			
9292.1 *9*	(7/2,11/2)			J^{π}: (7/2,11/2) and $(11/2^+)$ in Table I and the latter in Fig. 5 (2013Je04).
9325.3 *11*	(7/2,11/2)			
9398.7 *11*	$7/2^-$			
9400.9 *7*	(3/2,7/2)			
9541.1 *12*	$(13/2^+)$			
9627.9[c] *9*	$11/2^-$	2.8 fs *14*		$T_{1/2}$: From τ=4 fs *2* (2013Je04).
9802.9[b] *7*	$15/2^+$	4.2 fs *14*		$T_{1/2}$: From τ=6 fs *2* : Weighted average of mean lifetimes 4 fs *2* (2013Je04), 12 fs *8* (1976Ba05), 11 fs *6* (1977Ke05)), and 21 fs *9* (1977Ev02).
9875.2 *8*	(7/2,11/2)			
9917.3 *11*	(1/2,9/2)			

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$^{12}C(^{12}C,p\gamma)$ **2013Je04,1977Ke05,1979Lu02 (continued)**

^{23}Na Levels (continued)

E(level)[†]	J^π[@]	$T_{1/2}$[&]	Comments
9923.9 *11*	(3/2,7/2)		
9964.2 *12*	(9/2,13/2)		
9987.9 *12*	$11/2^-$		
10033.4 *9*	(3/2,11/2)		
10036.0 *11*	(3/2,7/2)		
10156.0 *11*	(1/2,9/2)		
10212.4 *12*	(3/2,11/2)		
10237.5 *11*	(3/2,11/2)		
10333.5 *11*	(3/2,11/2)		
10353.6[c] *7*	$13/2^-$	<0.69 fs	$T_{1/2}$: From τ < 1 fs (2013Je04). Other: <18 fs (τ <25 fs (1973Fr07)).
10404.1 *12*	$(11/2^-)$		
10408.5 *11*	(3/2,11/2)		
10438.2 *11*	(1/2,9/2)		
10590.2 *7*	$13/2^-$		
10697.5 *8*	(7/2,11/2)		
10759.2 *12*	(9/2,17/2)		
10797.7 *11*	(3/2,11/2)		
10860.5 *8*	(3/2,9/2)		
10922.7 *11*	(3/2,11/2)		
11073.2[b] *9*	$17/2^+$	34.7 fs *69*	$T_{1/2}$: From τ=50 fs *10* (2013Je04).
11271.4 *9*	$11/2^-$	12.5 fs *21*	$T_{1/2}$: From τ=18 fs *3* (2013Je04).
11424.3 *9*	$(11/2^+)$		
11538.4 *9*	$15/2^+$		
11651.2 *9*	$(13/2^+)$		
12013.2 *11*	(3/2,11/2)		
12592.8 *9*		<14 fs	E(level): From 1979Lu02. $T_{1/2}$: From τ<20 fs (1977Ke05).

[†] From least-squares fit to γ-ray energies, except otherwise noted.
[‡] From 1984Fo12.
[#] Doublet.
[@] From 2013Je04, based on γ-ray multipolarities and placements.
[&] From mean lifetime (listed in comments) determined by fractional Doppler shift technique (2013Je04), except where otherwise noted.
[a] From 1984Fo12 in units of μb.
[b] Band(A): $K^\pi=1/2^+$ g.s. band.
[c] Band(B): $K^\pi=(1/2^-)$ band.

$\gamma(^{23}Na)$

E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[&]	Comments
170 *1*	0.13 *3*	3847.8	$5/2^-$	3677.8	$3/2^-$			
312 *1*	0.06 *1*	6353.8	$9/2^-$	6041.5	$7/2^-$			
439.80 *15*		439.82	$5/2^+$	0.0	$3/2^+$	M1+E2	+0.12 *5*	DCO=0.95 *1* (2013Je04); A_2=−0.19 *4*; A_4=+0.14 *10* (1977Ke05) E_γ: From 1973Wa26. Other: 440 *1* (2013Je04).
591 *1*	0.3 *1*	2982.1	$3/2^+$	2391.1	$1/2^+$			
626.8 *4*	35.2 *2*	2703.2	$9/2^+$	2075.9	$7/2^+$	M1+E2	+0.07 *5*	DCO=0.90 *1* (2013Je04); A_2=−0.18 *4*; A_4=+0.01 *6* (1977Ke05) E_γ: From 1973Wa26. Other: 627 *1* (2013Je04).

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$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02 (continued)

$\gamma(^{23}Na)$ (continued)

E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[&]	Comments
701 *1*	2.0 *1*	6234.7	13/2+	5533.7	11/2+	M1+E2	+1.05 *70*	DCO=0.90 *2* (2013Je04); A_2=−0.03 *7*; A_4=+0.06 *12*(1977Ke05)
819 *1*	0.4 *1*	6353.8	9/2−	5533.7	11/2+	D		DCO=1.00 *12* (2013Je04) E_γ: 820 in figure 11 of 2013Je04.
860 *1*	0.6 *1*	4774.8	7/2+	3914.5	5/2+	D		DCO=0.91 *10* (2013Je04)
866 *1*	0.16 *4*	3847.8	5/2−	2982.1	3/2+	D		DCO=0.82 *7* (2013Je04)
932 *1*	0.08 *2*	3914.5	5/2+	2982.1	3/2+			
984 *1*	0.3 *1*	8820.3	9/2−	7835.3	7/2+			
1033 *1*	0.5 *1*	7267.7	13/2+	6234.7	13/2+			DCO=1.56 *16* (2013Je04); A_2=+0.00 *19*; A_4=+0.18 *27*(1977Ke05) ΔJ=0 transition.
1037 *1*	0.2 *1*	3677.8	3/2−	2640.5	1/2−	D		DCO=0.81 *2* (2013Je04)
1070 *1*	0.6 *1*	11424.3	(11/2+)	10353.6	13/2−	D		DCO=0.76 *7* (2013Je04)
1087 *1*	0.2 *1*	10033.4	(3/2,11/2)	8946.4	7/2−			
1110 *1*	0.4 *1*	9101.0	13/2+	7991.0	11/2+	D+Q		DCO=0.77 *21* (2013Je04)
1151 *1*	0.3 *1*	5925.5	7/2+	4774.8	7/2+	D+Q		DCO=1.39 *25* (2013Je04)
1153 *1*	3.1 *1*	7267.7	13/2+	6114.6	11/2+	M1+E2		DCO=0.76 *2* (2013Je04); A_2=−0.33 *7*; A_4=+0.15 *10*(1977Ke05) I_γ: Branching 84 *3* (2013Je04), 68 *6* (1979Lu02) relative to $I\gamma$(2506γ).
1207 *1*	1.2 *3*	3847.8	5/2−	2640.5	1/2−	Q		DCO=1.76 *7* (2013Je04)
1259 *1*	2.3 *1*	7184.9	9/2+	5925.5	7/2+	D+Q		DCO=0.80 *1* (2013Je04)
1266 *1*	0.15 *5*	10212.4	(3/2,11/2)	8946.4	7/2−			
1287 *1*	0.6 *1*	3677.8	3/2−	2391.1	1/2+	D		DCO=0.68 *9* (2013Je04)
1523[a] *1*	0.2[a] *1*	3914.5	5/2+	2391.1	1/2+			3/2+ listed for initial level in Table I of 2013Je04 seems a misprint.
1523[a] *1*	0.2[a] *1*	9210.0	11/2+	7686.6	9/2+			
1579 *1*	1.8 *1*	6353.8	9/2−	4774.8	7/2+	D		DCO=0.84 *2* (2013Je04)
1636 *1*	100.0	2075.9	7/2+	439.82	5/2+	D[@]		A_2=−0.16 *4*; A_4=+0.02 *7* (1977Ke05)
1701 *1*	0.09 *3*	8318.9	9/2+	6617.9	(7/2+)			
1708 *1*	0.9 *1*	9101.0	13/2+	7393.0	11/2+	D+Q		DCO=0.71 *9* (2013Je04)
1734 *1*	1.3 *1*	7267.7	13/2+	5533.7	11/2+	M1+E2		DCO=1.39 *12* (2013Je04)
1756 *1*	0.7 *1*	7991.0	11/2+	6234.7	13/2+	D+Q		DCO=1.15 *12* (2013Je04)
1771 *1*	0.5 *2*	9039.0	15/2+	7267.7	13/2+			A_2=−0.21 *10*; A_4=+0.03 *15*(1977Ke05) I_γ: Branching 16 *6* (2013Je04), 32 *3* (1979Lu02) relative to $I\gamma$(2804γ).
1772 *1*	18.0 *2*	3847.8	5/2−	2075.9	7/2+	D		DCO=1.00 *1* (2013Je04)
1817 *1*	0.13 *1*	9210.0	11/2+	7393.0	11/2+			
1821 *1*	1.6 *1*	8946.4	7/2−	7125.3	9/2+	D		DCO=0.83 *11* (2013Je04)
1838 *1*	0.4 *1*	3914.5	5/2+	2075.9	7/2+	D+Q		DCO=0.56 *8* (2013Je04)
1859 *1*	0.6 *1*	7393.0	11/2+	5533.7	11/2+			DCO=1.20 *9* (2013Je04)
1943 *1*	0.3 *1*	9210.0	11/2+	7267.7	13/2+			
1951 *1*	1.3 *1*	2391.1	1/2+	439.82	5/2+			I_γ: Branching 68 *5* (2013Je04), 56 *3* (1979Lu02) relative to $I\gamma$ 2391γ.
2010 *1*	0.6 *1*	5925.5	7/2+	3914.5	5/2+	D		DCO=0.91 *5* (2013Je04)
2025 *1*	5.1 *3*	9210.0	11/2+	7184.9	9/2+	D+Q		DCO=1.01 *4* (2013Je04)
2034 *1*	0.8 *2*	11073.2	17/2+	9039.0	15/2+	D+Q		DCO=0.85 *7* (2013Je04)
2072 *1*	2.1 *2*	4774.8	7/2+	2703.2	9/2+			
2076 *1*	11.8 *8*	2075.9	7/2+	0.0	3/2+	Q		DCO=1.72 *4* (2013Je04); A_2=+0.38 *15*; A_4=−0.46 *27* (1977Ke05)
2194 *1*	2.9 *1*	6041.5	7/2−	3847.8	5/2−	D+Q		DCO=0.67 *3* (2013Je04)
2263 *1*	58.9 *3*	2703.2	9/2+	439.82	5/2+	E2		DCO=1.62 *6* (2013Je04); A_2=+0.40 *4*; A_4=−0.25 *7* (1977Ke05)
2288 *1*	0.8 *2*	5965.9	3/2−	3677.8	3/2−			
2325 *1*	0.2 *1*	11271.4	11/2−	8946.4	7/2−			

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$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02 (continued)

$\gamma(^{23}Na)$ (continued)

E_γ [†]	I_γ [†]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	δ [&]	Comments
2350 *1*	0.4 *1*	7125.3	9/2+	4774.8	7/2+			
2362 *1*	0.4 *1*	10353.6	13/2−	7991.0	11/2+			
2364 *1*	3.8 *2*	6041.5	7/2−	3677.8	3/2−	Q		DCO=1.75 *15* (2013Je04)
2391 *1*	1.9 *2*	2391.1	1/2+	0.0	3/2+			
2441 *1*	0.7 *2*	11651.2	(13/2+)	9210.0	11/2+			
2457 *1*	1.7 *2*	7991.0	11/2+	5533.7	11/2+			DCO=1.82 *17* (2013Je04) ΔJ=0 transition.
2506 *1*	9.2 *1*	6353.8	9/2−	3847.8	5/2−	Q		DCO=1.65 *3* (2013Je04) E_γ: Other: 2502 (1979Lu02).
2535 *1*	1.5 *1*	9802.9	15/2+	7267.7	13/2+	D+Q		DCO=0.64 *3* (2013Je04); A_2=−0.39 *10*; A_4=−0.34 *19*(1977Ke05)
2542 *1*	3.4 *1*	2982.1	3/2+	439.82	5/2+	D+Q		DCO=0.54 *7* (2013Je04)
2592 *1*	0.5 *1*	8946.4	7/2−	6353.8	9/2−			
2599 *1*	0.4 *1*	10590.2	13/2−	7991.0	11/2+			
2632 *1*	0.6 *1*	9210.0	11/2+	6577.6	9/2+			7/2+ listed for initial level in Table I of 2013Je04 seems a misprint.
2640 *1*	3.1 *3*	2640.5	1/2−	0.0	3/2+			
2663 *1*	0.4 *1*	6577.6	9/2+	3914.5	5/2+			
2674 *1*	0.04 *1*	9292.1	(7/2,11/2)	6617.9	(7/2+)			
2699 *1*	3.7 *2*	4774.8	7/2+	2075.9	7/2+			DCO=1.72 *6* (2013Je04) Mult.: DCO value more consistent with Q, whereas levels scheme indicates D as ΔJ=0. M1+E2 in 2013Je04. M1 in Adopted Gammas.
2780 *1*	1.4 *1*	8820.3	9/2−	6041.5	7/2−			E_γ: 2777 in figure 11 of 2013Je04.
2792 [‡]	25 [‡]	12592.8		9802.9	15/2+			
2804 *1*	3.1 *2*	9039.0	15/2+	6234.7	13/2+	D+Q		DCO=0.74 *3* (2013Je04); A_2=−0.17 *5*; A_4=−0.21 *8* (1977Ke05)
2830 *1*	14.2 *2*	5533.7	11/2+	2703.2	9/2+	D+Q	+0.17 *11*	DCO=1.24 *2* (2013Je04); A_2=+0.03 *7*; A_4=+0.01 *12*(1977Ke05)
2866 *1*	0.8 *1*	9101.0	13/2+	6234.7	13/2+			DCO=1.63 *21* (2013Je04) ΔJ=0 transition.
2911 *1*	0.5 *1*	7686.6	9/2+	4774.8	7/2+			
2960 *1*	0.11 *3*	10353.6	13/2−	7393.0	11/2+			
2973 *1*	0.7 *1*	6820.0	5/2−	3847.8	5/2−			DCO=1.53 *13* (2013Je04) ΔJ=0 transition. E_γ: 2972 in Figure 11 of 2013Je04.
2982 *1*	4.4 *1*	2982.1	3/2+	0.0	3/2+			
2986 *1*	0.9 *1*	9101.0	13/2+	6114.6	11/2+			
3095 *1*	1.8 *2*	9210.0	11/2+	6114.6	11/2+			DCO=1.82 *16* (2013Je04) ΔJ=0 transition.
3141 *1*	2.5 *2*	6820.0	5/2−	3677.8	3/2−			E_γ: 3142 in Figure 11 of 2013Je04.
3237 *1*	6.6 *1*	3677.8	3/2−	439.82	5/2+			
3274 *1*	3.4 *3*	9627.9	11/2−	6353.8	9/2−	D+Q		DCO=0.60 *5* (2013Je04)
3284 *1*	0.7 *1*	9210.0	11/2+	5925.5	7/2+			
3322 *1*	0.2 *1*	10590.2	13/2−	7267.7	13/2+			
3325 *1*	0.7 *1*	5965.9	3/2−	2640.5	1/2−	D+Q		DCO=1.12 *11* (2013Je04)
3408 *1*	3.1 *2*	3847.8	5/2−	439.82	5/2+			
3411 *1*	10.7 *1*	6114.6	11/2+	2703.2	9/2+	M1(+E2)	+0.26 *33*	DCO=1.21 *5* (2013Je04); A_2=+0.15 *15*; A_4=+0.39 *22*(1977Ke05)
3458 *1*	3.9 *1*	5533.7	11/2+	2075.9	7/2+	Q		DCO=1.65 *7* (2013Je04); A_2=+0.55 *18*; A_4=−0.82 *32*(1977Ke05)
3474 *1*	0.3 *1*	3914.5	5/2+	439.82	5/2+			
3505 *1*	0.5 *1*	9039.0	15/2+	5533.7	11/2+			A_2=+0.06 *14*; A_4=+0.50 *25*(1977Ke05) I_γ: Branching 16 *3* (2013Je04), 35 *3* (1979Lu02) relative to Iγ(2804γ).

Continued on next page (footnotes at end of table)

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02 (continued)

$\gamma(^{23}Na)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	Comments
3531 *1*	16.4 *2*	6234.7	13/2+	2703.2	9/2+	E2	DCO=1.82 *3* (2013Je04); A_2=+0.39 *7*; A_4=−0.24 *12*(1977Ke05) Mult.,δ: Other: δ=−0.03 *15* for 13/2+ and +1.05 *70* for 9/2+ for D+Q (1977Ke05).
3568 *1*	2.1 *1*	9802.9	15/2+	6234.7	13/2+	D+Q	DCO=1.50 *7* (2013Je04); A_2=+0.23 *5*; A_4=+0.08 *9* (1977Ke05) E_γ: Other: 3569.2 *8* (1977Ke05).
3586 *1*	2.4 *2*	9627.9	11/2−	6041.5	7/2−	Q	DCO=1.71 *17* (2013Je04)
3650 *1*	4.6 *1*	6353.8	9/2−	2703.2	9/2+		DCO=1.69 *6* (2013Je04) E_γ: Other: 3646 (1979Lu02). I_γ: Branching 50 *1* (2013Je04), 28 *1* (1979Lu02) relative to Iγ(2506γ). ΔJ=0 transition.
3811 *1*	2.3 *2*	7489.0	3/2−	3677.8	3/2−		
3833 *1*	1.6 *2*	9875.2	(7/2,11/2)	6041.5	7/2−		
3848 *1*	6.9 *3*	3847.8	5/2−	0.0	3/2+	D+Q	DCO=1.23 *5* (2013Je04) I_γ: Branching 38 *2* (2013Je04), 25 (1979Lu02) relative to Iγ 1772γ.
3850 *1*	1.8 *2*	5925.5	7/2+	2075.9	7/2+	D+Q	DCO=1.51 *6* (2013Je04)
3874 *1*	0.5 *1*	6577.6	9/2+	2703.2	9/2+		
3914 *1*	2.7 *3*	3914.5	5/2+	0.0	3/2+	D+Q	DCO=1.13 *8* (2013Je04)
3920 *1*	0.3 *1*	7835.3	7/2+	3914.5	5/2+	D+Q	DCO=1.10 *13* (2013Je04)
3946 *1*	2.2 *2*	9987.9	11/2−	6041.5	7/2−	Q	DCO=1.76 *15* (2013Je04)
3999 *1*	5.1 *2*	10353.6	13/2−	6353.8	9/2−	Q	DCO=1.61 *6* (2013Je04)
4007 *1*	0.6 *1*	9541.1	(13/2+)	5533.7	11/2+	D+Q	DCO=1.07 *8* (2013Je04)
4038 *1*	3.2 *3*	6114.6	11/2+	2075.9	7/2+		I_γ: Branching 30 *3* (2013Je04), 20 (1979Lu02) relative to Iγ 2391γ.
4047 *1*	3.3 *2*	8820.3	9/2−	4774.8	7/2+	D+Q	DCO=0.83 *4* (2013Je04)
4169 *1*	1.3 *1*	10404.1	(11/2−)	6234.7	13/2+	(D)	DCO=0.86 *11* (2013Je04)
4177 *1*	2.5 *3*	6880.6	(7/2,11/2)	2703.2	9/2+		DCO=0.86 *7* (2013Je04)
4236 *1*	0.5 *1*	10590.2	13/2−	6353.8	9/2−		
4269 *1*	0.6 *1*	9802.9	15/2+	5533.7	11/2+	Q	DCO=1.85 *16* (2013Je04); A_2=+0.45 *10*; A_4=−0.14 *17*(1977Ke05)
4270 *1*	0.2 *1*	11538.4	15/2+	7267.7	13/2+		
4278 *1*	7.4 *2*	6353.8	9/2−	2075.9	7/2+	D	DCO=1.01 *2* (2013Je04) E_γ: Other: 4273 (1979Lu02). I_γ: Branching 80 *2* (2013Je04), 20 *5* (1979Lu02) relative to Iγ(2506γ).
4335 *1*	7.5 *2*	4774.8	7/2+	439.82	5/2+	D+Q	DCO=1.08 *2* (2013Je04) δ: By evaluators based on DCO value of 1.08 *2*. M1 in 2013Je04.
4343 *1*	0.4 *1*	10697.5	(7/2,11/2)	6353.8	9/2−	D+Q	DCO=0.95 *9* (2013Je04) (11/2−) listed for initial level in Table I of 2013Je04.
4351 *1*	1.0 *2*	7054.7	(5/2,13/2)	2703.2	9/2+		
4355 *1*	0.5 *1*	10590.2	13/2−	6234.7	13/2+	D+Q	DCO=1.77 *19* (2013Je04) ΔJ=0 transition.
4422 *1*	2.8 *1*	7125.3	9/2+	2703.2	9/2+		DCO=1.51 *9* (2013Je04) ΔJ=0 transition.
4430 *1*	0.9 *1*	9964.2	(9/2,13/2)	5533.7	11/2+	D+Q	DCO=0.57 *6* (2013Je04)
4466 *1*	0.2 *1*	11651.2	(13/2+)	7184.9	9/2+		
4482 *1*	2.1 *2*	7184.9	9/2+	2703.2	9/2+		DCO=1.74 *5* (2013Je04) ΔJ=0 transition.
4501 *1*	2.0 *2*	6577.6	9/2+	2075.9	7/2+	D+Q	DCO=0.90 *4* (2013Je04) Mult.: DCO ratio indicates D. ΔJ=1 transition. M1+E2 in 2013Je04 and in Adopted Gammas.
4524 *1*	0.5 *1*	10759.2	(9/2,17/2)	6234.7	13/2+		

Continued on next page (footnotes at end of table)

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02 (continued)

$\gamma(^{23}Na)$ (continued)

E_γ [†]	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	Comments
4564 *1*	3.7 *1*	7267.7	13/2+	2703.2	9/2+	E2	DCO=1.50 *13* (2013Je04); A_2=+0.45 *11*; A_4=−0.37 *19*(1977Ke05)
4689 *1*	6.1 *1*	7393.0	11/2+	2703.2	9/2+	D+Q	DCO=1.03 *2* (2013Je04) E_γ: Other: 4686 (uncertain placement in 1973Fr07).
4736 *1*	0.4 *1*	8651.0	(3/2,7/2)	3914.5	5/2+		DCO=1.05 *9* (2013Je04)
4768 *1*	0.4 *1*	7750.6	5/2+	2982.1	3/2+	D+Q	DCO=0.94 *9* (2013Je04)
4820 *1*	0.6 *1*	10353.6	13/2−	5533.7	11/2+	D	DCO=0.80 *5* (2013Je04) E_γ: 4819 in figure 11 of 2013Je04.
4838 *1*	0.4 *1*	11073.2	17/2+	6234.7	13/2+	Q	DCO=1.69 *22* (2013Je04)
4848 *1*	0.3 *1*	7489.0	3/2−	2640.5	1/2−	D+Q	DCO=0.93 *9* (2013Je04)
4890 *1*	0.2 *1*	7872.7	3/2+	2982.1	3/2+		
4950 *1*	0.16 *4*	8798.4	(3/2,7/2)+	3847.8	5/2−		
4983 *1*	0.6 *1*	7686.6	9/2+	2703.2	9/2+	D+Q	DCO=1.11 *14* (2013Je04) ΔJ=0 transition.
5030 *1*	0.2 *1*	8945.1	(3/2+)	3914.5	5/2+		
5036 *1*	0.6 *1*	11271.4	11/2−	6234.7	13/2+	D	DCO=1.02 *7* (2013Je04)
5049 *1*	2.1 *1*	7125.3	9/2+	2075.9	7/2+	D+Q	DCO=0.85 *4* (2013Je04) Mult.: DCO ratio indicates D. ΔJ=1 transition. M1+E2 in 2013Je04.
5056 *1*	1.2 *2*	10590.2	13/2−	5533.7	11/2+	D	DCO=0.82 *3* (2013Je04)
5097 *1*	2.4 *1*	7489.0	3/2−	2391.1	1/2+	D	DCO=1.15 *13* (2013Je04)
5108 *1*	2.1 *1*	7184.9	9/2+	2075.9	7/2+	D+Q	DCO=0.98 *6* (2013Je04)
5131 *1*	0.8 *2*	7835.3	7/2+	2703.2	9/2+	D+Q	DCO=1.03 *9* (2013Je04)
5258 *1*	1.0 *2*	10033.4	(3/2,11/2)	4774.8	7/2+		(9/2+) listed for initial level in Table I of 2013Je04.
5287 *1*	4.2 *1*	7991.0	11/2+	2703.2	9/2+	D+Q	DCO=0.68 *2* (2013Je04)
5292 *1*	0.2 *1*	9207.1	3/2−	3914.5	5/2+	D	DCO=1.00 *15* (2013Je04)
5323.6 [‡] *19*	50 [‡]	12592.8		7267.7	13/2+		A_2=+0.04 *7*; A_4=−0.32 *11* (1977Ke05)
5481 *1*	0.9 *1*	7872.7	3/2+	2391.1	1/2+	D+Q	DCO=1.11 *18* (2013Je04)
5484 *1*	2.4 *1*	5925.5	7/2+	439.82	5/2+	D+Q	DCO=1.54 *5* (2013Je04)
5486 *1*	0.2 *1*	9400.9	(3/2,7/2)	3914.5	5/2+		
5487 *1*	0.3 *1*	7563.6	(5/2,9/2)	2075.9	7/2+		DCO=0.70 (2013Je04)
5615 *1*	0.9 *1*	8318.9	9/2+	2703.2	9/2+	Q	DCO=1.63 *16* (2013Je04) 13/2+ listed as initial level in Table I of 2013Je04 seems a misprint ΔJ=0 transition for J^π(8319)=9/2+.
5722 *1*	0.4 *1*	9400.9	(3/2,7/2)	3677.8	3/2−		
5728 *1*	0.8 *1*	8432.0	(5/2,13/2)	2703.2	9/2+		
5897 *1*	0.9 *2*	7973.7	(3/2,11/2)	2075.9	7/2+		
5925 *1*	4.6 *3*	5925.5	7/2+	0.0	3/2+	Q	DCO=1.92 *7* (2013Je04)
5990 *1*	0.05 *1*	8972.9	5/2+	2982.1	3/2+		
6002 *1*	0.3 *1*	9917.3	(1/2,9/2)	3914.5	5/2+		
6004 *1*	0.2 *1*	11538.4	15/2+	5533.7	11/2+		
6114 *1*	2.7 *2*	8820.3	9/2−	2703.2	9/2+		DCO=1.65 *10* (2013Je04) ΔJ=0 transition. E_γ: 6115 in figure 11 of 2013Je04.
6137 *1*	2.0 *2*	6577.6	9/2+	439.82	5/2+		
6177 *1*	2.6 *2*	6617.9	(7/2+)	439.82	5/2+		
6230 *1*	0.14 *2*	9213.0	(1/2,5/2)	2982.1	3/2+		DCO=1.53 *34* (2013Je04)
6240 *1*	2.4 *2*	8946.4	7/2−	2703.2	9/2+	D	DCO=1.02 *5* (2013Je04) Initial level is listed as 8944 in table I of 2013Je04, it should be 8945 as for 2592γ. E_γ: 6242 listed in figure 11 of 2013Je04.
6355 [‡]	25 [‡]	12592.8		6234.7	13/2+		
6397 *1*	1.0 *2*	9101.0	13/2+	2703.2	9/2+	Q	DCO=1.83 *18* (2013Je04)
6418 *1*	0.07 *2*	9400.9	(3/2,7/2)	2982.1	3/2+		(1/2,7/2) listed for initial level in Table I of 2013Je04 seems a misprint.

Continued on next page (footnotes at end of table)

^{12}C(^{12}C,pγ) 2013Je04,1977Ke05,1979Lu02 (continued)

γ(^{23}Na) (continued)

E_γ †	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	Comments
6436 *1*	0.2 *1*	8828.1	1/2+	2391.1	1/2+		
6468 *1*	0.5 *1*	9172.2	(7/2,11/2)	2703.2	9/2+		DCO=1.04 *15* (2013Je04)
6553 *1*	0.13 *2*	8945.1	(3/2+)	2391.1	1/2+	D+Q	DCO=1.29 *20* (2013Je04)
6588 *1*	1.4 *2*	9292.1	(7/2,11/2)	2703.2	9/2+		(7/2,11/2) listed for initial level in Table I of 2013Je04 seems a misprint.
6621 *1*	1.8 *2*	9325.3	(7/2,11/2)	2703.2	9/2+		
6839 *1*	1.9 *2*	7279.9	(1/2,9/2)	439.82	5/2+		
6872 *1*	0.6 *1*	8946.4	7/2−	2075.9	7/2+		
6965 *1*	2.1 *1*	9042.3	(7/2,9/2)+	2075.9	7/2+		
7036 *1*	3.3 *2*	7477.0	(1/2,9/2)	439.82	5/2+		
7171 *1*	1.6 *2*	9875.2	(7/2,11/2)	2703.2	9/2+		DCO=1.09 *11* (2013Je04)
7208 *1*	2.2 *2*	9285.1	(5/2,9/2)	2075.9	7/2+		DCO=1.03 *5* (2013Je04)
7860 *1*	1.6 *1*	8301.3	(7/2−)	439.82	5/2+	D	DCO=0.93 *5* (2013Je04)
7993 *1*	1.9 *2*	10697.5	(7/2,11/2)	2703.2	9/2+	(D)	DCO=1.08 *5* (2013Je04)
8160 *1*	1.6 *2*	10237.5	(3/2,11/2)	2075.9	7/2+		
8256 *1*	2.6 *2*	10333.5	(3/2,11/2)	2075.9	7/2+		
8331 *1*	1.3 *2*	10408.5	(3/2,11/2)	2075.9	7/2+		
8357 *1*	1.4 *1*	8798.4	(3/2,7/2)+	439.82	5/2+	D+Q	DCO=0.85 *3* (2013Je04)
8522 *1*	0.2 *1*	8963.5	(1/2,9/2)	439.82	5/2+		
8601 *1*	0.4 *1*	9042.3	(7/2,9/2)+	439.82	5/2+		
8720 *1*	0.05 *1*	10797.7	(3/2,11/2)	2075.9	7/2+		
8782 *1*	0.13 *5*	10860.5	(3/2,9/2)	2075.9	7/2+		
8845 *1*	0.06 *1*	10922.7	(3/2,11/2)	2075.9	7/2+		
8957 *1*	0.4 *1*	9398.7	7/2−	439.82	5/2+	D	DCO=0.92 *12* (2013Je04) E_γ: 8956 in figure 11 of 2013Je04.
9347 *1*	0.04 *2*	11424.3	(11/2+)	2075.9	7/2+		
9482 *1*	0.4 *1*	9923.9	(3/2,7/2)	439.82	5/2+		DCO=0.54 *9* (2013Je04)
9594 *1*	0.5 *1*	10036.0	(3/2,7/2)	439.82	5/2+		DCO=1.01 *15* (2013Je04)
9714 *1*	0.08 *2*	10156.0	(1/2,9/2)	439.82	5/2+		
9935 *1*	0.22 *4*	12013.2	(3/2,11/2)	2075.9	7/2+		
9996 *1*	0.05 *1*	10438.2	(1/2,9/2)	439.82	5/2+		
10419 *1*	0.03 *1*	10860.5	(3/2,9/2)	439.82	5/2+		

† From 2013Je04. Uncertainty of 1 keV is assigned based on a note in 2013Je04 that crossover transition energies were reproduced within 0.5 to 1 keV as compared to the energy sums of two coincident γ-ray energies.

‡ From 1979Lu02. Iγ in % from the level.

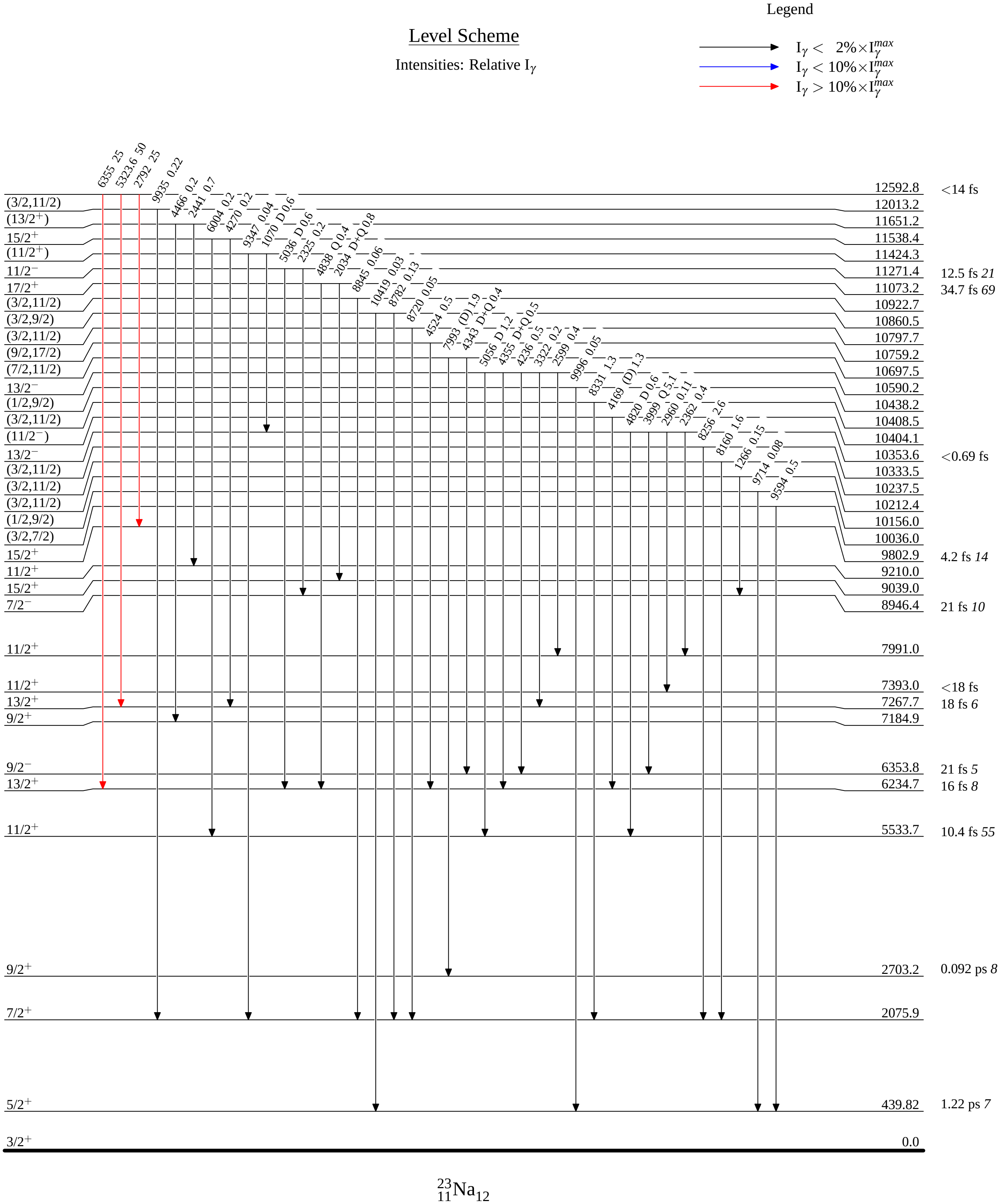
From DCO ratios (2013Je04), except otherwise noted. A value of 0.9 *1* was expected for pure stretched-dipole transitions and 1.8 *1* for pure stretched-quadrupole ones (2013Je04). The DCO ratio was extracted from measured γ-ray intensities at 90° as well as at 32° and 37° against gating on the "all" axis. Evaluators assign without sign as D, D+Q, Q compared to M1 or E1, M1+E2, E2, etc. in 2013Je04, except where RUL can be used for known level lifetime.

@ From $\gamma(\theta)$ measurements. A2 and A4 values listed in comments.

& From 1977Ke05, except otherwise noted. Phase convention from 1970Kr03 (ENSDF policy).

[a] Multiply placed with intensity suitably divided.

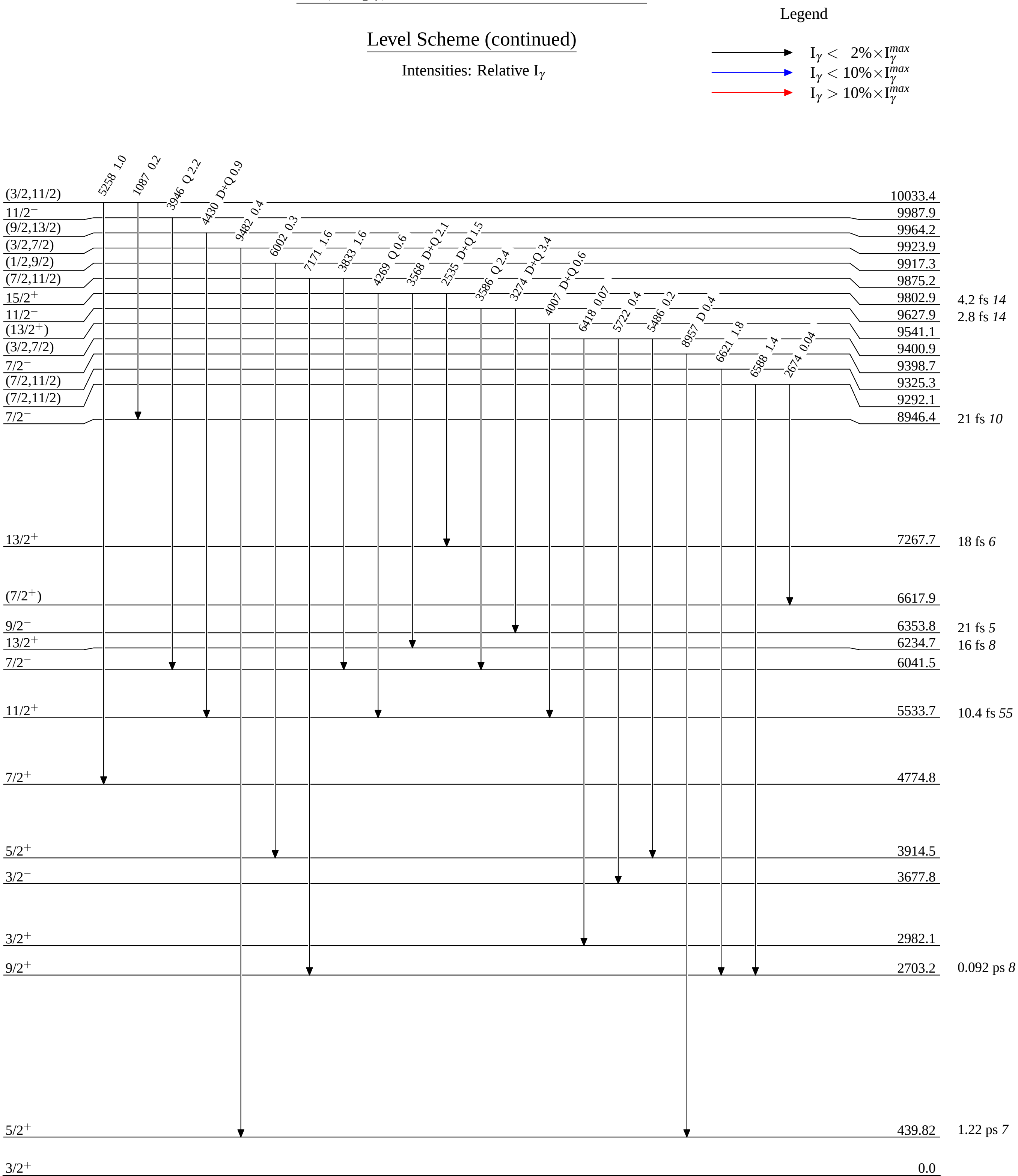
$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02



$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02

Level Scheme (continued)

Intensities: Relative I_γ



$^{23}_{11}Na_{12}$

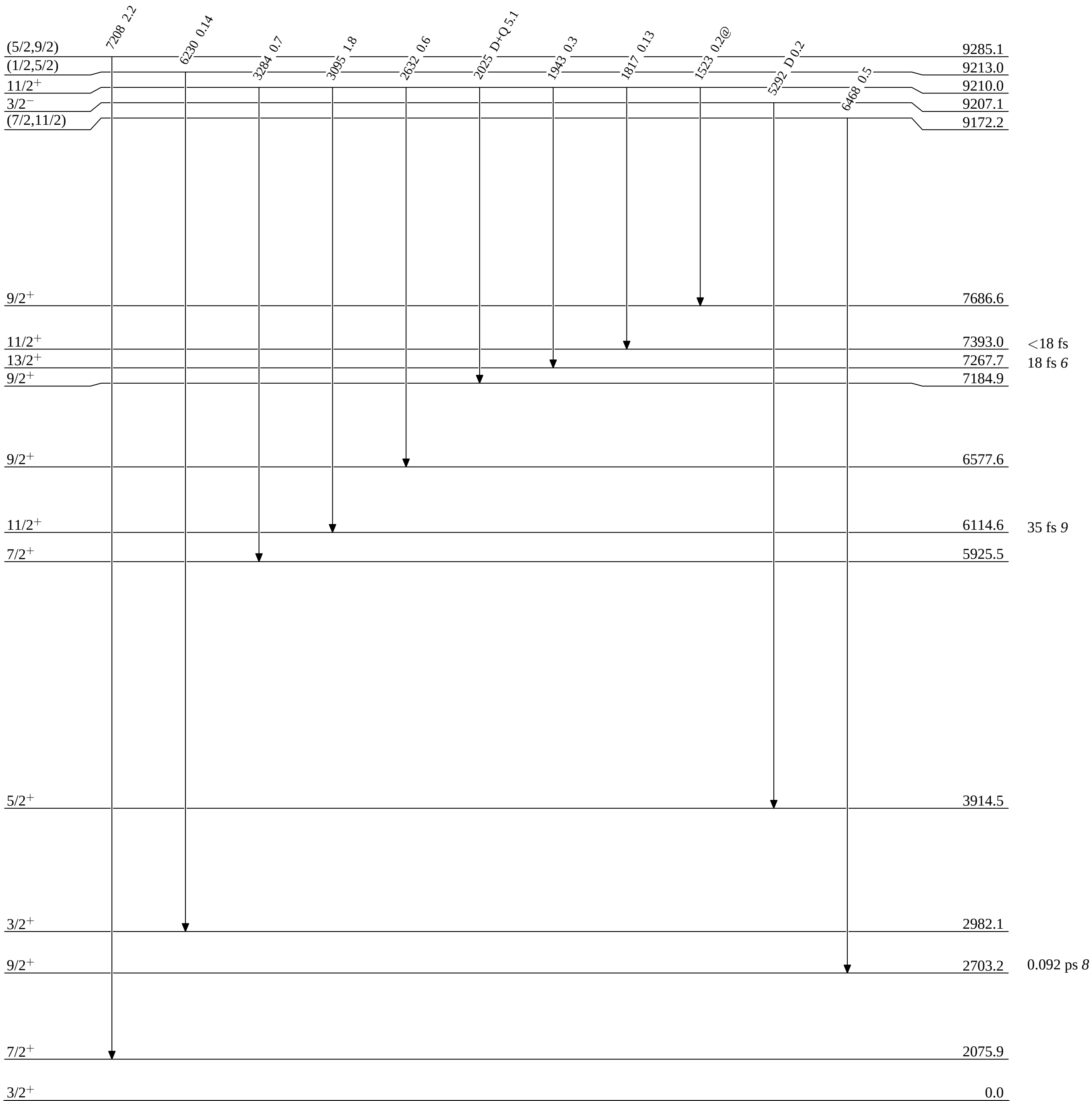
$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02

Level Scheme (continued)

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

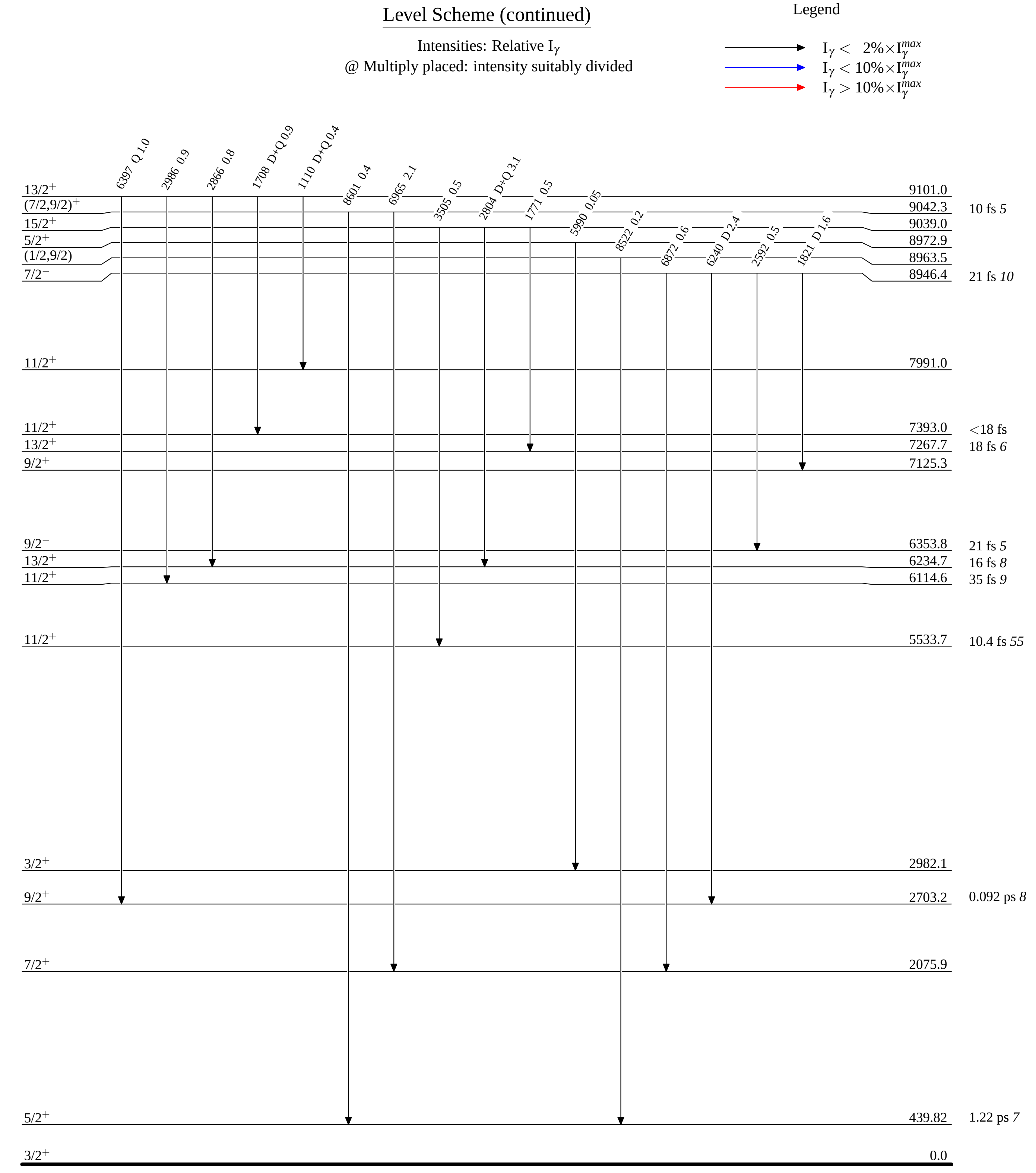
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$



$^{23}_{11}Na_{12}$

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02



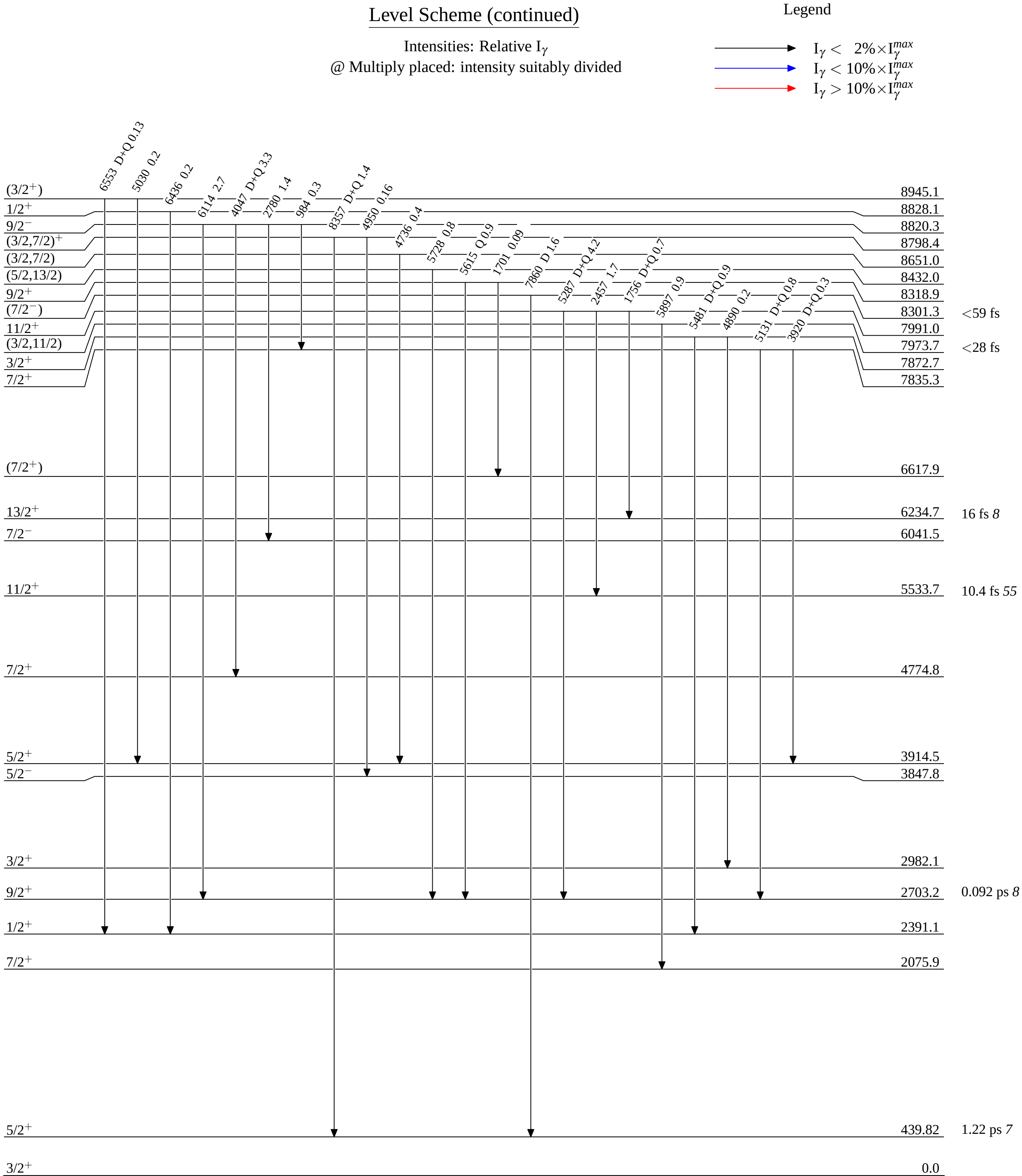
$^{23}_{11}Na_{12}$

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02

Level Scheme (continued)

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided



$^{23}_{11}Na_{12}$

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02

Level Scheme (continued)

Intensities: Relative I_γ

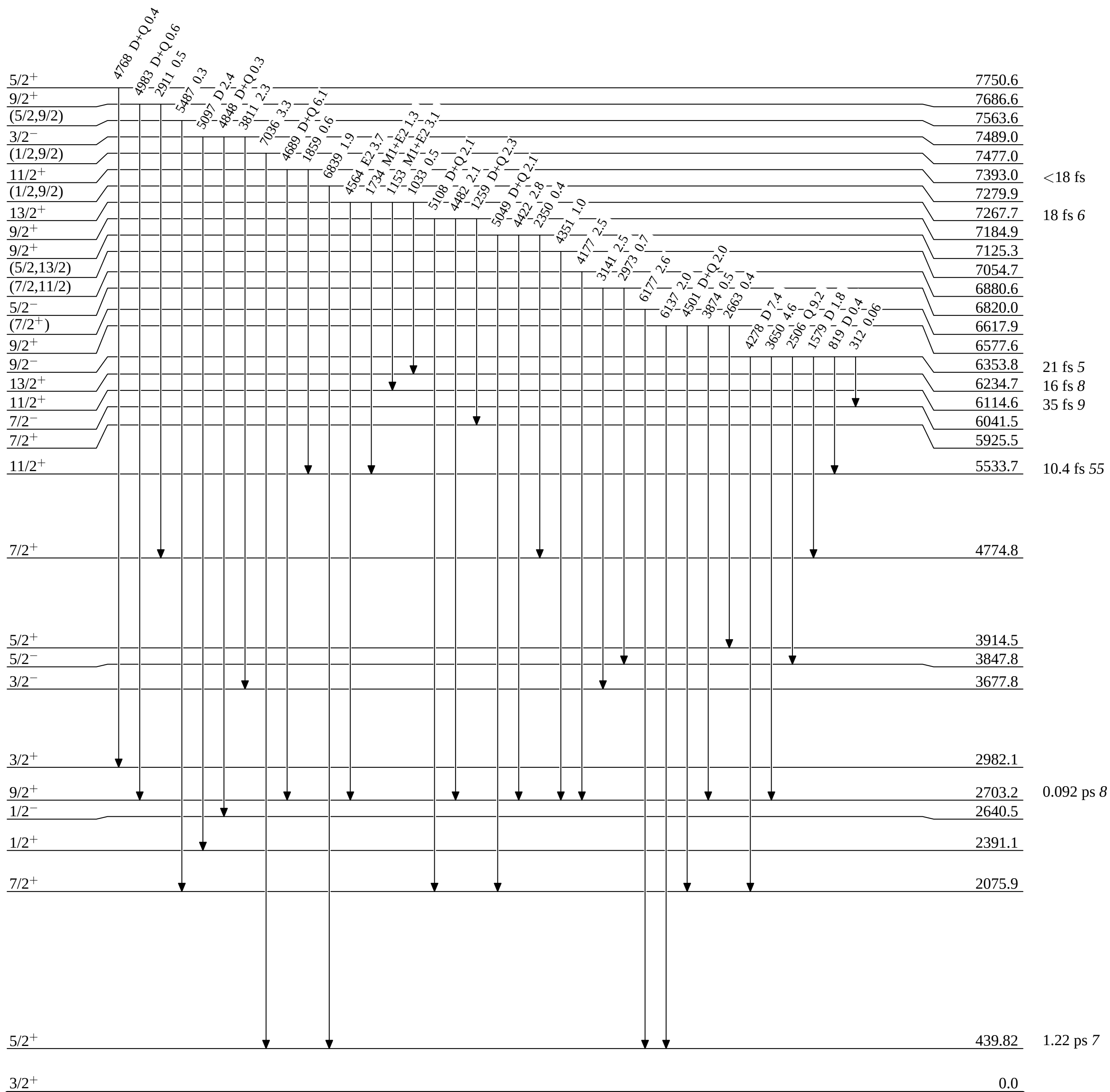
@ Multiply placed: intensity suitably divided

Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$



$^{23}_{11}Na_{12}$

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02

Level Scheme (continued)

Intensities: Relative I_γ

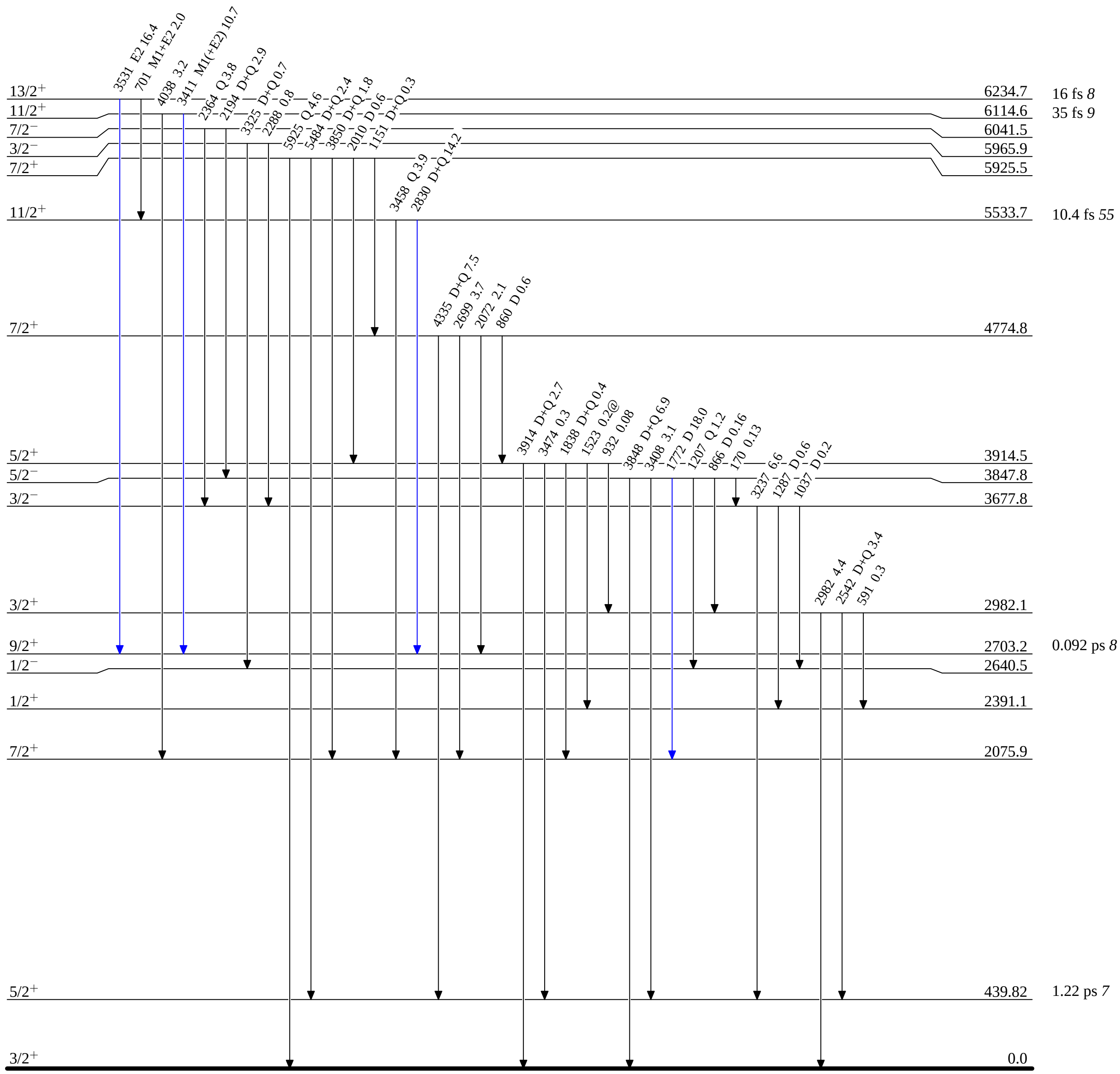
@ Multiply placed: intensity suitably divided

Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

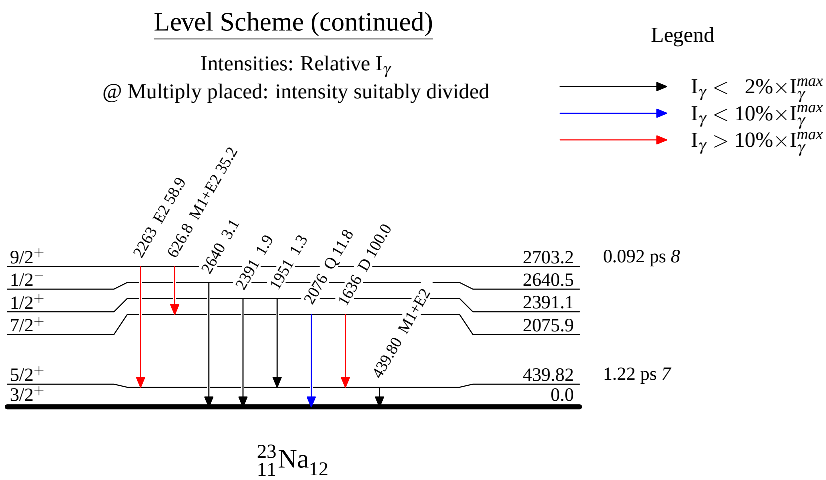
$I_\gamma < 10\% \times I_\gamma^{max}$

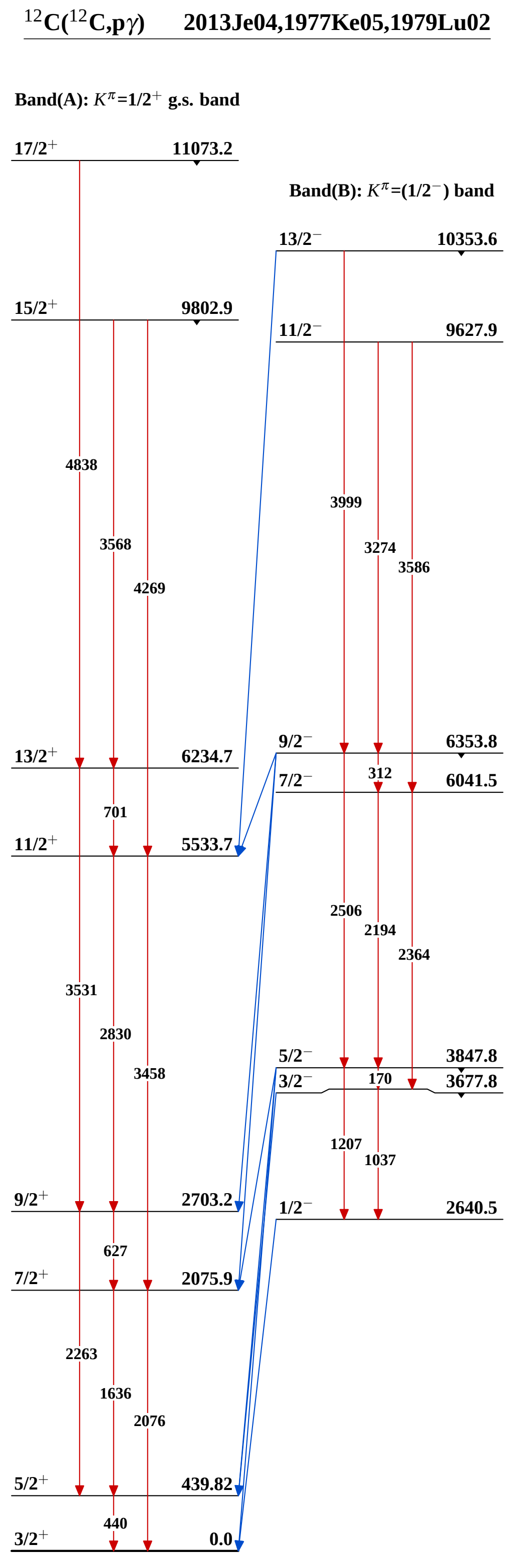
$I_\gamma > 10\% \times I_\gamma^{max}$



$^{23}_{11}Na_{12}$

$^{12}C(^{12}C,p\gamma)$ 2013Je04,1977Ke05,1979Lu02





12C(12C,pγ) 2013Je04,1977Ke05,1979Lu02
Band(A): Kπ=1/2+ g.s. band
Band(B): Kπ=(1/2−) band
17/2+ 11073.2
15/2+ 9802.9
13/2+ 6234.7
11/2+ 5533.7
9/2+ 2703.2
7/2+ 2075.9
5/2+ 439.82
3/2+ 0.0
13/2− 10353.6
11/2− 9627.9
9/2− 6353.8
7/2− 6041.5
5/2− 3847.8
3/2− 3677.8
1/2− 2640.5
4838
3568
4269
701
3531
2830
3458
627
2263
1636
2076
440
3999
3274
3586
312
2506
2194
2364
170
1207
1037

$^{23}_{11}Na_{12}$

$^{12}C(^{15}N,\alpha)$ **1978Th01**

Other references: 1990Ti02, 1976Gu05.
1978Th01, 1976Gu05: $^{12}C(^{15}N,\alpha)$ E=36.0-39.2 MeV. Measured $\sigma(E,E\alpha,\theta)$, FWHM 60 keV, shell model calculation.
1990Ti02: $^{12}C(^{15}N,\alpha)$ E=15-27 MeV. Measured DSA, (n,γ) coincidence.

^{23}Na Levels

E(level)[†]	$T_{1/2}$	Comments
0		
440	1.24 ps *8*	$T_{1/2}$: From 1990Ti02.
2076		
2391		
2641		
2704		
2982		
3678		
3848		
3915		
4430		
4775		
5379		
5534		
5741		
5766		
5776		
5926		E(level): 5931 in 1978Th01.
5966		
6042		
6115		
6195		E(level): 6191 in 1978Th01.
6235		
6354		E(level): 6350 in 1978Th01.
6578		
7100		E(level): Multiplet – not referenced in the adopted level.
7268		
7385		
7412		
7452		E(level): 7446 in 1978Th01.
7687		E(level): 7680 in 1978Th01.
7840		E(level): 1978Th01 list as a multiplet.
7964		
7974		E(level): 7983 in 1978Th01.
8061		
8320		
8480		E(level): 1978Th01 list as a multiplet.
8640		E(level): Multiplet.
8799		
8821		
9040		E(level): 9038 in 1978Th01.
9180		E(level): Multiplet – as listed in 1978Th01.
9810[‡]		
10010[‡]		E(level): Multiplet.
10220[‡]		
10350[‡]		
10600[‡]		
10980[‡]		
11290[‡]		

Continued on next page (footnotes at end of table)

$^{12}C(^{15}N,\alpha)$ 1978Th01 (continued)

^{23}Na Levels (continued)

E(level)†	E(level)†	E(level)†	E(level)†
11550‡	12820‡	14080‡	15900‡
11670‡	12920‡	14380‡	15980‡
12050‡	13050‡	14440‡	16320‡
12330‡	13210‡	14980‡	16600
12540‡	13720‡	15450‡	

† From Adopted Levels (rounded value to nearest keV), except otherwise note. 1978Th01 quote excited levels below 9810 keV from literature and list a level at 6263 keV, not found in earlier evaluations. Evaluators omit the 6263 keV level.
‡ From 1978Th01.

$^{12}C(^{16}O,\alpha p\gamma)$ 2018Bo17

Other: 2017Bo08.

2018Bo17,2017Bo08: E=60-70 MeV; measured charged particles by the 4π DIAMANT detector consisting of 80 CsI(Tl) scintillators, neutrons by the neutron wall array of 50 liquid scintillators, Eγ, Iγ (numerical value not given), particle-$\gamma\gamma$-coin using γ-ray array EXOGAM of 10 Compton suppressed clovers of 4 segmented HPGe, seven clovers were placed at 90° and three clovers at 135° with respect to the beam direction; deduced excited levels and MED (Mirror Energy Differences) between ^{23}Mg and ^{23}Na.

^{23}Na Levels

E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡
0.0	3/2+	2703 *1*	9/2+	6235 *1*	13/2+	9803 *1*	15/2+
440 *1*	5/2+	5534 *1*	11/2+	7268 *1*	13/2+	11073 *1*	17/2+
2076 *1*	7/2+	6115 *1*	11/2+	9039 *1*	15/2+		

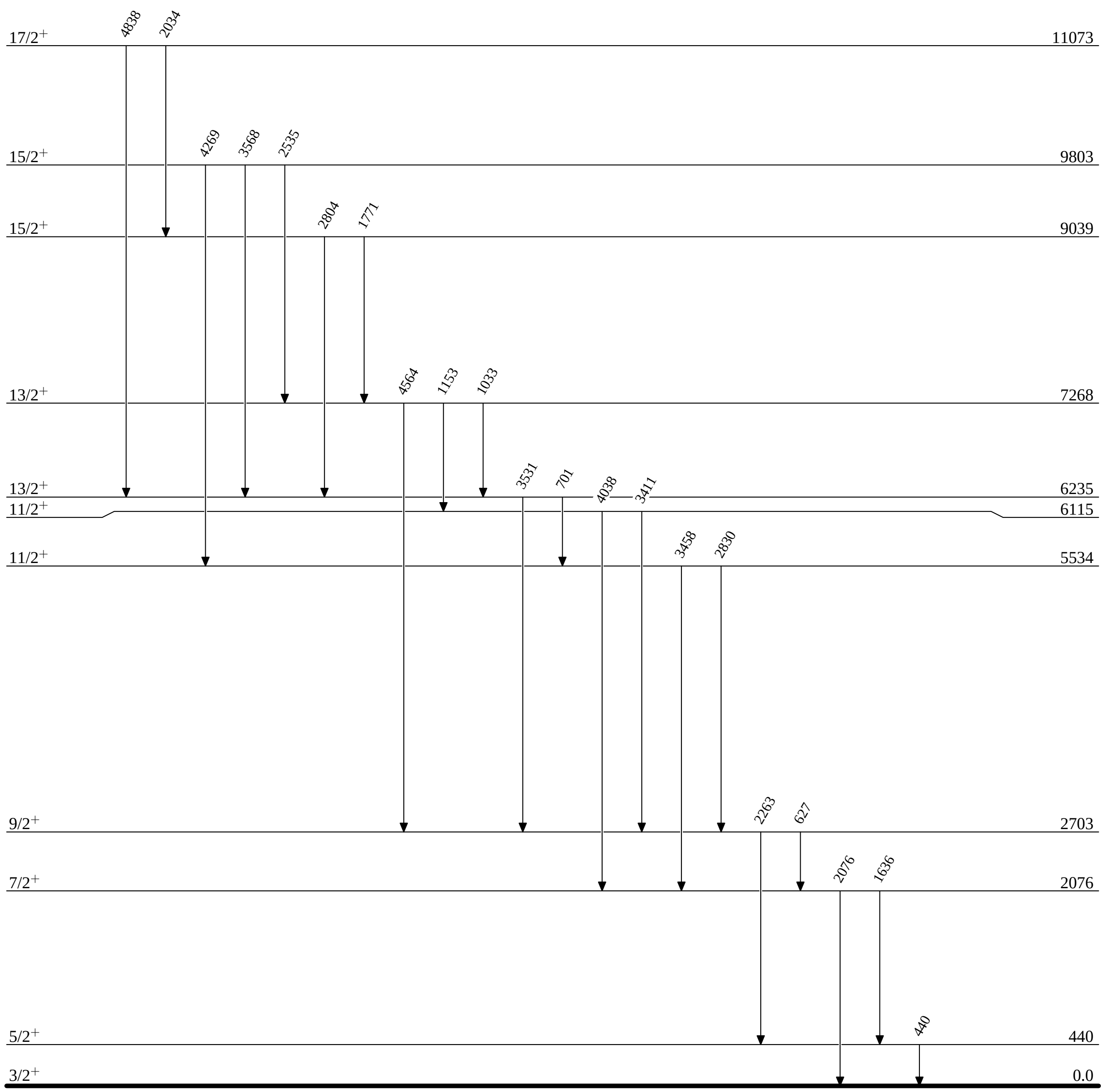
† From least-squares fit to γ-ray energies, assuming ΔE=1 keV.
‡ Proposed by 2017Bo08, based on decay scheme and yrast/yrare band structure.

$\gamma(^{23}$Na)

Eγ	Ei(level)	Jπi	Ef	Jπf	Eγ	Ei(level)	Jπi	Ef	Jπf
440	440	5/2+	0.0	3/2+	2804	9039	15/2+	6235	13/2+
627	2703	9/2+	2076	7/2+	2830	5534	11/2+	2703	9/2+
701	6235	13/2+	5534	11/2+	3411	6115	11/2+	2703	9/2+
1033	7268	13/2+	6235	13/2+	3458	5534	11/2+	2076	7/2+
1153	7268	13/2+	6115	11/2+	3531	6235	13/2+	2703	9/2+
1636	2076	7/2+	440	5/2+	3568	9803	15/2+	6235	13/2+
1771	9039	15/2+	7268	13/2+	4038	6115	11/2+	2076	7/2+
2034	11073	17/2+	9039	15/2+	4269	9803	15/2+	5534	11/2+
2076	2076	7/2+	0.0	3/2+	4564	7268	13/2+	2703	9/2+
2263	2703	9/2+	440	5/2+	4838	11073	17/2+	6235	13/2+
2535	9803	15/2+	7268	13/2+					

$^{12}C(^{16}O,\alpha p\gamma)$ 2018Bo17

Level Scheme



$^{23}_{11}Na_{12}$

^{19}F(α,γ) 1984Cs01

Other: 1986No05.

1984Cs01: Target – SrF_2 (thickness 40 keV at E_α=2.1 MeV) onto 0.3 mm thick Cu backing; Projectile: α beam, E=1.5-3.7 MeV; γ rays were measured by Ge(Li) detector (FWHM 2.7 keV at 1330 keV), for $\gamma(\theta)$ measurements NaI and another Ge(Li) detectors were used as moving and monitoring detectors, respectively, at five angles; Deduced resonance levels, width, strength, γ-ray branching. FWHM 6 keV in the c.m. system at Eα=2.35 MeV.

^{23}Na Levels

E(level)†	J$^\pi$#	Γ@	Comments
0.0	3/2$^+$		
440‡	5/2$^+$		
2076‡	7/2$^+$		
2391‡	1/2$^+$		
2641‡	1/2$^-$		
2982‡	3/2$^+$		
3678‡	3/2$^-$		
3848‡	5/2$^-$		
3915‡	5/2$^+$		
12122 *5*		4 keV *2*	E_α=2003 keV *5* (Lab). Strength S=(2J+1)($\Gamma_\alpha\Gamma_\gamma$)/Γ=39 meV *17* of the ($\alpha$,$\gamma$) resonance.
12184 *5*	5/2,3/2		E_α=2078 keV *5* (Lab). Strength S=98 meV *48* relative to the (α,γ) strength of the 12122 keV resonance level. J$^\pi$: From γ-ray (res to g.s.) angular distribution measurements.
12202 *5*		9 keV *4*	E_α=2100 keV *5* (Lab).
12272 *5*		6 keV *3*	E_α=2185 keV *5* (Lab).
12317 *5*			E_α=2240 keV *5* (Lab).
12488 *5*		5 keV *2*	E_α=2446 keV *5* (Lab).
12545 *5*		6 keV *3*	E_α=2515 keV *5* (Lab).
12602 *5*		8 keV *4*	E_α=2585 keV *5* (Lab).
12640 *5*		10 keV *5*	E_α=2631 keV *5* (Lab).
12729 *5*		13 keV *6*	E_α=2738 keV *5* (Lab).
12800 *5*		6 keV *3*	E_α=2824 keV *5* (Lab).
12818 *5*		5 keV *2*	E_α=2846 keV *5* (Lab).
12848 *5*		11 keV *5*	E_α=2882 keV *5* (Lab).
12852 *5*		9 keV *4*	E_α=2887 keV *5* (Lab).
12942 *5*		6 keV *3*	E_α=2996 keV *5* (Lab).
13074 *5*		12 keV *6*	E_α=3156 keV *5* (Lab).
13184 *5*		9 keV *4*	E_α=3289 keV *5* (Lab).
13196 *5*		9 keV *4*	E_α=3303 keV *5* (Lab).
13248 *5*		10 keV *5*	E_α=3366 keV *5* (Lab).
13279 *5*		14 keV *7*	E_α=3404 keV *5* (Lab).
13337 *5*		8 keV *4*	E_α=3474 keV *5* (Lab).
13399 *5*		13 keV *6*	E_α=3549 keV *5* (Lab).
13460 *5*		23 keV *11*	E_α=3623 keV *5* (Lab).
13509 *5*		10 keV *5*	E_α=3682 keV *5* (Lab).
13528 *5*			E_α=3706 keV *5* (Lab).

† From E_α (Lab) (1984Cs01 – listed in comments) and Q(α)=10467.3 (2017Wa10), except where otherwise noted. Uncertainty for E_α (Lab) noted as 3-5 keV – evaluators list 5 keV for all.
‡ From Adopted Levels, rounded value to the nearest keV and without uncertainty. Listed for γ-ray placement.
# From Adopted Levels, except where otherwise noted.
@ Uncertainty 30-50% (1984Cs01).

$^{19}F(\alpha,\gamma)$ 1984Cs01 (continued)

$\gamma(^{23}Na)$

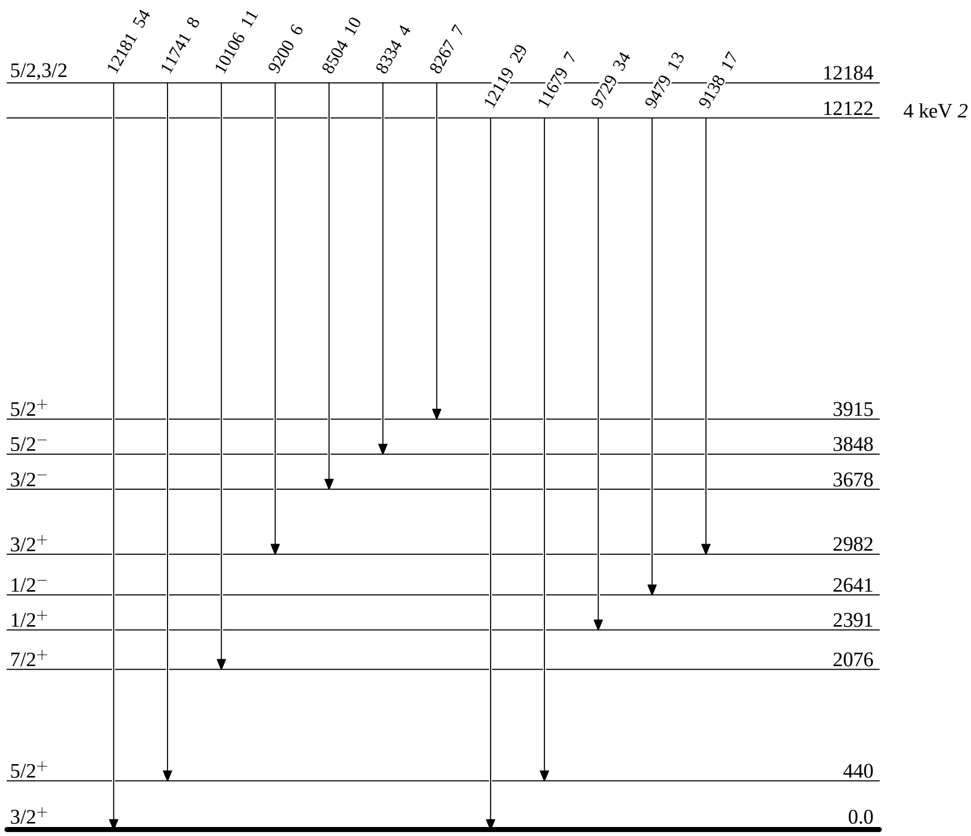
E_i(level)	J_i^π	E_γ †	I_γ	E_f	J_f^π
12122		9138	17 *3*	2982	$3/2^+$
		9479	13 *4*	2641	$1/2^-$
		9729	34 *9*	2391	$1/2^+$
		11679	7 *3*	440	$5/2^+$
		12119	29 *7*	0.0	$3/2^+$
12184	5/2,3/2	8267	7 *2*	3915	$5/2^+$
12184	5/2,3/2	8334	4 *1*	3848	$5/2^-$
		8504	10 *2*	3678	$3/2^-$
		9200	6 *1*	2982	$3/2^+$
		10106	11 *2*	2076	$7/2^+$
		11741	8 *2*	440	$5/2^+$
		12181	54 *4*	0.0	$3/2^+$

† From level energy differences, recoil energy subtracted.

$^{19}F(\alpha,\gamma)$ **1984Cs01**

Level Scheme

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

$^{19}F(^{6}Li,d)$ 1995Fo03

Others references: 1978Fo17 (E=16.0 MeV), 1979Es07 (E=36.0 MeV), 1987Le18 (E=34.0 MeV).
$J^{\pi}(^{19}F)=1/2^{+}$.
1995Fo03: E=16.0 MeV; Measured deuteron spectrum at seven angles from 7.5° to 52.5° in step of 7.5°, angular distribution; deduce level cross section, L value. DWBA calculations. FWHM 25 keV.

All data from 1995Fo03.

^{23}Na Levels

E(level)	L[#]	(2J+1)S_{rel}[@]	Comments
6310 *10*	0	1.9	σ_{max}=9.7 μb/sr. L: and 0+(5) in E=34 MeV. (2J+1)S_{rel}: 2.6 in E=34 MeV.
6340 *10*	(5), n.s.	≤(13)	σ_{max}=37 μb/sr. (2J+1)S_{rel}: 12 in E=34 MeV.
6600[†] *10*	(4), n.s.	≤(5.6)	σ_{max}=14 μb/sr (for doublet). (2J+1)S_{rel}: 2.0 in E=34 MeV.
6730 *10*	2	1.9	σ_{max}=15 μb/sr. (2J+1)S_{rel}: 3.0 in E=34 MeV.
6820 *10*	3		σ_{max}=8 μb/sr. L: or 3(+2).
6920 *10*	1	8.6	L: or 1+2 in E=16 MeV; L=(1)+2 in E=34 MeV. σ_{max}=103 μb/sr. (2J+1)S_{rel}: 5.8+4.0 in E=16 MeV; (4.0)+12.6 in E=34 MeV.
7080 *10*	1	3.9	σ_{max}=44 μb/sr. L: or 1+2 in E=16 MeV and 2 in E=34 MeV. (2J+1)S_{rel}: 2.8+1.9 for E=16 MeV; 9.0 for E=34 MeV.
7130 *10*	2(+4,5)	2.7	σ_{max}=22 μb/sr.
7180 *10*			σ_{max}=5.5 μb/sr.
7270 *10*	3	2.7	σ_{max}=17 μb/sr.
7390 *10*	4, n.s.	8.4	σ_{max}=25 μb/sr.
7480[†] *10*	1+2		σ_{max}=123 μb/sr. L: and 2(+1) in 34 MeV. (2J+1)S_{rel}: 6.5+5.1 in E=16 MeV; 39 in 34 MeV.
7560 *10*	2	2.0	σ_{max}=16 μb/sr.
7680 *10*			σ_{max}=20 μb/sr.
7730[†] *10*	0(+3,4)	(1.8)	σ_{max}=25 μb/sr.
7840 *10*	(5), n.s.	≤(6.9)	σ_{max}=19 μb/sr.
7890 *10*	1, n.s.	1.5	σ_{max}=21 μb/sr.
7980[†] *10*	(2+5)		σ_{max}=11 μb/sr. L: or n.s. (2J+1)S_{rel}: (1.4+4.4) in E=16 MeV.
8360 *10*	2(+5,6)	2.0	σ_{max}=17 μb/sr.
8470[†] *10*	4	(25)	σ_{max}=83 μb/sr. L: and 3 in E=34 MeV. (2J+1)S_{rel}: 17.6 in E=34 MeV.
8650 *10*	4, n.s.	(13)	σ_{max}=65 μb/sr. L: and 2 in E=34 MeV. (2J+1)S_{rel}: 10.8 in E=34 MeV.
8820 *10*	5	5.5	σ_{max}=13 μb/sr.
8940 *10*	4, n.s.	(5.6)	σ_{max}=27 μb/sr. L: and 3 in E=34 MeV. (2J+1)S_{rel}: 4.0 in E=34 MeV.
9110 *10*	2(+6)		σ_{max}=28 μb/sr. (2J+1)S_{rel}: 3.0(+28) in E=16 MeV.

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$^{19}F(^6Li,d)$ 1995Fo03 (continued)

^{23}Na Levels (continued)

E(level)	L[#]	(2J+1)S_{rel}[@]	Comments
9210 *10*	(4)	(7.3)	σ_{max}=40 μb/sr. L: and 1 in E=34 MeV. (2J+1)S_{rel}: 4.4 in E=34 MeV.
9430 *10*	2(+5)		σ_{max}=59 μb/sr. L: and L=2(+large) in E=34 MeV. (2J+1)S_{rel}: 6.2(+15) in E=16 MeV; (12) in E=34 MeV.
9700 *10*	3,(4)	3.1	σ_{max}=33 μb/sr. L: and 2 in E=34 MeV. (2J+1)S_{rel}: (or 6.2) in E=16 MeV; 6.0 in E=34.0 MeV.
9810 *10*	2	4.8	E(level),L,(2J+1)S_{rel}: In E=34 MeV.
10030 *10*	3,4, n.s.	3.8,7.3	σ_{max}=43 μb/sr. E(level): Possible doublet. L: and 5 in E=34 MeV. (2J+1)S_{rel}: 18 in E=34.0 MeV.
10260 *10*	6+2,3,4	(31)	σ_{max}=41 μb/sr. L: or n.s.
10470 *10*	2(+4)	4.8(+9.4)	σ_{max}=126 μb/sr. (2J+1)S_{rel}: 4.8(+9.4).
10990[‡] *10*	3,4	5.2,9.8	σ_{max}=39 μb/sr. L: and L=4 in E=34 MeV. (2J+1)S_{rel}: 17.
11290 *10*	4, n.s.	(20)	σ_{max}=78 μb/sr.
11520 *10*	(0)	(15)	σ_{max}=86 μb/sr.
11600 *10*	(4)	(15)	σ_{max}=58 μb/sr.
12230 *10*	2,(3)	28,18	σ_{max}=110 μb/sr.
12920 *10*	2,3, n.s.	16,10	σ_{max}=66 μb/sr.
13110 *10*	(4), n.s.	(20)	σ_{max}=68 μb/sr.
13250 *10*	3	27	σ_{max}=156 μb/sr.

† Doublet.

‡ Overlaps three excited level energies in Adopted Levels − not cross-referenced (XREF) in Adopted Levels.

From Table I. Non-stripping listed as ‘n.s.’.

@ Relative values for E=16.0 MeV, normalized to S_{rel}=1 (g.s.), are listed in column. Relative values for 34.0 MeV, normalized to S_{rel}=1 (4780 keV level), are listed in comments section. For a few levels, two values are listed with a ‘+’ sign, presumably for two different J values and follows the listing of L values, not described in the text. These are also listed in the comments section.

^{20}Ne(α,p) 1979Bi04

Target: Enriched ^{20}Ne in a gas cell at 200-300 Torr pressure at the center of a scattering chamber; Projectile: Momentum-analyzed α beam, E=39.5 MeV; outgoing particles were detected by ΔE-E Si counter telescope; Measured σ(Ep,θ); Deduced excitation energy and differential cross section. DWBA analysis. FWHM ~100 keV.

^{23}Na Levels

Integral cross section (dσ/dΩ) c.m. over the angular range corresponding to θ_{lab}=7°−70°.

E(level)[†]	Jπ[&]	C_{exp}[a]	Comments
0.0	3/2+	12	$(d\sigma/d\Omega)_{int}$=1.0 mb/sr.
0.44×10³ 2	5/2+	50	$(d\sigma/d\Omega)_{int}$=4.7 mb/sr.
2.07×10³ 2	7/2+	6.7	$(d\sigma/d\Omega)_{int}$=0.8 mb/sr.
2.38×10³ 2	1/2+	102	$(d\sigma/d\Omega)_{int}$=3.4 mb/sr.
2.68×10³[‡] 2	9/2+	≈10	$(d\sigma/d\Omega)_{int}$=2.4 mb/sr.
2.97×10³ 2	3/2+	88	$(d\sigma/d\Omega)_{int}$=5.7 mb/sr.
3.87×10³[‡] 2			$(d\sigma/d\Omega)_{int}$=1.0 mb/sr. Jπ,C_{exp}: 1/2+ and 3/2+; (29) and (10).
4.40×10³ 10	1/2+	≈5	$(d\sigma/d\Omega)_{int}$~0.2 mb/sr.
4.77×10³ 2	7/2+	18	$(d\sigma/d\Omega)_{int}$=1.6 mb/sr.
5.37×10³ 2	5/2+	14	$(d\sigma/d\Omega)_{int}$=1.5 mb/sr. E(level): 1979Bi04 list as doublet − no other level within the range in Adopted Levels.
5.75×10³[#] 2	(5/2+,7/2+)	12	$(d\sigma/d\Omega)_{int}$=1.3 mb/sr. C_{exp}: 13 for 7/2+.
6.24×10³ 2	13/2+	30	$(d\sigma/d\Omega)_{int}$=2.2 mb/sr.
6.33×10³[‡] 2	1/2+	≤20	$(d\sigma/d\Omega)_{int}$=2.4 mb/sr.
6.58×10³ 2	9/2+	39	$(d\sigma/d\Omega)_{int}$=5.6 mb/sr.
6.91×10³ 3	3/2+	23	$(d\sigma/d\Omega)_{int}$=5.3 mb/sr. C_{exp}: The 3/2+ part of 3/2−, 3/2+ least-squares fit of known doublet. 67 for 3/2− (Table 4).
7.12×10³[#] 3		18	$(d\sigma/d\Omega)_{int}$=2.5 mb/sr. Jπ,C_{exp}: (5/2+) and (9/2+) − uncertain. Note it is a triplet. C_{exp} =15 for (9/2+).
7.27×10³ 2	13/2+	40	$(d\sigma/d\Omega)_{int}$=4.0 mb/sr.
7.45×10³[‡] 2		50	$(d\sigma/d\Omega)_{int}$=7.2 mb/sr. Jπ: 9/2+ for doublet in 1979Bi04. (3/2+,5/2+) for 7451 in Adopted Levels.
7.71×10³ 3			$(d\sigma/d\Omega)_{int}$=13 mb/sr for 7.71×10³ and 7.81×10³.
7.81×10³[‡] 3			
7.97×10³[@] 3	7/2+	15	$(d\sigma/d\Omega)_{int}$=1.4 mb/sr.
8.30×10³[‡] 2	(9/2+,13/2+)	20	$(d\sigma/d\Omega)_{int}$=2.8 mb/sr. C_{exp}: 31 for 13/2+. 18 for 7/2− (in Table 4).
8.45×10³[‡@] 3			$(d\sigma/d\Omega)_{int}$=2.4 mb/sr. Jπ: 13/2+ in Fig. 5.
8.93×10³ 3			$(d\sigma/d\Omega)_{int}$=2.4 mb/sr.
9.10×10³ 2	13/2+	123	$(d\sigma/d\Omega)_{int}$=12 mb/sr.
9.36×10³ 3	(9/2+,13/2+)	15	$(d\sigma/d\Omega)_{int}$=2.4 mb/sr. C_{exp}: 24 for 13/2+.
9.66×10³[@] 3	13/2+	26	$(d\sigma/d\Omega)_{int}$=2.6 mb/sr.
9.95×10³ 2			$(d\sigma/d\Omega)_{int}$=9.3 mb/sr.
10.45×10³[@] 3	(5/2+,9/2+)	29	$(d\sigma/d\Omega)_{int}$=3.6 mb/sr. C_{exp}: 22 for 9/2+.
10.69×10³[@] 3	13/2+	25	$(d\sigma/d\Omega)_{int}$=2.5 mb/sr.
10.94×10³[@] 2	(9/2+,13/2+)	27	$(d\sigma/d\Omega)_{int}$=4.0 mb/sr.

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^{20}Ne(α,p) 1979Bi04 (continued)

^{23}Na Levels (continued)

E(level)[†]	Jπ[&]	C_{exp}[a]	Comments
			C_{exp}: 38 for 13/2$^+$.
11.25×10^3[‡@] *2*	13/2$^+$	143	$(d\sigma/d\Omega)_{int}$=15 mb/sr. C_{exp}: 125 for 15/2$^-$ (in Table 4).
11.43×10^3[@] *4*			$(d\sigma/d\Omega)_{int}$=3.5 mb/sr.
11.55×10^3[#@] *2*			$(d\sigma/d\Omega)_{int}$=5.3 mb/sr.
11.72×10^3 *2*	13/2$^+$	53	$(d\sigma/d\Omega)_{int}$=5.9 mb/sr.
11.92×10^3 *3*			$(d\sigma/d\Omega)_{int}$=2.9 mb/sr.
12.13×10^3 *3*			$(d\sigma/d\Omega)_{int}$=2.9 mb/sr.
12.27×10^3 *3*	(7/2$^+$,9/2$^+$)	≈40	$(d\sigma/d\Omega)_{int}$=4.7 mb/sr. C_{exp}: 34 for 9/2$^+$.
12.49×10^3 *3*	(13/2$^+$)	33	$(d\sigma/d\Omega)_{int}$=4.0 mb/sr. C_{exp}: 34 for 9/2$^+$. 29 and 36 for 15/2$^-$ and 13/2$^-$, respectively (Table 4).
12.78×10^3 *4*	(9/2$^+$)	35	$(d\sigma/d\Omega)_{int}$=4.6 mb/sr. C_{exp}: 37 for 15/2$^-$ (in Table 4).
12.85×10^3[@] *4*	(13/2$^+$)	55	$(d\sigma/d\Omega)_{int}$=5.9 mb/sr. C_{exp}: 45 for 15/2$^-$ (in Table 4).
13.18×10^3[@] *4*			$(d\sigma/d\Omega)_{int}$=5.8 mb/sr.
13.33×10^3 *4*			$(d\sigma/d\Omega)_{int}$=5.4 mb/sr.
13.56×10^3 *4*			$(d\sigma/d\Omega)_{int}$=4.3 mb/sr.
13.68×10^3 *3*			$(d\sigma/d\Omega)_{int}$=6.8 mb/sr.
13.97×10^3 *3*			$(d\sigma/d\Omega)_{int}$=7.1 mb/sr.
14.26×10^3 *4*			$(d\sigma/d\Omega)_{int}$=3.9 mb/sr.
14.41×10^3 *4*			$(d\sigma/d\Omega)_{int}$=6.0 mb/sr.
14.65×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(3) mb/sr.
14.77×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(4) mb/sr.
14.91×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(7) mb/sr.
14.99×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(3) mb/sr.
15.26×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(3) mb/sr.
15.52×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(4) mb/sr.
15.61×10^3 *5*			$(d\sigma/d\Omega)_{int}$=(4) mb/sr.

[†] From 1979Bi04.
[‡] Doublet.
[#] Triplet (1979Bi04), not referenced in the Adopted Levels.
[@] Overlaps more than two levels – not referenced in Adopted Levels.
[&] From (dσ/dΩ) (θ) and DWBA calculations.
[a] $C_{exp}=(d\sigma/d\Omega)_{exp}/(d\sigma/d\Omega)_{DWUCK}$. For two possible spins, listed value in column for the 1st and in comments for the 2nd spin. Some other C_{exp} values are given in Table 4. Evaluators list only the one's for levels also given in Table 3.

^{21}Ne(^{3}He,p) 1978Fo15

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

Target: Enriched (86.5%) ^{21}Ne in a rotating gas cell with Mylar window (thickness 522 $\mu g/cm^2$); Projectile: ^{7}Li, E=18.0 MeV; outgoing α particles were momentum analyzed in a multiangle spectrograph and detected in nuclear emulsion plates. Absorber foil stopped all particles except protons. Deduced excitation energy and differential cross section. DWBA calculations. FWHM ~42 keV.

^{23}Na Levels

E(level)[†]	J^{π}[@]	L[@]	σ_{exp}/σ_{th}[&]	Comments
0.0	$3/2^+$		210	σ_{exp}/σ_{th}: 250.
443 *3*	$5/2^+$		335	σ_{exp}/σ_{th}: 405.
2072 *6*	$7/2^+$		190	σ_{exp}/σ_{th}: 225.
2390 *6*	$1/2^+$		640	σ_{exp}/σ_{th}: 900.
2640 *10*				E(level): Very weak.
2703 *6*	$9/2^+$		200	σ_{exp}/σ_{th}: 225.
2984 *5*	$3/2^+$		470	σ_{exp}/σ_{th}: 550.
3678 *4*		1+3		
3855 *6*		1+3		
3913 *4*	$5/2^+$		360	σ_{exp}/σ_{th}: 400.
4429 *4*	$1/2^+$		360	σ_{exp}/σ_{th}: 440.
4772 *4*	$7/2^+$		290	σ_{exp}/σ_{th}: 300.
5375 *10*		2(+0)		
5542 *4*	$11/2^+$		(1200)	E(level): Unresolved state with $J^{\pi}=(3/2,5/2,1/2)^+$. Not referenced in the Adopted Levels. σ_{exp}/σ_{th}: (1400).
5743[#] *10*				
5927[‡] *12*		(2)		

[†] From 1978Fo15.
[‡] Doublet (1978Fo15).
[#] Triplet (1978Fo15), not referenced in the Adopted Levels.
[@] From measured $d\sigma/d\Omega$ (θ) and DWBA calculations (1978Fo15).
[&] For potential (n,n). Other value for potential (4,1) listed in comments section.

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Others: 1959Ku79,1960Mo07,1962Br21,1963Ar05,1966We05,1970Bi14,1970We13, 1971Du07,1971Pi08,1972Vi02,1973Ve04,1973Me11,1975An14,1977Ke04, 1983Go21,1983Ke12,2000Ka52,2004Vo21,2004Vo26,2004Vo27,2005Vo22, 2006Ka65,2009Us01,2010Lo05,2014Ca47,2015Ca27,2015De33,2015Ke05, 2016De34,2018Fe04,2018Fe10,2019Ka53,2019Hu08 (to estimate the ^{22}Ne concentration in the targets),2020Le11,2020Wi08.

1989Ba42: ^{22}Ne(p,γ) E=0.6-1.8 MeV. Measured Eγ, σ(γ,θ), Iγ(θ), DSA.

1979Sm02: ^{22}Ne(p,γ) E=1.11,1.91 MeV. Measured Eγ, σ(Ep,Eγ), Iγ(θ), DSA.

2017Ke01: ^{22}Ne(p,γ) E=165, 192, 425, 441 keV. Measured Eγ, Iγ, γγ-coin in singles and coincidence modes using a 135% HPGe detector surrounded by a 16-fold segmented NaI(Tl) annulus.

1975An14: ^{22}Ne(p,γ) E<2 MeV. Measured mean lifetime by DSA method.

1973Me11: ^{22}Ne(p,γ) E=0.43-1.11 MeV. Measured σ(E; Eγ,θ(γ)), DSA.

2019Ka53: ^{22}Ne(p,γ), E=1-3 MeV, Measured γ using Ge(Li) detector. Deduced Center-of-Gravity (CG) of magnetic dipole resonance (MDR) 6.0 MeV on the state of 440 keV and up to 10.2 MeV on the state of 2982 keV. Compared with Brink-Axel hypothesis.

^{23}Na Levels

E(level)[†]	J$^{\pi}$[#]	T or Γ	Comments
0.0	3/2$^+$		
439.991 *10*	5/2$^+$		
2076.01 *3*	7/2$^+$	24 fs *2*	T or Γ: From 1979Sm02. Others: 19 fs *5* (1973Me11), 29 fs *5* (1975An14), 26 fs *6* (1970Bi14).
2390.732 *18*	1/2$^+$	526 fs *139*	T or Γ: Weighted average of 527 fs *146* (1979Sm02), 589 fs *139* (1975An14), and 402 fs *194* (1971Du07). Uncertainty – lowest input value. Others: 520 fs *416* (1970Bi14), >347 fs (1973Me11).
2639.86 *5*	1/2$^-$	73 fs *9*	T or Γ: Weighted average of 78 fs *12* (1975An14), 70 fs *14* (1970Bi14), 64 fs *12* (1979Sm02), 61 fs *12* (1971Du07), 82 fs *9* (uncertainty 3 in 1983Ke12 from wt. ave. – evaluators take lowest value). Other: 40 fs *7* (1973Me11).
2703.50 *3*	9/2$^+$	65 fs *22*	T or Γ: Weighted average of 45 fs *10* (1973Me11) and 90 fs *11* (1975An14).
2982.06 *4*	3/2$^+$	3.2 fs *7*	T or Γ: Weighted average of 1.9 fs *14* (1973Me11), 2.4 fs *7* (1975An14), and 4.4 fs *7* (1970Bi14). Other value <2.1 fs (1979Sm02).
3677.60 *8*	3/2$^-$	24 fs *3*	T or Γ: Weighted average of 18 fs *3* (1973Me11), 29 fs *5* (1975An14), 30 fs *4* (1979Sm02), and 24 fs *4* (1970Bi14).
3848.07 *4*	5/2$^-$	82 fs *21*	T or Γ: Weighted average of 66 fs *21* (1973Me11), 97 fs *21* (1975An14), 83 fs *21* (1979Sm02), and 80 fs *24* (1970Bi14).
3914.24 *4*	5/2$^+$	8.5 fs *14*	T or Γ: Weighted average of 8 fs *2* (1973Me11), 10 fs *2* (1975An14), 6.9 fs *28* (1979Sm02), and 8.3 fs *14* (1970Bi14).
4429.63 *16*	1/2$^+$	1.4[a] fs *14*	
4774.61 *10*	7/2$^+$	<1.4[&a] fs	
5378.56 *15*	5/2$^+$	<3.5[b] fs	
5741.8 *3*	5/2$^+$	<5[b] fs	J$^{\pi}$: 5/2 from pγ(θ) measurements of 9396.3 → 5740 → g.s. cascade and transition strength analysis (1989Ba42).
5766.03 *16*	3/2$^+$	<7[b] fs	
5926.8 *3*	7/2$^+$	13[&] fs *5*	J$^{\pi}$: From pγ(θ) measurements of resonance level → 5926.8 → g.s. cascade and transition strength analysis (1989Ba42).
5964.4 *5*	3/2$^-$	<11[&] fs	
6042.19 *9*	7/2$^-$	6[&] fs *2*	J$^{\pi}$: From pγ(θ) measurements of resonance level → 6042 → 3677.9, 3847.9 cascade and transition strength analysis (1989Ba42).
6194.6 *2*	5/2$^-$	<70[&] fs	J$^{\pi}$: pγ(θ) from resonance level → this level implies 5/2,9/2. Sign from γ to 1/2$^-$ and 9/2 excluded by RUL (1989Ba42).
6307.96 *14*			
6354			E(level): From Adopted Levels. Listed to place 2688γ from 9042.4 keV level. Energy rounded to nearest keV.

Continued on next page (footnotes at end of table)

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[#]	T or Γ	Comments
6577.79 *18*	$9/2^+$,$(5/2^+)$	<11[&] fs	
6618.1 *9*	$7/2^+$,$(5/2)^+$	<0.7[&] fs	
6735.5 *2*	3/2		J^{π}: From 1989Ba42, based on feeding from $1/2^+$ (Ep=1350), and $3/2^-$ (Ep=661) resonance states.
6819.6 *3*	5/2	<8[&] fs	J^{π}: 5/2 from p$\gamma(\theta)$ (1989Ba42).
6867.7 *2*	$5/2^+$,$(3/2^+)$	<6[&] fs	
6920.61 *16*	$3/2^-$		
6947.40 *16*	3/2	<28[&] fs	J^{π}: From $\gamma(\theta)$ measurements (1989Ba42).
7070.82 *19*			
7081.9 *3*			
7133.5 *9*			
7190			
7277.1 *3*	7/2,5/2	9[&] fs *6*	J^{π}: D+Q γ to $5/2^+$ and $5/2^-$.
7385			E(level): From Adopted Levels. Listed to place 2223γ from 9608.2 keV level. Energy rounded to nearest keV.
7412.4 *3*	$5/2^+$,$7/2^+$,$9/2^+$	<35[&] fs	J^{π}: γ cascades from resonance state $(7/2^-)$ at 9396.4 → 7412 → $7/2^+$ state at 2076 (1989Ba42).
7451.5 *9*	5/2	<3[&] fs	J^{π}: From $\gamma(\theta)$ (1989Ba42).
7487.84 *19*	1/2,(3/2)	<3[&] fs	J^{π}: Proposed in 1989Ba42 based on $\gamma(\theta)$ measurements and γ to $1/2^-$ and $1/2^+$ states.
7566.2 *3*	5/2,$7/2^+$	<3[&] fs	J^{π}: Proposed in 1989Ba42 based on $\gamma(\theta)$ measurements and γ to g.s. $(3/2^+)$.
7724.45 *17*			
7750.5 *2*	5/2,$7/2^+$		
7834.13 *19*	7/2,$(5/2^+)$	<3.5[&] fs	J^{π}: $\gamma(\theta)$ measurements for γ from 7/2 resonance state, γ to $9/2^+$, D(+Q) γ to $5/2^+$ (p,γ).
7872.83 *16*	3/2,$(5/2^+)$	<3.5[&] fs	
7876.2 *9*	5/2	<12[&] fs	
7891.2 *3*	$5/2^+$	<0.7[&] fs	J^{π}: From Adopted Levels.
7970			
8060			
8261.0 *5*			
8302.0 *2*			
8360.0 *9*			
8417.43 *18*	3/2	<21[&] fs	
8475.7 *5*			
8611.1 *9*			
8631.0 *9*	3/2,$5/2^+$,$7/2^+$		
8663.8 *7*			E(level): From 1983Go21.
8829.5 *7*			E(level): From 1983Go21.
(8862[‡])	$1/2^+$[@]		E(level): From E_p(Lab)=71 keV (2018Fe10 quote from literature). Resonance strength $\omega\gamma \leq 6\times10^{-11}$ eV (2018Fe10). Screening enhancement factor 1.266 (2018Fe10).
(8895[‡])	$1/2^+$[@]		E(level): From E_p(Lab)=105 keV (2018Fe10 quote from literature). Resonance strength $\omega\gamma \leq 7\times10^{-11}$ eV (2018Fe10). Screening enhancement factor 1.140 (2018Fe10).
8943.5 *7*	$3/2^+$		E(level): From E_p(Lab)=156.2 keV *7* (2015Ca27). Other: E_r=151 keV (2017Ke01). J^{π}: From 2017Ke01. 2016De34 assume only $3/2^+$ state was populated by low energy proton beam, as $7/2^-$ state is strongly disfavored by the angular momentum barrier, considering the doublet at 8944 keV with tentative spin-parity of $3/2^+$ and $7/2^-$. Resonance strength $\omega\gamma=2.2\times10^{-7}$ eV *2* (2018Fe10), 1.8×10^{-7} eV *2* (2015Ca27 – erratum), 2.03×10^{-7} eV *40* (2017Ke01), 1.67×10^{-7} eV *+48−40* (2020Le11). Screening enhancement factor 1.074 (2018Fe10).

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^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[#]	T or Γ	$(2J+1)\Gamma_p\Gamma_\gamma/\Gamma$[d]	Comments
8975.3 *7*	$5/2^+$			E(level): E_p(Lab)=189.5 keV *7* (2015Ca27,2016De34). Other: E_p(Lab)=186 keV *3* (2014Ca47), E_r=178 keV (2017Ke01). J^{π}: From 2017Ke01, based on decay pattern. Resonance strength $\omega\gamma$=2.7×10^{-6} eV *2* (2018Fe10), 2.2×10^{-6} eV *2* (2015Ca27 – erratum), 2.32×10^{-6} eV *32* (2017Ke01), 2.17×10^{-6} eV *+37–35* (2020Le11). Screening enhancement factor 1.055 (2018Fe10).
9042.4[‡] *6*	$(7/2,9/2)^+$[@]			E(level): From E_p(Lab)=259.7 keV *6* (2015Ca27). Resonance strength $\omega\gamma$=8.2×10^{-6} eV *7* (2015Ca27-erratum), 9.7×10^{-6} eV *7* (2018Fe10), 8.5×10^{-6} eV *14* (2020Le11). Screening enhancement factor 1.034 (2018Fe10).
9201				E(level): From E_r=407 keV (2017Ke01).
9211.0[‡] *8*	$3/2^-$[@]		0.13[f] *3*	E(level): From Ep=435.8 *10* (1973Me11). Also E_r=417 keV (2017Ke01). Resonance strength $\omega\gamma$(436 keV)=0.080 eV *7* and 0.079 eV *8* (2015De33), $\omega\gamma$(436 keV)=0.065 eV *15* (deduced value in 2015De33 using data from 1973Me11).
9252.1[‡] *10*	$1/2^+$[@]		0.9[f] *2*	E(level): From Ep=478.9 *10* (1973Me11). Other: Ep=479.3 *18* (2010Lo05). Resonance strength $\omega\gamma$=0.524 eV *51* (2010Lo05), $\omega\gamma$(479 keV)=0.605 eV *62* (2015De33), $\omega\gamma$(479 keV)=0.583 eV *43* (2015Ke05), 0.44 eV *2* and 0.44 eV *5* (2020Le11,2020Wi08).
9396.4 *3*	$7/2^-$		0.06[f] *2*	E(level): From weighted average of Ep=630.5 *10* (1973Me11) and 629.6 *3* (1989Ba42 – calculated value from Ex based on measured Eγ). J^{π}: p$\gamma(\theta)$ and from an acceptable fraction for the reduced proton width of the Wigner limit for a lp=3 capture (1989Ba42 – (p,γ)). D+Q γ's to $5/2^-$ and $9/2^-$.
9401.2 *4*			0.05	E(level): From Ep=634.7 *4* (1989Ba42).
9404.8 *5*	1/2	65 eV	5.6[e] *6*	E(level): From weighted average of Ep=640.1 *10* (1973Me11) and 638.4 *3* (1989Ba42 – calculated value from Ex based on measured Eγ). J^{π}: From $\gamma(\theta)$ (1962Br21). T or Γ: From 1972Du21. Resonance strength $\omega\gamma$(639 keV)=2.46 eV *21* and 2.43 eV *25* (2015De33), $\omega\gamma$(639 keV)=2.8 eV *3* (deduced value in 2015De33 using data from 1977Ke04).
9426.1 *5*	3/2		0.7[e] *2*	E(level): From weighted average of Ep=662.0 *10* (1973Me11) and 660.5 *4* (1989Ba42 – calculated value from Ex based on measured Eγ). Resonance strength $\omega\gamma$(661 keV)=0.032 eV *+24–9* and 0.031 eV *+24–9* (2015De33 – seems a typo for an order of difference compared to literature data); $\omega\gamma$(661 keV)=0.35 eV *1* and 0.285 eV (deduce value in 2015De33 and 2020Wi08, respectively, using data from 1973Me11), 0.47 eV *7* and 11.7 eV *14* (2020Wi08). J^{π}: D+Q γ to $1/2^+$ and $5/2^+$.
9487.7 *8*	3/2		0.26[e] *8*	E(level): From Ep=725.1 *8* (1973Me11). J^{π}: From pγ angular distribution measurements (1973Me11).
9608.2[‡] *2*	$3/2^+$[@]		14[f] *5*	E(level): From weighted average of Ep=851.4 *7* (1973Me11) and 851.1 *2* (1989Ba42 – calculated value from Ex based on measured Eγ).
9652.2[‡] *10*	$3/2^+,5/2^+$[@]		3.6[f] *18*	E(level): From Ep=897.1 *10* (1973Me11).
9655.6 *10*			2.1[e] *10*	E(level): From Ep=900.7 *10* (1973Me11).

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^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[#]	T or Γ	$(2J+1)\Gamma_p\Gamma_\gamma/\Gamma$[d]	Comments
				J^{π}: 3/2,5/2 in 1973Me11, based on γ decay. ($1/2^+$) in Adopted Levels.
9674.1 *10*	$3/2^+,5/2^+$		1.6[e] *5*	E(level): From Ep=920.0 *10* (1973Me11). J^{π}: γ's to $1/2^+$ and $7/2^+$. D+Q γ's to $3/2^+$ and $5/2^+$.
9682.7 *4*	$3/2^+$		0.7[e] *2*	E(level): From weighted average of Ep=927.7 *10* (1973Me11) and 929.1 *3* (1989Ba42 – calculated value from Ex based on measured Eγ). J^{π}: 3/2 from pγ angular distribution measurements (1973Me11).
9700.9[‡] *10*	$3/2^+$[@]		12[f] *4*	E(level): From Ep=948.0 *10* (1973Me11).
9732.53 *13*	7/2		0.8[e] *2*	E(level): From Ep=981.08 *7* (1989Ba42 – calculated value from Ex based on measured Eγ). Other value: 981.3 *5* (1973Me11). J^{π}: D+Q to $5/2^+$ and $9/2^+$.
9755.5	$3/2^+$		4.8[e] *14*	E(level): From Ep=1005.1 *10* (1973Me11). J^{π}: γ's to $1/2^+$, $1/2^-$, $5/2^+$, $5/2^-$.
9815.7 *4*	$5/2^+$		1.8[e] *4*	E(level): From weighted average of Ep=1068.1 *8* (1973Me11) and 1068.0 *4* (1989Ba42 – calculated value from Ex based on measured Eγ). J^{π}: γ's to $1/2^+$ and $9/2^+$. D+Q γ to $3/2^+$.
9835.4[‡] *10*	$3/2^+$[@]		3.0[f] *11*	E(level): From Ep=1088.6 *10* (1973Me11).
9850.1[‡] *5*	$1/2^+$[@]		4.3 *11*	E(level): From weighted average of Ep=1105.0 *10* (1979Sm02) and 1103.8 *5* (1989Ba42 – calculated value from Ex based on measured Eγ).
9890.9 *6*	3/2		3.0 *8*	E(level): From Ep=1146.6 *6* (1979Sm02). J^{π}: γ's to $1/2^+$, $1/2^-$, $5/2^+$, $5/2^-$.
9917.0 *6*	$3/2^+$,5/2,7/2		1.2 *3*	E(level): From Ep=1173.9 *6* (1979Sm02).
10003.2[‡] *6*	$1/2^-$[@]		2.2 *6*	E(level): From Ep=1264.1 *6* (1979Sm02).
10017.4[‡] *10*	$5/2^+$[@]		21[e] *2*	E(level): From weighted average of Ep=1280.2 *5* (1979Sm02) and 1278.1 *4* (1989Ba42 – calculated value from Ex based on measured Eγ). Resonance strength $\omega\gamma$(1279 keV)=11.3 eV *10* (2015De33), $\omega\gamma$(1279 keV)=10.5 eV *10* (deduced value in 2015De33 using data from 1977Ke04), 12.7 eV *7* (singles) and 11.7 eV *14* (coincidences) (2020Wi08).
10049.1 *6*			0.4 *1*	E(level): From Ep=1312.0 *6* (1979Sm02).
10070.9	5/2,7/2		5.5 *14*	E(level): From Ep=1334.6 *6* (1979Sm02). J^{π}: Proposed in 1979Sm02 (p,γ), based on $\gamma(\theta)$ measurements.
10075.9[‡] *5*	3/2,7/2[@]		2.4 *6*	E(level): From Ep=1340.1 *5* (1979Sm02). J^{π}: 5/2,7/2 in 1979Sm02.
10085.3[‡] *5*	$1/2^+$[@]		1.6 *4*	E(level): From weighted average of Ep=1351.2 *5* (1979Sm02) and 1349.7 *2* (1989Ba42 – calculated value from Ex based on measured Eγ).
10114.8[‡] *5*	$1/2^+$[@]		1.3 *3*	E(level): From Ep=1380.7 *5* (1979Sm02).
10125.9[‡] *5*	5/2[@]		2.8 *7*	E(level): From Ep=1392.3 *5* (1979Sm02).
10164.5 *5*				E(level): From Ep=1432.7 *5* (1979Sm02).
10169.6 *2*	$5/2^+$		5.4 *14*	E(level): From weighted average of Ep=1438.0 *5* (1979Sm02) and 1438.0 *2* (1989Ba42 – calculated value from Ex based on measured Eγ). J^{π}: D+Q γ's to $3/2^+$ and $7/2^+$.
10231.7[‡] *4*	$5/2^+$[@]		9 *2*	E(level): From weighted average of Ep=1504.1 *10* (1979Sm02) and 1502.8 *3* (1989Ba42 – calculated value from Ex based on measured Eγ).
10243.7[‡] *14*	$1/2^+$[@]	2450[c] eV	2.2 *6*	E(level): From Ep=1515.5 *14* (1979Sm02).

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^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[#]	T or Γ	$(2J+1)\Gamma_p\Gamma_\gamma/\Gamma$[d]	Comments
10281.5 *6*	3/2+		2.8 *7*	E(level): From Ep=1555.0 *6* (1979Sm02). J^{π}: γ's to 1/2− and 7/2+.
10318.0[‡] *6*	3/2−[@]	2000[c] eV	10 *3*	E(level): From Ep(Lab)=1593.2 *6*(1979Sm02). Other: Ep(Lab)=1594.0 *8* (2009Us01).
10338.7[‡] *7*	(1/2−)[@]		2.1 *5*	E(level): From Ep(Lab)=1614.8 *7* (1979Sm02). Other: Ep(Lab)=1614.3 *9* (2009Us01).
10346.1[‡] *7*	5/2+[@]	8[c] eV	9 *2*	E(level): From Ep=1622.5 *7* (1979Sm02). Other: Ep(Lab)=1623.1 *9* (2009Us01).
10353.8[‡] *7*	3/2+[@]	210[c] eV	60 *15*	E(level): From Ep=1630.6 *7* (1979Sm02). Other: Ep(Lab)=1631.2 *9* (2009Us01).
10440.6[‡] *10*	5/2+[@]	25[c] eV	13 *3*	E(level): From Ep=1721.3 *10* (1979Sm02). Other: Ep(Lab)=1721.3 *9* (2009Us01).
10448.7 *12*			3.5 *9*	E(level): From Ep=1729.8 *12* (1979Sm02). Other: Ep(Lab)=1729.9 *10* (2009Us01).
10478.8[‡] *7*	3/2+[@]	470 eV	5.1 *13*	E(level): From Ep=1761.3 *7* (1979Sm02). Other: Ep(Lab)=1761.8 *8* (2009Us01). Γ from 1968Ke11. Γ_p=400 eV, $\Gamma_{p'}$=70 eV.
10501.9[‡] *7*	3/2−[@]	920 eV	6.6 *17*	E(level): From Ep=1785.4 *7* (1979Sm02). Other: Ep(Lab)=1785.5 *11* (2009Us01). Γ from 1968Ke11. Γ_p=880 eV, $\Gamma_{p'}$=40 eV.
10507.8[‡] *7*	1/2+[@]	560[c] eV	1.0 *3*	E(level): From Ep=1791.6 *7* (1979Sm02). Other: Ep(Lab)=1792.3 *11* (2009Us01).
10519.1[‡] *7*	5/2+[@]	100[c] eV	4.4 *11*	E(level): From Ep=1803.4 *7* (1979Sm02). Other: Ep(Lab)=1803.7 *8* (2009Us01).
10534.1 *7*			1.5 *4*	E(level): From Ep=1819.1 *7* (1979Sm02). Other: Ep(Lab)=1819.6 *8* (2009Us01).
10549.2[‡] *9*	5/2+[@]	540 eV	11 *3*	E(level): From Ep=1834.9 *9* (1979Sm02). Other: Ep(Lab)=1835.2 *8* (2009Us01). Γ from 1968Ke11. Γ_p=380 eV, $\Gamma_{p'}$=160 eV.
10574.6[‡] *8*	3/2−[@]	1100 eV	2.3 *6*	E(level): From Ep=1861.4 *8* (1979Sm02). Γ from 1968Ke11. Γ_p=1010 eV, $\Gamma_{p'}$=90 eV.
10616.9 *8*	5/2+,3/2+		7.5 *19*	E(level): From Ep=1905.6 (1979Sm02).
19590.6 *21*	5/2+	1900 eV *800*		T=5/2 E(level),J^{π}: Isobaric analogue state of ^{23}F g.s. (1985Ev01), Ep=11291.1 *21*. Γ also from 1985Ev01.

[†] Resonance level energies were deduced using Ep and Sp=8794.10 *2* (2017Wa10). Ep (Lab) are from 1979Sm02 and 1989Ba42, except as noted.
[‡] 2018Fe10 do not see any evidence of the suspected weak resonance. However, new and more stringent upper limits were determined at 90% confidence level.
[#] Assignments for levels up to 5378 keV from Adopted Level and where otherwise noted. Between 5378 and 8631 from 1989Ba42 based on $\gamma(\theta)$ measurements, γ feeding from/to resonance levels/low lying levels, and RUL (for levels with measured/known lifetimes).
[@] From Adopted Levels.
[&] From 1989Ba42.
[a] From 1973Me11.
[b] From 1979Sm02.
[c] Γ from 1968Ke11. Γ_p=Γ.

Continued on next page (footnotes at end of table)

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01 (continued)

^{23}Na Levels (continued)

[d] From 1979Sm02, except where otherwise noted.
[e] From 1977Ke04.
[f] From 1973EnVA, recalibrated on S(p,γ) for Ep=1278 keV.

γ(^{23}Na)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[d]	Comments
439.991	5/2+	439.986	100	0.0	3/2+	D+Q	+0.09 *4*	Mult.,δ: From γ-ray angular distribution measurements (1962Br21).
2076.01	7/2+	1635.96	91.1 *1*	439.991	5/2+			
		2075.91	8.9 *1*	0.0	3/2+			
2390.732	1/2+	1950.652	34.3 *4*	439.991	5/2+			
		2390.599	65.7 *4*	0.0	3/2+			
2639.86	1/2−	2199.76	<0.2[#]	439.991	5/2+			
		2639.70	100	0.0	3/2+			
2703.50	9/2+	627.48	35.1 *8*	2076.01	7/2+			
		2263.39	64.9 *8*	439.991	5/2+			
2982.06	3/2+	342.20	<0.2[#]	2639.86	1/2−			
		591.32	0.3 *1*	2390.732	1/2+			I_γ: Other: <0.4 (1979Sm02).
		2541.92	41.1 *2*	439.991	5/2+			
		2981.85	58.6 *2*	0.0	3/2+			
3677.60	3/2−	695.53	0.5 *1*	2982.06	3/2+			I_γ: Other: <2 (1979Sm02).
		974.08	<1[#]	2703.50	9/2+			
		1037.71	19.6 *5*	2639.86	1/2−			
		1286.83	1.3 *1*	2390.732	1/2+			
		1601.53	<2[#]	2076.01	7/2+			
		3237.36	78.6 *6*	439.991	5/2+			
		3677.28	<6[#]	0.0	3/2+			
3848.07	5/2−	865.99	2.0 *2*	2982.06	3/2+			
		1144.54	<2[#]	2703.50	9/2+			
		1208.18	4.5 *1*	2639.86	1/2−			
		1771.99	61.1 *7*	2076.01	7/2+			
		3407.81	9.5 *9*	439.991	5/2+			
		3847.72	22.9 *6*	0.0	3/2+			
3914.24	5/2+	932.16	2.3 *2*	2982.06	3/2+			
		1210.71	<0.6[#]	2703.50	9/2+			
		1523.45	1.1 *1*	2390.732	1/2+			I_γ: Other: <5 (1979Sm02).
		1838.15	9.0 *2*	2076.01	7/2+			
		3473.97	8.1 *1*	439.991	5/2+			
		3913.88	79.5 *3*	0.0	3/2+			
4429.63	1/2+	1447.52	<2[#]	2982.06	3/2+			
		1726.06	<2[#]	2703.50	9/2+			
		1789.70	<2[#]	2639.86	1/2−			
		2038.80	9 *3*	2390.732	1/2+			
		2353.49	<2[#]	2076.01	7/2+			
		3989.27	<3[#]	439.991	5/2+			
		4429.17	91 *3*	0.0	3/2+			

$^{23}_{11}$Na$_{12}$-111

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[d]	Comments
4774.61	7/2+	1792.47	<2[#]	2982.06	3/2+			
		2071.01	3.8 *10*	2703.50	9/2+			
		2134.64	<5[#]	2639.86	1/2−			
		2698.43	29.4 *12*	2076.01	7/2+			
		4334.18	66.8 *13*	439.991	5/2+			
		4774.08	<5[#]	0.0	3/2+			
5378.56	5/2+	2396.27	7.1 *6*	2982.06	3/2+			
		2674.89	<2[#]	2703.50	9/2+			
		2738.52	<2[#]	2639.86	1/2−			
		3302.30	20.6 *10*	2076.01	7/2+			
		4938.00	57.3 *10*	439.991	5/2+	D+Q	−0.10 *7*	Mult.: A_2=0.22 *5*. δ: or +2.2 *4* (1989Ba42). −0.10 7 value assumed to be associated with spin 5/2 and the other for 3/2.
		5377.89	15.0 *10*	0.0	3/2+	D+Q	−0.20 *9*	Mult.: A_2=−0.46 *9* (1989Ba42). δ: assumed for 5/2 or −2.1 *5* for 3/2 (1989Ba42).
5741.8	5/2+	3101.72	<10[#]	2639.86	1/2−			
		3350.81	<5[#]	2390.732	1/2+			
		5301.2	24.7 *14*	439.991	5/2+	D+Q	+0.3 *2*	Mult.: A_2=0.65 *15* and 0.31 *17* (1989Ba42).
		5741.0	75.3 *14*	0.0	3/2+	D+Q	+0.17 *3*	Mult.: A_2=0.00 *4*, −0.10 *6*, and 0.14 *6* (1989Ba42).
5766.03	3/2+	1917.87	1.5 *7*	3848.07	5/2−			
		2783.79	<3[#]	2982.06	3/2+			
		3062.31	<4[#]	2703.50	9/2+			
		3125.94	4.4 *9*	2639.86	1/2−			
		3375.03	<3[#]	2390.732	1/2+			
		3689.70	<3[#]	2076.01	7/2+			
		5325.38	43 *3*	439.991	5/2+	D+Q	−0.07 *8*	Mult.: A_2=−0.01 *7* (1989Ba42). δ: or −3.4 *10* (1989Ba42).
		5765.25	51 *3*	0.0	3/2+	M1+E2	−0.09 *5*	Mult.: A_2=0.20 *7* (1989Ba42). δ: or +6 *2* (1989Ba42).
5926.8	7/2+	1152.2	1.9 *1*	4774.61	7/2+			
		2012.5	6.7 *3*	3914.24	5/2+			
		2944.54	<2[#]	2982.06	3/2+			
		3223.06	<2[#]	2703.50	9/2+			
		3535.78	<2[#]	2390.732	1/2+			
		3850.4	13.6 *13*	2076.01	7/2+			
		5486.1	24.0 *9*	439.991	5/2+	D+Q	+4.4 *6*	Mult.: A_2=0.41 *3*, A_4=0.23 *4* (1989Ba42).
		5926.0	53.8 *11*	0.0	3/2+	Q(+O)	+0.01 *2*	Mult.: A_2=0.46 *2*, A_4=−0.20 *2* (1989Ba42).
5964.4	3/2−	1534.8	5 *2*	4429.63	1/2+			
		2286.8	15 *5*	3677.60	3/2−			

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[d]	Comments
5964.4	3/2$^-$	3324.4	50 *10*	2639.86	1/2$^-$	D(+Q)	0.0 *2*	Mult.: A_2=−0.13 *10* (1989Ba42). δ: or −1.4 *7*.
		3573.5	10 *5*	2390.732	1/2$^+$			
		5523.8	10 *4*	439.991	5/2$^+$			
		5963.7	10 *4*	0.0	3/2$^+$			
6042.19	7/2$^-$	2127.84	2.8 *5*	3914.24	5/2$^+$			
		2194.01	49 *2*	3848.07	5/2$^-$	D+Q	−0.13 *3*	Mult.: A_2=−0.45 *5*, −0.45 *2*, −0.50 *3* (1989Ba42).
		2364.46	12 *3*	3677.60	3/2$^-$	(Q)		Mult.: A_2=0.35 *7*. A_4=−0.23 *6* (1989Ba42) gives M1+E2, δ=−0.13 *14*. Mult Q from decay to 3/2$^-$.
		5601.47 *9*	36 *2*	439.991	5/2$^+$	D+Q	+0.17 *6*	Mult.: A_2=+0.06 *13*, −0.06 *5* (1989Ba42).
6194.6	5/2$^-$	2346.4	32 *5*	3848.07	5/2$^-$			
		2516.9	34 *7*	3677.60	3/2$^-$			
		3554.4	23 *5*	2639.86	1/2$^-$			
		6193.7	11 *5*	0.0	3/2$^+$			
6307.96		3916.87	100	2390.732	1/2$^+$			I_γ: From 1979Sm02.
6577.79	9/2$^+$,(5/2$^+$)	2663.38	14 *3*	3914.24	5/2$^+$			
		3873.94	18 *4*	2703.50	9/2$^+$			
		4501.31	43 *5*	2076.01	7/2$^+$	D+Q	−0.25 *10*	Mult.: A_2=−0.64 *10* and δ for 9/2 (1989Ba42).
		6136.92	25 *4*	439.991	5/2$^+$			
6618.1	7/2$^+$,(5/2)$^+$	1843.4	2.8 *1*	4774.61	7/2$^+$			
		2703.7	1.1 *2*	3914.24	5/2$^+$			
		4541.6	1.1 *2*	2076.01	7/2$^+$			
		6177.2	91.2 *6*	439.991	5/2$^+$	D+Q	+0.09 *1*	Mult.: A_2=−0.13 *2*, δ for J(6618)=7/2 (1989Ba42).
		6617.1	3.8 *5*	0.0	3/2$^+$			
6735.5	3/2	3753.1	18 *5*	2982.06	3/2$^+$			
		6294.6	34 *6*	439.991	5/2$^+$			
		6734.4	48 *6*	0.0	3/2$^+$			
6819.6	5/2	2971.3	45 *5*	3848.07	5/2$^-$	D+Q	−0.29 *9*	E_γ: Missing gamma deexcitation intensity Iγ=25 from 6120 level. Mult.: A_2=0.09 *9* (1989Ba42). δ: or +3.1 *10* (1989Ba42).
		3141.8	30 *5*	3677.60	3/2$^-$			
6867.7	5/2$^+$,(3/2$^+$)	3885.29	<10[#]	2982.06	3/2$^+$			
		4163.80	<7[#]	2703.50	9/2$^+$			
		4476.50	<9[#]	2390.732	1/2$^+$			
		6426.7	82 *3*	439.991	5/2$^+$	D+Q	+0.5 *4*	Mult.: A_2=0.64 *15* and 0.48 *15*, A_4=−0.33 *15*, δ for J(6868)=5/2 (1989Ba42).
		6866.6	18 *3*	0.0	3/2$^+$			
6920.61	3/2$^-$	4216.69	<10[#]	2703.50	9/2$^+$			
		6479.64	30 *2*	439.991	5/2$^+$			
		6919.49	70 *2*	0.0	3/2$^+$			
6947.40	3/2	3032.94	9.4 *16*	3914.24	5/2$^+$			
		3964.97	31 *2*	2982.06	3/2$^+$	D(+Q)	+0.1 *2*	Mult.: A_2=0.50 *20* (1989Ba42). δ: or +2.5 *14* (1989Ba42).

$^{23}_{11}Na_{12}$-113

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[d]	Comments
6947.40	3/2	4307.11	8 *2*	2639.86	1/2$^-$			
		4556.18	15 *2*	2390.732	1/2$^+$			
		6506.42	19 *3*	439.991	5/2$^+$			
		6946.27	17 *3*	0.0	3/2$^+$			
7070.82		3156.35	9 *2*	3914.24	5/2$^+$			
		7069.65	91 *2*	0.0	3/2$^+$			
7081.9		6640.8	30[#] *10*	439.991	5/2$^+$			
		7080.6	70[#] *10*	0.0	3/2$^+$			
7133.5		4151.0	13 *2*	2982.06	3/2$^+$			
		5056.9	13 *3*	2076.01	7/2$^+$			
		6692.5	30 *2*	439.991	5/2$^+$			
		7132.3	44 *2*	0.0	3/2$^+$			
7277.1	7/2,5/2	x	37					I_γ: Missing gamma deexcitation intensity of Iγ=37 from this level.
		3428.8	25 *3*	3848.07	5/2$^-$	D+Q	−0.2 *1*	Mult.: A_2=−0.58 *9* for J(7277)=7/2 (1989Ba42).
		6836.0	38 *3*	439.991	5/2$^+$	D+Q	+0.07 *6*	Mult.: A_2=−0.16 *10* for J(7277)=7/2 (1989Ba42).
7412.4	5/2$^+$,7/2$^+$,9/2$^+$	3497.9	24 *6*	3914.24	5/2$^+$			
		5335.7	31 *5*	2076.01	7/2$^+$			A_2=−0.30 *30*, A_4=0.8 *2* (1989Ba42).
		6971.3	45 *5*	439.991	5/2$^+$			A_2=−0.01 *15* (1989Ba42).
7451.5	5/2	3603.1	7.4 *12*	3848.07	5/2$^-$			
		5060.2	3.0 *11*	2390.732	1/2$^+$			
		7010.4	89.6 *15*	439.991	5/2$^+$	D+Q	−0.8 *2*	Mult.: A_2=−0.18 *4* (1989Ba42).
7487.84	1/2,(3/2)	3809.90	45 *7*	3677.60	3/2$^-$			A_2=0.00 *5* (1989Ba42).
		4847.43	20 *5*	2639.86	1/2$^-$	D		Mult.: A_2=0.18 *11* (1989Ba42).
		5096.50	35 *6*	2390.732	1/2$^+$	D		Mult.: A_2=0.05 *8* (1989Ba42).
7566.2	5/2,7/2$^+$	7125.0	30 *15*	439.991	5/2$^+$			
		7564.9	70 *15*	0.0	3/2$^+$			
7724.45		4741.87	25 *5*	2982.06	3/2$^+$			
		7723.06	75 *5*	0.0	3/2$^+$			
7750.5	5/2,7/2$^+$	4767.9	50 *2*	2982.06	3/2$^+$			
		7309.3	50 *2*	439.991	5/2$^+$			
7834.13	7/2,(5/2$^+$)	3919.53	20 *6*	3914.24	5/2$^+$			
		5130.02	22 *7*	2703.50	9/2$^+$			
		7392.86	58 *9*	439.991	5/2$^+$	D(+Q)	−0.07 *7*	Mult.: A_2=−0.40 *11* for J(7834)=7/2 (1989Ba42).
7872.83	3/2,(5/2$^+$)	x	32					I_γ: Missing gamma deexcitation intensity Iγ=32 from this level.
		4890.21	20 *5*	2982.06	3/2$^+$			
		5481.40	13 *3*	2390.732	1/2$^+$			
		7431.55	35 *5*	439.991	5/2$^+$	D+Q	−0.8 *6*	Mult.: A_2=0.33 *17* for J(7873)=3/2 (1989Ba42).
7876.2	5/2	x	27					I_γ: Missing gamma deexcitation intensity Iγ=27 from this level.
		4027.8	18 *3*	3848.07	5/2$^-$			
		4198.2	20 *4*	3677.60	3/2$^-$			
		7874.8	35 *2*	0.0	3/2$^+$			
7891.2	5/2$^+$	5814.4	10 *5*	2076.01	7/2$^+$			

$^{23}_{11}$Na$_{12}$-114

γ(^{23}Na) (continued)

E_i(level)	J^{π}_i	E_{γ}[†]	I_{γ}[‡]	E_f	J^{π}_f	Mult.	δ[d]	Comments
7891.2	5/2+	7449.9	27 *2*	439.991	5/2+	D(+Q)	0.0 *2*	Mult.: A_2=0.29 *11* (1989Ba42). δ: or +1.8 *6* (1989Ba42).
		7889.7	63 *2*	0.0	3/2+	D+Q	−0.06 *4*	Mult.: A_2=−0.34 *6* (1989Ba42). δ: or −3.1 *5* (1989Ba42).
7970		x	29					I_{γ}: Missing gamma deexcitation intensity Iγ=29 from this level.
		5893	33 *6*	2076.01	7/2+			
		7529	38 *7*	439.991	5/2+			
8060		5356	50 *20*	2703.50	9/2+			
		7619	50 *20*	439.991	5/2+			
8302.0		7860.6	100 *25*	439.991	5/2+			
8417.43	3/2	x	33					Missing gamma deexcitation intensity Iγ=33 from this level.
		5434.68	15 *5*	2982.06	3/2+			
		5776.79	<10[#]	2639.86	1/2−			
		6025.85	37 *5*	2390.732	1/2+			
		6340.48	<10[#]	2076.01	7/2+			
		8415.78	15 *5*	0.0	3/2+			
8475.7	3/2,5/2+,7/2+	8034.2	100	439.991	5/2+			
8631.0		8629.3	100	0.0	3/2+			
8943.5	3/2+	5028.7	77[&] *4*	3914.24	5/2+			I_{γ}: From 2016De34. Other: 80 *6* in 2017Ke01.
		6551.8	23[&] *4*	2390.732	1/2+			I_{γ}: From 2016De34. Other: 20 *4* in 2017Ke01.
8975.3	5/2+	2357.1	3.4[&f] *7*	6618.1	7/2+,(5/2)+			I_{γ}: From 3.3 *7*: unweighted ave. of 4.7 *9* (2017Ke01), 2.7 *9* [2018Fe04 − 2.5 *8*], 2.4 *2* [2016De34 − 2.7 *2*]; × 1.03 for ΣIγ=100 from the level.
		4200.3	1.7 *2*	4774.61	7/2+			I_{γ}: Wt. ave. of 1.9 *4* (2018Fe04) and 1.8 *2* (2016De34). Others: ≤3 (2017Ke01).
		5060.5	1.9[&f] *6*	3914.24	5/2+			I_{γ}: Unweighted ave. of 3.1 *6* (2017Ke01), 1.7 *5* (2018Fe04 − 1.6 *5*), 1.0 *3* (2016De34 − 1.1 *3*).
		5297.0	2.6[&f] *4*	3677.60	3/2−			I_{γ}: From 2.5 *4*: Wt. ave. of 2.6 *5* [2018Fe04 − 2.4 *5*] and 2.2 *8* (2017Ke01); × 1.03 for ΣIγ=100 from the level.
		5992.4	3.7[&f] *4*	2982.06	3/2+			I_{γ}: From 3.6 *4*: weighted ave. of 5.0 *8* (2017Ke01), 3.6 *8* [2018Fe04 − 3.3 *7*], 3.3 *4* [2016De34 − 3.7 *5*]; × 1.03 for ΣIγ=100 from the level.
		6898.2	42.6[&f] *11*	2076.01	7/2+			I_{γ}: From 41.5 *11*: weighted ave. of 39.8 *13* (2017Ke01), and 42.2 *8* [2016De34 − 47.9 *9*]; × 1.03 for ΣIγ=100 from the level. Other: 53 *6* (2018Fe04).
		8533.6	38.7[&f] *7*	439.991	5/2+			I_{γ}: From 37.7 *7*: Weighted ave. of 37.7 *15* (2017Ke01), 37.7 *65* [2018Fe04 − 35 *6*], 37.7 *8* [2016De34 − 42.8 *9*].
		8973.4	5.3[&] *14*	0.0	3/2+			I_{γ}: From 2017Ke01. Other: ≤1 (2018Fe04).
9042.4	(7/2,9/2)+	2222	2.2[b] *2*	6819.6	5/2			
		2688	1.5[b] *2*	6354				

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01 (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Comments
9042.4	(7/2,9/2)$^+$	3000	2.6[b] *2*	6042.19	7/2$^-$	
		3115	3.6[b] *2*	5926.8	7/2$^+$	
		5128	1.8[b] *4*	3914.24	5/2$^+$	
		5194	13.3[b] *5*	3848.07	5/2$^-$	
		6337	10.9[b] *5*	2703.50	9/2$^+$	
		6965	18.7[b] *6*	2076.01	7/2$^+$	
		8601	45.4[b] *9*	439.991	5/2$^+$	
9211.0	3/2$^-$	1338	0.44[&] *9*	7872.83	3/2,(5/2$^+$)	
		1723	1.07[&] *10*	7487.84	1/2,(3/2)	I_γ: Other: 2.8 *6* (2015De33).
		2129	2.80[&] *20*	7081.9		
		2290	1.24[&] *13*	6920.61	3/2$^-$	
		2343	1.84[&] *17*	6867.7	5/2$^+$,(3/2$^+$)	
		2903	2.27[&] *17*	6307.96		
		3016	2.74[&] *19*	6194.6	5/2$^-$	I_γ: Other: 3.4 *3* (2015De33).
		3247	16.9[&] *9*	5964.4	3/2$^-$	I_γ: Other: 17.1 *8* (2015De33).
		3469	1.90[&] *16*	5741.8	5/2$^+$	
		4781	3.08[&] *20*	4429.63	1/2$^+$	I_γ: Other: 4.7 *4* (2015De33).
		5297	22.2[&] *12*	3914.24	5/2$^+$	I_γ: Other: 30.0 *17* (2015De33).
		5363	2.44[&] *18*	3848.07	5/2$^-$	I_γ: Other: 2.0 *3* (2015De33).
		5533	1.21[&] *16*	3677.60	3/2$^-$	I_γ: Other: 3.1 *4* (2015De33).
		6229	27.8[&] *15*	2982.06	3/2$^+$	E_γ: A comparable γ ray placed from 9212.9-keV in Adopted Levels – see footnote for 9212.9-keV level. I_γ: Other: 22.4 *10* (2015De33).
		6571	3.23[&] *22*	2639.86	1/2$^-$	I_γ: Other: 6.4 *5* (2015De33).
		6820	1.44[&] *13*	2390.732	1/2$^+$	I_γ: Other: 2.0 *3* (2015De33).
		7135	1.27[&] *12*	2076.01	7/2$^+$	
		8771	2.89[&] *19*	439.991	5/2$^+$	I_γ: Other: 4.9 *5* (2015De33).
		9211	3.08[&] *23*	0.0	3/2$^+$	I_γ: Other: 1.2 *6* (2015De33).
9252.1	1/2$^+$	2170	2.06[a] *9*	7081.9		
		2331	2.43[a] *9*	6920.61	3/2$^-$	I_γ: Other: 2.2 *1* (2015De33).
		3486	2.78[a] *9*	5766.03	3/2$^+$	I_γ: Other: 2.0 *1* (2015De33).
		4821	1.69[a] *9*	4429.63	1/2$^+$	I_γ: Other: 1.9 *1* (2015De33).
		5337	0.37[a] *9*	3914.24	5/2$^+$	I_γ: Other: <0.1 (2015De33).
		5573	4.85[a] *16*	3677.60	3/2$^-$	I_γ: Other: 4.5 *3* (2015De33).
		6269	31.7[a] *5*	2982.06	3/2$^+$	I_γ: Other: 32.7 *6* (2015De33).
		6611	8.27[a] *18*	2639.86	1/2$^-$	I_γ: Other: 9.4 *3* (2015De33).

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[d]	Comments
9252.1	1/2$^+$	6860	4.05[a] *12*	2390.732	1/2$^+$			I_γ: Other: 3.6 *2* (2015De33).
		9250	41.8[a] *7*	0.0	3/2$^+$			A_2=0.04 *3*; A_4=−0.07 *6* (1973Me11) I_γ: Other: 43.6 *9* (2015De33).
9396.4	7/2$^-$	978.9	0.1	8417.43	3/2			
		1520.1	11	7876.2	5/2	D+Q	+0.08 *7*	Mult.: A_2=−0.20 *14* (1989Ba42).
		1645.8	1.3	7750.5	5/2,7/2$^+$			
		1830.1	1.5	7566.2	5/2,7/2$^+$	D+Q	+0.13 *7*	Mult.: A_2=0.07 *12* (1989Ba42).
		1944.8	1.0	7451.5	5/2			
		1983.9	5	7412.4	5/2$^+$,7/2$^+$,9/2$^+$	D+Q		Mult.: A_2=0.36 *6*, A_4=0.17 *6* (1989Ba42).
		2119.2	10	7277.1	7/2,5/2	D(+Q)	−0.04 *6*	Mult.: A_2=0.47 *10*, for J(7277)=7/2 (1989Ba42).
		2206	2	7190				
		2576.6	12	6819.6	5/2	D+Q	+0.06 *2*	Mult.: A_2=−0.22 *3* (1989Ba42).
		2818.4	4.4	6577.79	9/2$^+$,(5/2$^+$)			
		3041.7	2	6354		D+Q	+0.24 *7*	Mult.: A_2=−0.51 *9* (1989Ba42).
		3201.6	7.4	6194.6	5/2$^-$	D+Q	−0.11 *2*	Mult.: A_2=−0.53 *4* (1989Ba42).
		3353.9	9.7	6042.19	7/2$^-$	D(+Q)	+0.03 *6*	Mult.: A_2=0.46 *4* (1989Ba42).
		3654.3	10	5741.8	5/2$^+$	D(+Q)	+0.02 *2*	Mult.: A_2=−0.29 *3* (1989Ba42).
		4621.3	0.7	4774.61	7/2$^+$			
		5481.5	2.8	3914.24	5/2$^+$			
		5547.6	12	3848.07	5/2$^-$	D(+Q)	+0.02 *2*	Mult.: A_2=−0.31 *3* (1989Ba42).
		6691.9	4.7	2703.50	9/2$^+$			
		8954.5	3.0	439.991	5/2$^+$	D+Q	+2.6 *7*	Mult.: A_2=0.67 *10*, A_4=0.43 *10* (1989Ba42).
9404.8	1/2	1680.3	0.44[c] *3*	7724.45				
		3638.5	0.41[c] *3*	5766.03	3/2$^+$			
		4974.6	3.4[c] *1*	4429.63	1/2$^+$			
		5726.4	7.6[c] *2*	3677.60	3/2$^-$			
		6421.8	7.8[c] *4*	2982.06	3/2$^+$			
		6763.9	2.9[c] *1*	2639.86	1/2$^-$			
		8962.9	1.5[c] *1*	439.991	5/2$^+$			
		9402.7	76.0[c] *7*	0.0	3/2$^+$			
9426.1	3/2	1938.2		7487.84	1/2,(3/2)	D+Q	+0.098 *9*	A_2=−0.32 *2* (1989Ba42)
		2344.1		7081.9		D(+Q)	+0.11 *15*	A_2=0.41 *2* (1989Ba42)
		2606.3		6819.6	5/2	D+Q	+0.18 *4*	A_2=−0.20 *10* (1989Ba42) δ: or <−8.
		2690.4	1.6	6735.5	3/2	D(+Q)	+0.04 *5*	A_2=0.48 *8* (1989Ba42)
		3117.9		6307.96		D(+Q)	−0.01 *3*	A_2=−0.50 *5* (1989Ba42) δ: or −1.7 *2*.
		3461.4		5964.4	3/2$^-$	D(+Q)	+0.01 *5*	A_2=0.47 *7*; A_4=−0.16 *7* (1989Ba42)
		3659.8		5766.03	3/2$^+$	D+Q	−0.18 *6*	A_2=0.12 *9* (1989Ba42)
		4995.9		4429.63	1/2$^+$	D(+Q)	+0.005 *10*	A_2=−0.48 *2* (1989Ba42)
		5511.2		3914.24	5/2$^+$	D+Q	−0.07 *2*	A_2=−0.02 *3* (1989Ba42)
		5577.3		3848.07	5/2$^-$	D+Q	−0.28 *2*	A_2=0.18 *2* (1989Ba42)
		6785.2		2639.86	1/2$^-$	D+Q	+0.25 *4*	A_2=−0.03 *7* (1989Ba42)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[d]	Comments
9426.1	3/2	7034.2		2390.732	1/2$^+$	D+Q	+0.022 *4*	A_2=−0.453 *8* (1989Ba42)
		8984.2		439.991	5/2$^+$	D+Q	+0.40 *5*	A_2=−0.53 *4* (1989Ba42) δ: or +6 *2*.
		9424.0		0.0	3/2$^+$	D+Q	+0.35 *3*	A_2=0.83 *3* (1989Ba42) δ: or +1.5 *2*.
9487.7	3/2	3179.5	1.6[@]	6307.96				
		3292.8	0.5[@]	6194.6	5/2$^-$			
		3523.0	1.1[@]	5964.4	3/2$^-$			
		3721.3	2.0[@]	5766.03	3/2$^+$			
		4108.7	1.2[@]	5378.56	5/2$^+$			
		5057.5	2.1[@]	4429.63	1/2$^+$			
		5573.7	3.3[@]	3914.24	5/2$^+$			
		5809.3	0.9[@]	3677.60	3/2$^-$			
		6504.7	2.5[@]	2982.06	3/2$^+$			
		6846.7	18[@]	2639.86	1/2$^-$			
		7095.8	0.8[@]	2390.732	1/2$^+$			
		9045.8	36[@]	439.991	5/2$^+$	D+Q	−1.2 *+2−8*	A_2=0.34 *10*; A_4=−0.07 *17* (1973Me11)
		9485.6	30[@]	0.0	3/2$^+$	D+Q	+0.36 *10*	A_2=0.84 *7*; A_4=−0.23 *10* (1973Me11) δ: or +1.7 *5*.
9608.2	3/2$^+$	1735.3	0.3	7872.83	3/2,(5/2$^+$)			
		1883.7	0.5	7724.45				
		2120.3	0.6	7487.84	1/2,(3/2)			
		2223	0.1	7385				
		2537.2	0.7	7070.82				
		2660.6	1.2	6947.40	3/2			
		2788.4	0.4	6819.6	5/2			
		2872.5	0.2	6735.5	3/2			
		3300.0	0.2	6307.96				
		3643.5	0.1	5964.4	3/2$^-$			
		3841.8	0.6	5766.03	3/2$^+$			
		3866.1	2.2	5741.8	5/2$^+$	D+Q[e]	−0.38[e] *14*	A_2=−0.108 *118*; A_4=−0.033 *119*; A_6=−0.080 *133* (2006Ka65)
		4229.2	0.9	5378.56	5/2$^+$			
		5177.9	0.5	4429.63	1/2$^+$			
		5693.2	18	3914.24	5/2$^+$	D+Q[e]	+0.13[e] *4*	A_2=−0.138 *32*; A_4=0.85 *37*; A_6=−0.050 *34* (2006Ka65)
		5759.4	1.8	3848.07	5/2$^-$			
		6625.1	1.8	2982.06	3/2$^+$			
		6967.2	1.8	2639.86	1/2$^-$			
		7216.3	0.8	2390.732	1/2$^+$	D+Q	+0.20 *2*	
		9166.2	43	439.991	5/2$^+$	D+Q[e]	+0.32[e] *4*	A_2=−0.242 *25*; A_4=0.095 *25*; A_6=−0.056 *26* (2006Ka65)
		9606.0	24	0.0	3/2$^+$	D+Q[e]	+0.40[e] *10*	A_2=0.430 *55*; A_4=0.59 *49*; A_6=−0.055 *51* (2006Ka65)

$^{23}_{11}$Na$_{12}$-118

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ†	I_γ‡	E_f	J^π_f	Mult.	δ[d]	Comments
9652.2	3/2$^+$,5/2$^+$	2784.3	1.5[@]	6867.7	5/2$^+$,(3/2$^+$)			
		4877.0	19[@]	4774.61	7/2$^+$			
		5737.2	1.0[@]	3914.24	5/2$^+$			
		5803.3	0.7[@]	3848.07	5/2$^-$			
		5973.8	3.0[@]	3677.60	3/2$^-$			
		7260.2	0.8[@]	2390.732	1/2$^+$			
		7574.9	1.0[@]	2076.01	7/2$^+$			
		9210.2	46[@]	439.991	5/2$^+$			
		9650.0	27[@]	0.0	3/2$^+$			
9655.6		4880.4	5.0[@]	4774.61	7/2$^+$			
		5225.3	1.2[@]	4429.63	1/2$^+$			
		5740.6	0.6[@]	3914.24	5/2$^+$			
		5977.2	28[@]	3677.60	3/2$^-$			
		6672.5	0.8[@]	2982.06	3/2$^+$			
		7014.6	3.8[@]	2639.86	1/2$^-$			
		7263.6	0.6[@]	2390.732	1/2$^+$			
		9213.6	16[@]	439.991	5/2$^+$			
		9653.4	44[@]	0.0	3/2$^+$			
9674.1	3/2$^+$,5/2$^+$	1782.8	1.2[@]	7891.2	5/2$^+$			
		2806.2	9.2[@]	6867.7	5/2$^+$,(3/2$^+$)			
		3479.2	2.0[@]	6194.6	5/2$^-$			
		3907.7	3.2[@]	5766.03	3/2$^+$			
		5759.1	7.0[@]	3914.24	5/2$^+$			
		5825.2	1.3[@]	3848.07	5/2$^-$			
		5995.7	3.2[@]	3677.60	3/2$^-$			
		6691.0	6.9[@]	2982.06	3/2$^+$			
		7282.1	1.0[@]	2390.732	1/2$^+$			
		7596.7	19[@]	2076.01	7/2$^+$			
		9232.1	33[@]	439.991	5/2$^+$	D+Q	−0.11 *7*	A_2=0.34 *9*; A_4=−0.06 *14* (1979Sm02) δ: or −2.1 *12* (1979Sm02).
		9671.9	13[@]	0.0	3/2$^+$	D+Q	−3.7 *5*	A_2=−42 *7*; A_4=0.80 *12* (1979Sm02) δ: From 1979Sm02.
9682.7	3/2$^+$	1380.7	0.5[@]	8302.0				
		2116.4	5.8[@]	7566.2	5/2,7/2$^+$			
		2231.1	4.5[@]	7451.5	5/2			

$^{23}_{11}$Na$_{12}$-119

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[d]	Comments
9682.7	3/2$^+$	2600.6	2.5[@]	7081.9				
		4907.5	3.5[@]	4774.61	7/2$^+$			
		5767.7	3.1[@]	3914.24	5/2$^+$			
		5833.8	25[@]	3848.07	5/2$^-$			
		6004.3	8.3[@]	3677.60	3/2$^-$			
		6699.6	15[@]	2982.06	3/2$^+$			
		7605.3	1.4[@]	2076.01	7/2$^+$			
		9240.7	2.4[@]	439.991	5/2$^+$	D(+Q)	−1.2 *+15−11*	A_2=0.13 *12*; A_4=0.59 *21* (1973Me11) δ: From 1973Me11.
		9680.5	28[@]	0.0	3/2$^+$	D+Q	−0.36 *10*	A_2=−0.28 *3*; A_4=0.11 *6* (1973Me11) δ: or −5.7 *+57−20* (1973Me11).
9700.9	3/2$^+$	1809.6	0.3[@]	7891.2	5/2$^+$			
		1950.3	0.3[@]	7750.5	5/2,7/2$^+$			
		1976.4	0.2[@]	7724.45				
		2965.2	0.4[@]	6735.5	3/2			
		3958.7	1.9[@]	5741.8	5/2$^+$			
		5270.6	0.3[@]	4429.63	1/2$^+$			
		5785.9	2.0[@]	3914.24	5/2$^+$	D+Q[e]	+0.16[e] *11*	A_2=−0.105 *104*; A_4=0.049 *109*; A_6=0.031 *105* (2006Ka65)
		6022.5	2.5[@]	3677.60	3/2$^-$	D+Q[e]	+0.35[e] *9*	A_2=0.423 *52*; A_4=−0.033 *40*; A_6=−0.015 *53* (2006Ka65)
		6717.8	3.9[@]	2982.06	3/2$^+$	D+Q	+20 *12*	A_2=0.008 *73*; A_4=−0.097 *6*; A_6=−0.068 *84* (2006Ka65)
		7059.9	8.0[@]	2639.86	1/2$^-$	D+Q[e]	−0.58[e] *7*	A_2=−0.702 *1*; A_4=−0.046 *72*; A_6=0.045 *70* (2006Ka65)
		7308.9	0.7[@]	2390.732	1/2$^+$			
		7622.5	1.5[@]	2076.01	7/2$^+$			
		9258.9	30[@]	439.991	5/2$^+$	D+Q[e]	−0.18[e] *6*	A_2=−0.005 *34*; A_4=−0.009 *35*; A_6=−0.020 *30* (2006Ka65)
		9698.7	48[@]	0.0	3/2$^+$	D+Q[e]	+0.14[e] *4*	A_2=0.312 *37*; A_4=−0.070 *37*; A_6=0.020 *39* (2006Ka65)
9732.53	7/2	1256.8	1.4	8475.7				A_2=−0.28 *5*.
		1430.5	0.9	8302.0				
		1671	0.6	8060				
		1856.2	1.2	7876.2	5/2			
		1898.3	0.6	7834.13	7/2,(5/2$^+$)			
		1981.9	1.0	7750.5	5/2,7/2$^+$	D(+Q)	+0.02 *4*	Mult.: A_2=−0.28 *8*, for J(7750)=5/2 (1989Ba42).
		2320.0	0.2	7412.4	5/2$^+$,7/2$^+$,9/2$^+$			
		2455.3	0.6	7277.1	7/2,5/2			
		2912.7	1.2	6819.6	5/2	D+Q	−0.11 *4*	Mult.: A_2=−0.50 *6* (1989Ba42).
		3154.50	2.8	6577.79	9/2$^+$,(5/2$^+$)	D(+Q)	−0.01 *3*	Mult.: A_2=−0.14 *16*, for J(6578)=9/2$^+$.
		3537.6	1.5	6194.6	5/2$^-$	D+Q	−3.4 *7*	Mult.: A_2=−0.23 *9* (1989Ba42).
		3690.02	14	6042.19	7/2$^-$	D+Q	+0.05 *4*	Mult.: A_2=−0.43 *3*, A_4=0.07 *3* (1989Ba42).
		3990.4	3.5	5741.8	5/2$^+$	D(+Q)	0.00 *3*	Mult.: A_2=−0.34 *3* (1989Ba42).

γ(^{23}Na) (continued)

E$_i$(level)	J$^\pi_i$	E$_\gamma$ [†]	I$_\gamma$ [‡]	E$_f$	J$^\pi_f$	Mult.	δ [d]	Comments
9732.53	7/2	4353.53	3.9	5378.56	5/2$^+$	D(+Q)	+0.02 *3*	Mult.: A$_2$=−0.29 *4* (1989Ba42).
		5817.50	4.1	3914.24	5/2$^+$	D+Q	−0.12 *5*	Mult.,δ: From 2005Vo22.
		5883.65	19	3848.07	5/2$^-$	D+Q	−0.05 *2*	Mult.: A$_2$=−0.40 *2* (1989Ba42).
		7027.88	17	2703.50	9/2$^+$	D(+Q)	−0.02 *2*	Mult.: A$_2$=−0.12 *2* (1989Ba42).
		7655.15	6.7	2076.01	7/2$^+$	D+Q	+0.118 *5*	Mult.: A$_2$=0.47 *3*, A$_4$=0.10 *3* (1989Ba42).
		9290.52 *13*	20	439.991	5/2$^+$	D+Q	+0.033 *7*	Mult.: A$_2$=−0.257 *11* (1989Ba42). δ: Also same value in 2005Vo22.
9755.5	3/2$^+$	5325.3	0.6[@]	4429.63	1/2$^+$			
		5840.5	4.2[@]	3914.24	5/2$^+$			
		5906.6	8.1[@]	3848.07	5/2$^-$			
		6077.0	10[@]	3677.60	3/2$^-$			
		7114.5	59[@]	2639.86	1/2$^-$			
		7363.5	0.8[@]	2390.732	1/2$^+$			
		9313.5	7.9[@]	439.991	5/2$^+$			
		9753.3	9.4[@]	0.0	3/2$^+$			
9815.7	5/2$^+$	1513.6	0.1	8302.0				
		1846	1.5	7970				
		1924.4	0.3	7891.2	5/2$^+$			
		1942.8	0.5	7872.83	3/2,(5/2$^+$)			
		2403.2	0.7	7412.4	5/2$^+$,7/2$^+$,9/2$^+$			
		2682.0	0.9	7133.5				
		2744.7	3.0	7070.82				
		2868.1	3.6	6947.40	3/2			
		3080.0	0.7	6735.5	3/2			
		3197.6	0.5	6618.1	7/2$^+$,(5/2)$^+$			
		3888.5	0.5	5926.8	7/2$^+$			
		4049.3	7.7	5766.03	3/2$^+$	D+Q	−0.039 *13*	Mult.: A$_2$=−0.48 *3* (1989Ba42).
		4073.5	1.6	5741.8	5/2$^+$			
		5040.5	1.4	4774.61	7/2$^+$			
		5385.4	2.4	4429.63	1/2$^+$			
		5900.6	4.8	3914.24	5/2$^+$			
		5966.8	0.2	3848.07	5/2$^-$			
		6832.6	32	2982.06	3/2$^+$			
		7111.0	6.7	2703.50	9/2$^+$			
		7423.7	0.6	2390.732	1/2$^+$			
		7738.3	16	2076.01	7/2$^+$			
		9373.7	7.3	439.991	5/2$^+$			
		9813.5	6.4	0.0	3/2$^+$			
9835.4	3/2$^+$	1944.1	1.5[@]	7891.2	5/2$^+$			
		2702.0	2.0[@]	7133.5				
		2764.4	0.3[@]	7070.82				

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f
9835.4	3/2$^+$	3099.7	1.4[@]	6735.5	3/2
		3640.5	4.4[@]	6194.6	5/2$^-$
		4093.2	1.6[@]	5741.8	5/2$^+$
		4456.4	2.2[@]	5378.56	5/2$^+$
		5405.1	4.8[@]	4429.63	1/2$^+$
		5920.3	12[@]	3914.24	5/2$^+$
		5986.5	3.4[@]	3848.07	5/2$^-$
		6156.9	0.2[@]	3677.60	3/2$^-$
		6852.2	0.2[@]	2982.06	3/2$^+$
		7443.4	12[@]	2390.732	1/2$^+$
		9393.3	14[@]	439.991	5/2$^+$
		9833.1	40[@]	0.0	3/2$^+$
9850.1	1/2$^+$	5419.8	3.5[@]	4429.63	1/2$^+$
		6171.6	11[@]	3677.60	3/2$^-$
		6866.9	2.2[@]	2982.06	3/2$^+$
		7209.0	32[@]	2639.86	1/2$^-$
		7458.1	33[@]	2390.732	1/2$^+$
		9408.9	0.3[@]	439.991	5/2$^+$
		9847.8	18[@]	0.0	3/2$^+$
9890.9	3/2	4124.5	2.1[#]	5766.03	3/2$^+$
		4511.9	2.1[#]	5378.56	5/2$^+$
		5975.8	10[#]	3914.24	5/2$^+$
		6042.0	5.7[#]	3848.07	5/2$^-$
		6212.4	7.9[#]	3677.60	3/2$^-$
		7249.8	22[#]	2639.86	1/2$^-$
		7498.9	8.2[#]	2390.732	1/2$^+$
		9448.8	18[#]	439.991	5/2$^+$
		9888.6	24[#]	0.0	3/2$^+$
9917.0	3/2$^+$,5/2,7/2	3049.1	5.0[#]	6867.7	5/2$^+$,(3/2$^+$)
		5141.8	7.0[#]	4774.61	7/2$^+$
		6001.9	40[#]	3914.24	5/2$^+$
		6068.1	22[#]	3848.07	5/2$^-$
		9474.9	22[#]	439.991	5/2$^+$
		9914.7	4.0[#]	0.0	3/2$^+$
10003.2	1/2$^-$	4038.4	2.6[#]	5964.4	3/2$^-$

γ(^{23}Na) (continued)

E$_i$(level)	J_i^π	E$_\gamma$[†]	I$_\gamma$[‡]	E$_f$	J_f^π	Mult.	δ[d]	Comments
10003.2	1/2$^-$	4236.8	11[#]	5766.03	3/2$^+$			
		5572.8	3.0[#]	4429.63	1/2$^+$			
		6324.7	3.5[#]	3677.60	3/2$^-$			
		7020.0	1.9[#]	2982.06	3/2$^+$			
		7362.1	47[#]	2639.86	1/2$^-$			
		7611.1	12[#]	2390.732	1/2$^+$			
		10000.9	19[#]	0.0	3/2$^+$			
10017.4	5/2$^+$	1386.4	0.1	8631.0	3/2,5/2$^+$,7/2$^+$			
		1599.9	0.3	8417.43	3/2	D+Q	+0.37 *4*	Mult.: A_2=−0.50 *6*(1989Ba42).
		2141.1	0.3	7876.2	5/2	D+Q	−0.09 *7*	Mult.: A_2=0.35 *8* (1989Ba42).
		2565.7	0.6	7451.5	5/2	D+Q	−0.49 *3*	Mult.: A_2=−0.14 *3* (1989Ba42).
		2740.1	0.3	7277.1	7/2,5/2			
		2884.0	0.2	7133.5				
		3096.6	0.3	6920.61	3/2$^-$			
		3281.6	0.2	6735.5	3/2			
		3399.0	3.7	6618.1	7/2$^+$,(5/2)$^+$	D(+Q)	0.00 *1*	Mult.: A_2=−0.12 *2*, for J(6618)=7/2 (1989Ba42).
		3974.8	0.1	6042.19	7/2$^-$			
		4250.9	0.3	5766.03	3/2$^+$	D+Q	−0.15 *4*	Mult.: A_2=−0.65 *6* (1989Ba42).
		4276.0	0.4	5741.8	5/2$^+$			
		4638.3	0.7	5378.56	5/2$^+$	D+Q	−0.05 *4*	Mult.: A_2=0.39 *5* (1989Ba42). δ: or +1.3 *2* (1989Ba42).
		5242.1	0.3	4774.61	7/2$^+$			
		6102.3	19	3914.24	5/2$^+$	D+Q	+0.05 *2*	Mult.: A_2=0.49 *2* (1989Ba42).
		6168.4	5	3848.07	5/2$^-$	D(+Q)	0.00 *2*	Mult.: A_2=0.44 *2* (1989Ba42).
		6338.9	12	3677.60	3/2$^-$	D+Q	−0.020 *6*	Mult.: A_2=−0.422 *11* (1989Ba42).
		7034.2	34	2982.06	3/2$^+$	D+Q	−0.032 *5*	Mult.: A_2=−0.445 *9* (1989Ba42).
		7312.7	0.1	2703.50	9/2$^+$			
		7625.3	0.4	2390.732	1/2$^+$			
		7939.9	5	2076.01	7/2$^+$	D+Q	−0.276 *14*	Mult.: A_2=0.217 *14* (1989Ba42). δ: Also same value in 2005Vo22.
		9575.3	15	439.991	5/2$^+$	D+Q	−0.207 *13*	Mult.: A_2=0.206 *16* (1989Ba42).
		10015.1	1.6	0.0	3/2$^+$	D+Q	−0.126 *11*	Mult.: A_2=−0.614 *13* (1989Ba42).
10049.1		6200.1	32[#]	3848.07	5/2$^-$			
		7971.6	24[#]	2076.01	7/2$^+$			
		9607.0	44[#]	439.991	5/2$^+$			
10070.9	5/2,7/2	7993.4	56[#]	2076.01	7/2$^+$			A_2=−0.14 *4*, A_4=−0.06 *7* (1989Ba42).
		9628.7	36[#]	439.991	5/2$^+$			A_2=0.65 *3*, A_4=−0.04 *6* (1989Ba42).
		10068.5	8.0[#]	0.0	3/2$^+$			
10075.9	3/2,7/2	3257.6	2.9[#]	6819.6	5/2			
		4033.3	5.1[#]	6042.19	7/2$^-$			

$^{22}Ne(p,\gamma)$ 1989Ba42,1979Sm02,2017Ke01 (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f
10075.9	3/2,7/2	4111.1	1.4[#]	5964.4	3/2⁻
		4333.7	2.3[#]	5741.8	5/2⁺
		5300.6	18[#]	4774.61	7/2⁺
		6226.9	16[#]	3848.07	5/2⁻
		6397.3	4.0[#]	3677.60	3/2⁻
		7092.7	15[#]	2982.06	3/2⁺
		7434.7	0.9[#]	2639.86	1/2⁻
		7998.4	22[#]	2076.01	7/2⁺
		9633.7	6.6[#]	439.991	5/2⁺
		10073.5	5.8[#]	0.0	3/2⁺
10085.3	1/2⁺	3137.7	4.0[#]	6947.40	3/2
		3164.5	6.7[#]	6920.61	3/2⁻
		3349.5	4.7[#]	6735.5	3/2
		3777.0	26[#]	6307.96	
		4318.8	22[#]	5766.03	3/2⁺
		5654.9	3.2[#]	4429.63	1/2⁺
		6406.7	6.3[#]	3677.60	3/2⁻
		7102.1	1.5[#]	2982.06	3/2⁺
		7693.2	4.7[#]	2390.732	1/2⁺
		9643.1	6.9[#]	439.991	5/2⁺
		10082.9	14[#]	0.0	3/2⁺
10114.8	1/2⁺	4150.0	4.3[#]	5964.4	3/2⁻
		4348.3	7.5[#]	5766.03	3/2⁺
		7131.6	77[#]	2982.06	3/2⁺
		7722.7	1.6[#]	2390.732	1/2⁺
		10112.4	9.6[#]	0.0	3/2⁺
10125.9	5/2	4083.3	2.7[#]	6042.19	7/2⁻
		4161.1	1.9[#]	5964.4	3/2⁻
		4384.2	8.0[#]	5741.8	5/2⁺
		4746.8	2.6[#]	5378.56	5/2⁺
		6210.8	3.5[#]	3914.24	5/2⁺
		6276.9	4.8[#]	3848.07	5/2⁻
		6447.3	21[#]	3677.60	3/2⁻
		7142.6	2.5[#]	2982.06	3/2⁺
		8048.4	24[#]	2076.01	7/2⁺

γ(^{23}Na) (continued)

E_i(level)	J_i^{π}	E_{γ} †	I_{γ} ‡	E_f	J_f^{π}	Mult.	δ [d]	Comments
10125.9	5/2	9683.7	17 [#]	439.991	$5/2^+$			
		10123.5	12 [#]	0.0	$3/2^+$			
10169.6	$5/2^+$	1693.8	0.6	8475.7				
		2109	1.0	8060				
		2296.6	2.5	7872.83	$3/2,(5/2^+)$	D+Q	+0.09 3	Mult.: A_2=−0.19 3, for J(7873)=3/2 (1989Ba42).
		2335.3	1.7	7834.13	$7/2,(5/2^+)$	D(+Q)	0.00 3	Mult.: A_2=−0.14 5, for J(7834)=7/2 (1989Ba42).
		2892.3	0.8	7277.1	7/2,5/2			
		3301.6	6.8	6867.7	$5/2^+,(3/2^+)$			
		3433.8	0.5	6735.5	3/2			
		3974.6	0.9	6194.6	$5/2^-$	D(+Q)	+0.05 17	Mult.: A_2=0.47 12 (1989Ba42).
		4127.0	1.1	6042.19	$7/2^-$	D(+Q)	+0.06 7	Mult.: A_2=−0.21 9 (1989Ba42).
		4242.4 4	1.9	5926.8	$7/2^+$	D+Q	+0.18 4	Mult.: A_2=−0.37 5 (1989Ba42). δ: or >−4.
		4427.3	2.6	5741.8	$5/2^+$	D+Q	−0.41 8	Mult.: A_2=−0.04 9 (1989Ba42). δ: or +2.7 7.
		4790.5	6.8	5378.56	$5/2^+$			
		5394.3	11	4774.61	$7/2^+$	D+Q	+0.30 2	Mult.: A_2=−0.52 2 (1989Ba42). δ: Also same value in 2005Vo22.
		6254.4	0.6	3914.24	$5/2^+$			
		6320.6	0.8	3848.07	$5/2^-$			
		7186.3	45	2982.06	$3/2^+$	D+Q	+0.14 2	Mult.: A_2=−0.10 3 (1989Ba42).
		7464.8	2	2703.50	$9/2^+$	Q(+O)	+0.03 5	Mult.: A_2=0.15 6 (1989Ba42).
		8092.1	1.5	2076.01	$7/2^+$	D+Q	+0.11 3	Mult.,δ: From 2005Vo22.
		9727.4	8.1	439.991	$5/2^+$	D+Q	+1.33 9	Mult.: A_2=0.51 3, A_4=−0.16 4 (1989Ba42).
		10167.2	4.0	0.0	$3/2^+$	D+Q	−3.4 19	Mult.: A_2=−0.37 3, A_4=0.49 3 (1989Ba42).
10231.7	$5/2^+$	1756.9	0.3	8475.7				
		1814.2	1.3	8417.43	3/2			
		1929.6	0.3	8302.0				
		2665.3	0.6	7566.2	$5/2,7/2^+$			
		2819.1	0.5	7412.4	$5/2^+,7/2^+,9/2^+$			
		3098.0	2.1	7133.5				
		3284.0	0.9	6947.40	3/2			
		3363.7	1.2	6867.7	$5/2^+,(3/2^+)$	D+Q	+0.12 10	Mult.: A_2=0.54 7, for J(6868)=5/2 (1989Ba42).
		3613.3	3.7	6618.1	$7/2^+,(5/2)^+$	D+Q	−0.03 2	Mult.: A_2=−0.09 3, for J(6618)=3/2 (1989Ba42).
		4189.1	3.7	6042.19	$7/2^-$	D(+Q)	−0.02 3	Mult.: A_2=−0.11 4 (1989Ba42).
		4304.5	18	5926.8	$7/2^+$	D+Q	+0.04 2	Mult.: A_2=−0.19 2 (1989Ba42). δ: Also same value in 2005Vo22.
		4465.2	0.6	5766.03	$3/2^+$			
		4489.4	0.3	5741.8	$5/2^+$			
		6316.5	11	3914.24	$5/2^+$			
		6382.7	0.3	3848.07	$5/2^-$			
		6553.1	4.5	3677.60	$3/2^-$	D(+Q)	−0.02 2	Mult.: A_2=−0.41 2 (1989Ba42).
		7839.5	3.6	2390.732	$1/2^+$	Q		Mult.: A_2=0.55 4, A_4=−0.42 4.

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ [†]	I_γ [‡]	E_f	J^π_f	Mult.	δ [d]	Comments
10231.7	5/2$^+$	9789.5	45	439.991	5/2$^+$	D+Q	+0.30 *3*	Mult.: A_2=0.67 *2* (1989Ba42).
		10229.3	2.1	0.0	3/2$^+$	D+Q	+0.03 *2*	Mult.: A_2=−0.32 *3* (1989Ba42).
10243.7	1/2$^+$	2519.1	7	7724.45				
		4477.2	6	5766.03	3/2$^+$			
		5813.3	2	4429.63	1/2$^+$			
		6565.1	50	3677.60	3/2$^-$			
		7260.4	5	2982.06	3/2$^+$			
		7603.0	6	2639.86	1/2$^-$			
		7851.5	19	2390.732	1/2$^+$			
		9801.5	5	439.991	5/2$^+$			
10281.5	3/2$^+$	3147.8	1.2 [#]	7133.5				
		4316.7	2.4 [#]	5964.4	3/2$^-$			
		4515.0	6.3 [#]	5766.03	3/2$^+$			
		4902.4	1.2 [#]	5378.56	5/2$^+$			
		5506.2	1.3 [#]	4774.61	7/2$^+$			
		6366.3	39 [#]	3914.24	5/2$^+$			
		7298.2	4.4 [#]	2982.06	3/2$^+$			
		7640.7	5.4 [#]	2639.86	1/2$^-$			
		7889.3	14 [#]	2390.732	1/2$^+$			
		9839.2	15 [#]	439.991	5/2$^+$			
		10279.0	9.8 [#]	0.0	3/2$^+$			
10318.0	3/2$^-$	5887.6	14 [#]	4429.63	1/2$^+$	D(+Q) [e]	−0.6 [e] *10*	A_2=−0.541 *151*; A_4=0.102 *140*; A_6=−0.079 *125* (2006Ka65)
		6469.0	4.5 [#]	3848.07	5/2$^-$	D(+Q) [e]	+7 [e] *8*	A_2=−0.267 *157*; A_4=0.001 *152*; A_6=−0.052 *159* (2006Ka65)
		6639.4	2.8 [#]	3677.60	3/2$^-$			
		7334.7	8.5 [#]	2982.06	3/2$^+$	D+Q [e]	+1.3 [e] *7*	A_2=0.425 *139*; A_4=0.004 *122*; A_6=−0.072 *136* (2006Ka65)
		7677.2	20 [#]	2639.86	1/2$^-$	D+Q [e]	−0.58 [e] *27*	A_2=−0.730 *175*; A_4=0.159 *152*; A_6=−0.125 *145* (2006Ka65)
		7925.8	1.2 [#]	2390.732	1/2$^+$			
		9875.7	34 [#]	439.991	5/2$^+$	D+Q [e]	+0.12 [e] *6*	A_2=−0.116 *46*; A_4=0.013 *40*; A_6=−0.019 *53* (2006Ka65)
		10315.5	15 [#]	0.0	3/2$^+$	D(+Q) [e]	+0.14 [e] *37*	A_2=0.441 *5*; A_4=−0.061 *74*; A_6=0.025 *1* (2006Ka65)
10338.7	(1/2$^-$)	3417.8	3.0 [#]	6920.61	3/2$^-$			
		3518.8	0.9 [#]	6819.6	5/2			
		4030.4	3.6 [#]	6307.96				
		4373.9	1.4 [#]	5964.4	3/2$^-$			
		6660.1	4.9 [#]	3677.60	3/2$^-$			
		7355.4	29 [#]	2982.06	3/2$^+$			
		7697.9	5.9 [#]	2639.86	1/2$^-$			
		7946.5	15 [#]	2390.732	1/2$^+$			

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[d]	Comments
10338.7	(1/2$^-$)	9896.4	3.3[#]	439.991	5/2$^+$			
		10336.2	33[#]	0.0	3/2$^+$			
10346.1	5/2$^+$	4303.5	1.2[#]	6042.19	7/2$^-$			
		4579.6	3.6[#]	5766.03	3/2$^+$			
		4603.8	2.4[#]	5741.8	5/2$^+$			
		4967.0	1.6[#]	5378.56	5/2$^+$			
		5570.8	1.9[#]	4774.61	7/2$^+$			
		6430.9	7.7[#]	3914.24	5/2$^+$	D+Q	−0.10 *7*	Mult.,δ: From 2009Us01.
		6497.0	0.7[#]	3848.07	5/2$^-$			
		6667.5	1.5[#]	3677.60	3/2$^-$			
		7362.8	3.8[#]	2982.06	3/2$^+$	D(+Q)	−0.09 *10*	Mult.,δ: From 2009Us01.
		7953.9	3.6[#]	2390.732	1/2$^+$			
		8268.5	15[#]	2076.01	7/2$^+$	D+Q	−0.06 *2*	Mult.,δ: From 2009Us01 and 2005Vo22.
		9903.8	28[#]	439.991	5/2$^+$	D+Q	+0.21 *8*	Mult.: A_2=0.64 *5*, A_4=0.10 *7* (1979Sm02). δ: From (1979Sm02). Other: +0.15 *9* (2009Us01).
		10343.6	29[#]	0.0	3/2$^+$	D+Q	−0.29 *4*	Mult.: A_2=−0.85 *10*, A_4=0.02 *14* (1979Sm02). δ: Wt. av. of −0.27 *5* (1979Sm02) and −0.30 *4* (2009Us01). Other possible values: −1.1 *2* (1979Sm02), −1.5 *2* (2009Us01).
10353.8	3/2$^+$	2462.5	1.7[#]	7891.2	5/2$^+$			
		3618.0	0.5[#]	6735.5	3/2			
		4587.3	3.2[#]	5766.03	3/2$^+$			
		4611.5	2.0[#]	5741.8	5/2$^+$			
		4974.7	3.5[#]	5378.56	5/2$^+$			
		5923.4	1.4[#]	4429.63	1/2$^+$			
		6438.6	0.9[#]	3914.24	5/2$^+$			
		6504.7	30[#]	3848.07	5/2$^-$			
		6675.2	8.0[#]	3677.60	3/2$^-$			
		7370.5	4.1[#]	2982.06	3/2$^+$			
		7713.0	34[#]	2639.86	1/2$^-$			
		7961.6	2.8[#]	2390.732	1/2$^+$			
		8276.2	2.6[#]	2076.01	7/2$^+$			
		9911.5	3.8[#]	439.991	5/2$^+$			
		10351.3	1.5[#]	0.0	3/2$^+$			
10440.6	5/2$^+$	2023.1	3.3[#]	8417.43	3/2			
		3028.0	2.1[#]	7412.4	5/2$^+$,7/2$^+$,9/2$^+$			

γ(^{23}Na) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	δ[d]	Comments
10440.6	5/2$^+$	3822.2	3.4[#]	6618.1	7/2$^+$,(5/2)$^+$			
		5061.4	1.2[#]	5378.56	5/2$^+$			
		6525.4	9.0[#]	3914.24	5/2$^+$	D+Q	+0.50 *10*	Mult.,δ: From 2009Us01.
		6761.9	0.5[#]	3677.60	3/2$^-$			
		7457.2	36[#]	2982.06	3/2$^+$	D+Q	−0.35 *8*	A_2=−0.320 *47*; A_4=0.019 *44*; A_6=−0.013 *40* (2006Ka65) Mult.,δ: From 2009Us01. Other: δ=−0.35 *7* (2006Ka65).
		8363.0	9.5[#]	2076.01	7/2$^+$	D+Q	+0.09 *3*	A_2=−0.128 *100*; A_4=−0.069 *113*; A_6=0.056 *117* (2006Ka65) Mult.,δ: From 2009Us01 and 2005Vo22. Other: δ=+0.12 *21* (2006Ka65).
		9998.3	20[#]	439.991	5/2$^+$	D+Q	−0.22 *10*	A_2=0.114 *109*; A_4=−0.030 *110*; A_6=−0.043 *124* (2006Ka65) Mult.,δ: From 2009Us01. Other: δ=−0.23 *15* (2006Ka65).
		10438.1	15[#]	0.0	3/2$^+$	D+Q	+0.24 *8*	A_2=0.250 *132*; A_4=−0.095 *146*; A_6=−0.092 *130* (2006Ka65) Mult.,δ: From 2009Us01. Other: δ=+0.38 *12* (2006Ka65).
10448.7		1972.9	5.7[#]	8475.7				
		2557.3	2.6[#]	7891.2	5/2$^+$			
		4406.1	5.3[#]	6042.19	7/2$^-$			
		6533.5	16[#]	3914.24	5/2$^+$			
		6599.6	33[#]	3848.07	5/2$^-$			
		7743.8	16[#]	2703.50	9/2$^+$			
		8371.1	18[#]	2076.01	7/2$^+$			
		10006.4	2.6[#]	439.991	5/2$^+$			
		10446.2	0.8[#]	0.0	3/2$^+$			
10478.8	3/2$^+$	2754.2	2.3[#]	7724.45				
		3660.4	1.3[#]	6819.6	5/2			
		4712.3	3.1[#]	5766.03	3/2$^+$			
		4737	14[#]	5741.8	5/2$^+$			
		5099.6	31[#]	5378.56	5/2$^+$			
		6563.6	11[#]	3914.24	5/2$^+$			
		6629.7	2.4[#]	3848.07	5/2$^-$			
		7838.0	1.4[#]	2639.86	1/2$^-$			
		8086.5	3.1[#]	2390.732	1/2$^+$			
		10036.5	3.4[#]	439.991	5/2$^+$			
		10476.2	27[#]	0.0	3/2$^+$			
10501.9	3/2$^-$	4760	0.7[#]	5741.8	5/2$^+$			
		6071.4	1.0[#]	4429.63	1/2$^+$			
		6652.8	7.0[#]	3848.07	5/2$^-$			
		6823.2	4.8[#]	3677.60	3/2$^-$			

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[d]	Comments
10501.9	3/2$^-$	7518.5	2.0[#]	2982.06	3/2$^+$			
		7861.1	1.7[#]	2639.86	1/2$^-$			
		8109.6	4.8[#]	2390.732	1/2$^+$			
		10059.5	25[#]	439.991	5/2$^+$			
		10499.3	53[#]	0.0	3/2$^+$			
10507.8	1/2$^+$	3425.6	5.9[#]	7081.9				
		3586.9	4.2[#]	6920.61	3/2$^-$			
		4199.4	1.8[#]	6307.96				
		4542.9	2.8[#]	5964.4	3/2$^-$			
		4741.2	3.3[#]	5766.03	3/2$^+$			
		6077.3	9.0[#]	4429.63	1/2$^+$			
		6829.1	8.8[#]	3677.60	3/2$^-$			
		7524.4	11[#]	2982.06	3/2$^+$			
		7867.0	29[#]	2639.86	1/2$^-$			
		8115.5	10[#]	2390.732	1/2$^+$			
		10065.4	3.2[#]	439.991	5/2$^+$			
		10505.2	11[#]	0.0	3/2$^+$			
10519.1	5/2$^+$	1888.0	0.7	8631.0	3/2,5/2$^+$,7/2$^+$			A_2=−0.40 *6* (1989Ba42).
		2101.6	1.7	8417.43	3/2	D(+Q)	+0.02 *2*	Mult.: A_2=−0.36 *3* (1989Ba42).
		2159.0	0.2	8360.0				
		2627.7	3.8	7891.2	5/2$^+$	D(+Q)	−0.01 *4*	Mult.: A_2=0.45 *4* (1989Ba42).
		2684.8	0.7	7834.13	7/2,(5/2$^+$)	D(+Q)	+0.01 *5*	Mult.: A_2=−0.15 *8*, for J(7834)=7/2 (1989Ba42).
		2952.7	0.3	7566.2	5/2,7/2$^+$			
		3067.4	0.8	7451.5	5/2	D+Q	−0.52 *7*	Mult.: A_2=−0.17 *7* (1989Ba42).
		3106.5	0.3	7412.4	5/2$^+$,7/2$^+$,9/2$^+$			
		3385.3	2.3	7133.5				
		3571.4	0.7	6947.40	3/2	D+Q	−0.06 *3*	Mult.: A_2=−0.49 *5* (1989Ba42).
		3598.2	0.7	6920.61	3/2$^-$			
		3651.1	1.9	6867.7	5/2$^+$,(3/2$^+$)	D(+Q)	+0.04 *5*	Mult.: A_2=0.48 *5*, for J(6868)=5/2 (1989Ba42).
		3699.2	0.5	6819.6	5/2	D(+Q)	+0.06 *13*	Mult.: A_2=0.50 *11* (1989Ba42).
		3783.3	0.5	6735.5	3/2			
		3900.6	1.8	6618.1	7/2$^+$,(5/2)$^+$	D+Q	+0.06 *4*	Mult.: A_2=−0.23 *5*, for J(6618)=7/2 (1989Ba42).
		4210.7	0.2	6307.96				
		4554.2	0.4	5964.4	3/2$^-$			
		4752.5	2.6	5766.03	3/2$^+$	D+Q	+0.17 *2*	Mult.: A_2=−0.04 *5* (1989Ba42).
		4776.8	1.5	5741.8	5/2$^+$	D(+Q)	+0.04 *6*	Mult.: A_2=0.49 *6* (1989Ba42).
		5139.9	0.6	5378.56	5/2$^+$			
		6088.6	0.4	4429.63	1/2$^+$			
		6840.4	2.1	3677.60	3/2$^-$	D(+Q)	0.00 *4*	Mult.: A_2=−0.40 *8* (1989Ba42).

$^{23}_{11}$Na$_{12}$-129

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[d]	Comments
10519.1	5/2$^+$	7535.7	3.5	2982.06	3/2$^+$	D(+Q)	+0.01 *3*	Mult.: A_2=−0.38 *5* (1989Ba42). δ: Other: +0.1 *2* (2009Us01).
		7814.2	0.8	2703.50	9/2$^+$			
		8126.8	2.4	2390.732	1/2$^+$	Q		Mult.: A_2=0.23 *8*, A_4=−0.43 *9* (1989Ba42).
		8441.4	4.2	2076.01	7/2$^+$	D+Q	+0.43 *2*	Mult.: A_2=−0.68 *2* (1989Ba42). δ: or +3.0 *2*. Other: +0.40 *3* or −2.9 *3* (2009Us01).
		10076.7	25	439.991	5/2$^+$	D+Q	−0.19 *3*	Mult.: A_2=0.24 *4* (1989Ba42). δ: Other: −0.18 *3* (2009Us01).
		10516.5	40	0.0	3/2$^+$	D+Q	−0.13 *2*	Mult.: A_2=−0.64 *4* (1989Ba42). δ: Also same value in 2009Us01.
10534.1		3613.2	8.4[#]	6920.61	3/2$^-$			
		5758.7	6.2[#]	4774.61	7/2$^+$			
		6855.4	8.5[#]	3677.60	3/2$^-$			
		7550.7	1.8[#]	2982.06	3/2$^+$			
		8141.8	5.2[#]	2390.732	1/2$^+$			
		8456.4	3.9[#]	2076.01	7/2$^+$			
		10091.7	11[#]	439.991	5/2$^+$			
		10531.5	55[#]	0.0	3/2$^+$			
10549.2	5/2$^+$	2657.8	1.2[#]	7891.2	5/2$^+$			
		2824.6	1.3[#]	7724.45				
		4582.3	2.8[#]	5964.4	3/2$^-$			
		4806.9	1.4[#]	5741.8	5/2$^+$			
		5170.0	3.2[#]	5378.56	5/2$^+$			
		6118.7	14[#]	4429.63	1/2$^+$			A_2=−0.205 *9*; A_4=0.103 *92*; A_6=−0.087 *95* (2006Ka65) δ: −0.11 *7* in 2006Ka65, but ΔJ=2 for the transition.
		6633.9	15[#]	3914.24	5/2$^+$	D+Q	−0.80 *12*	A_2=−0.254 *1*; A_4=0.026 *1*; A_6=0.021 *1* (2006Ka65) Mult.,δ: From 2009Us01. Other: δ=−1.0 *3* (2006Ka65).
		6870.5	0.8[#]	3677.60	3/2$^-$			
		7565.8	19[#]	2982.06	3/2$^+$	D(+Q)	−0.05 *7*	A_2=−0.091 *105*; A_4=−0.079 *117*; A_6=0.018 *114* (2006Ka65) Mult.,δ: From 2009Us01. Other: δ=−0.04 *8* (2006Ka65).
		8156.9	9.2[#]	2390.732	1/2$^+$			A_2=−0.592 *127*; A_4=0.109 *119*; A_6=−0.077 *1* (2006Ka65)
		8471.5	3.4[#]	2076.01	7/2$^+$	D+Q	−0.07 *6*	Mult.,δ: From 2009Us01 and 2005Vo22. Other: δ=−0.7 *7* (2006Ka65).
		10106.8	8.7[#]	439.991	5/2$^+$	D+Q[e]	−0.19[e] *8*	A_2=−0.552 *136*; A_4=0.054 *113*; A_6=0.058 *110* (2006Ka65) δ: Other: δ=−2.0 *5* (2009Us01).
		10546.6	20[#]	0.0	3/2$^+$	D+Q	+0.19 *6*	A_2=0.041 *109*; A_4=−0.011 *117*; A_6=−0.040 *123* (2006Ka65) Mult.,δ: From 2009Us01. Other: δ=+0.21 *9* (2006Ka65).
10574.6	3/2$^-$	3753.5	4.2[#]	6819.6	5/2			
		5195.4	1.8[#]	5378.56	5/2$^+$			

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[d]	Comments
10574.6	3/2⁻	6144.1	3.1[#]	4429.63	1/2⁺			
		6659.3	3.1[#]	3914.24	5/2⁺			
		6725.5	27[#]	3848.07	5/2⁻			
		6895.9	4.2[#]	3677.60	3/2⁻			
		7591.2	2.5[#]	2982.06	3/2⁺			
		7933.3	1.9[#]	2639.86	1/2⁻			
		8182.3	8.2[#]	2390.732	1/2⁺			
		10132.2	44[#]	439.991	5/2⁺			
10616.9	5/2⁺,3/2⁺	3748.9	4.8[#]	6867.7	5/2⁺,(3/2⁺)			
		4850.3	6.0[#]	5766.03	3/2⁺			
		6701.6	8.5[#]	3914.24	5/2⁺	D(+Q)[e]	+0.5[e] *11*	A_2=0.614 *135*; A_4=0.091 *110*; A_6=0.126 *140* (2006Ka65)
		6938.2	16[#]	3677.60	3/2⁻	D+Q[e]	−0.6[e] *5*	A_2=−0.614 *136*; A_4=−0.053 *123*; A_6=0.109 *111* (2006Ka65)
		8224.6	3.0[#]	2390.732	1/2⁺			
		8539.2	4.4[#]	2076.01	7/2⁺			
		10174.5	54[#]	439.991	5/2⁺	D(+Q)[e]	+0.5[e] *10*	A_2=0.564 *119*; A_4=−0.070 *106*; A_6=−0.002 *106* (2006Ka65)
		10614.3	3.3[#]	0.0	3/2⁺			

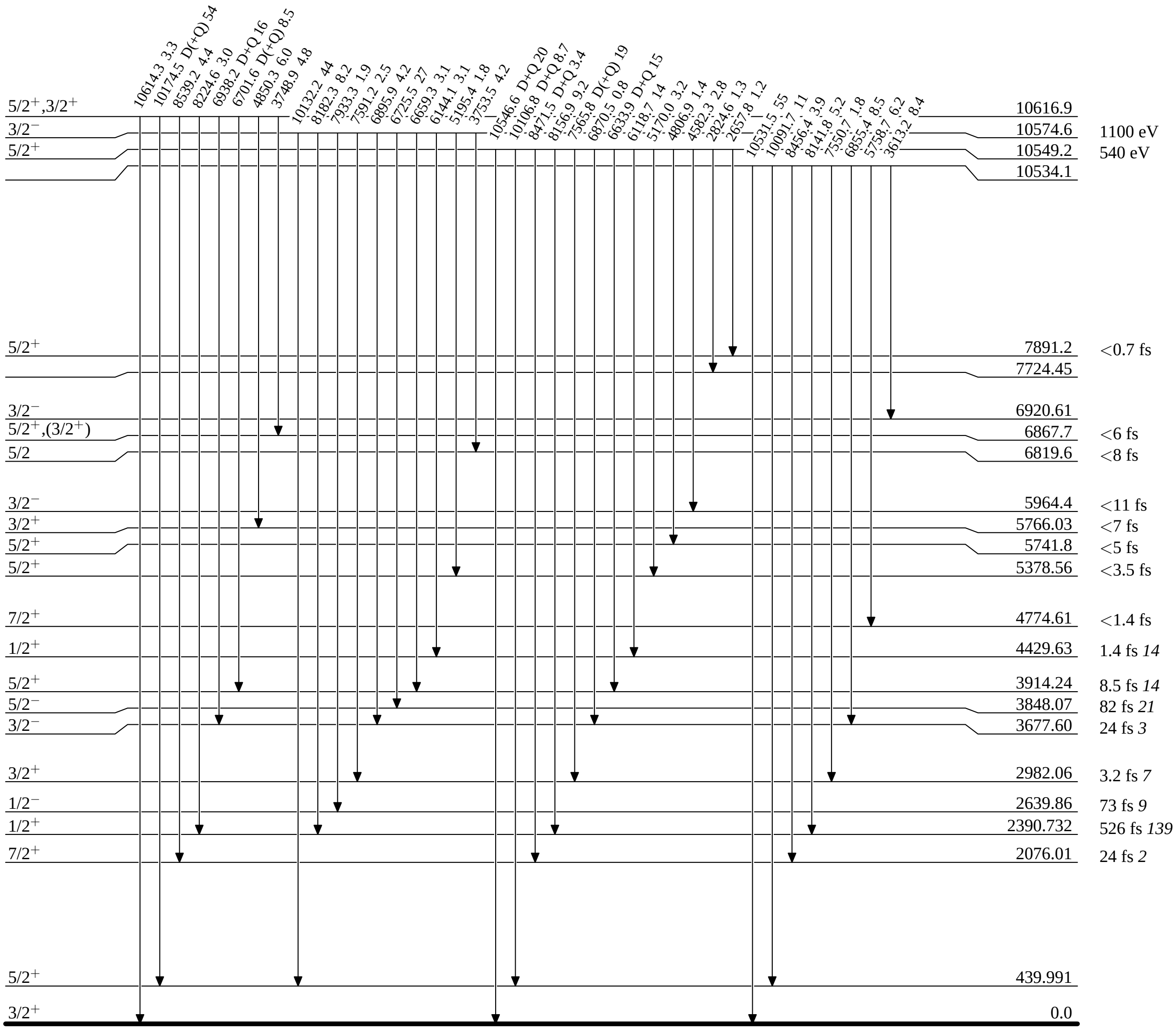
[†] From level energy differences, recoil energy subtracted.
[‡] From 1989Ba42, except otherwise noted.
[#] From 1979Sm02.
[@] From 1973Me11.
[&] From 2017Ke01. Recommended values of 2017Ke01 for 8975.3 (E_r=178) and 9211.0 keV (E_r=417) levels are listed. The recommended value is the arithmetic mean of values from singles and coincidence measurements.
[a] From 2015Ke05. New primary γ to 7082-keV level (2170γ).
[b] From 2016De34.
[c] From 2015De33.
[d] From 1989Ba42, except otherwise noted.
[e] From 2006Ka65. Sign from calculated reduced probabilities and the RUL, 2006Ka65 note. Evaluators assign without sign in this dataset.
[f] For weighted/unweighted average values of 2018Fe04 and 2016De34 are scaled by a ratio of Iγ(8533.6)(2017Ke01)/Iγ(8533.6)(2018Fe04) or Iγ(8533.6)(2017Ke01)/Iγ(8533.6)(2016De34).

$^{23}_{11}Na_{12}$-131

$^{22}Ne(p,\gamma)$ 1989Ba42,1979Sm02,2017Ke01

Level Scheme

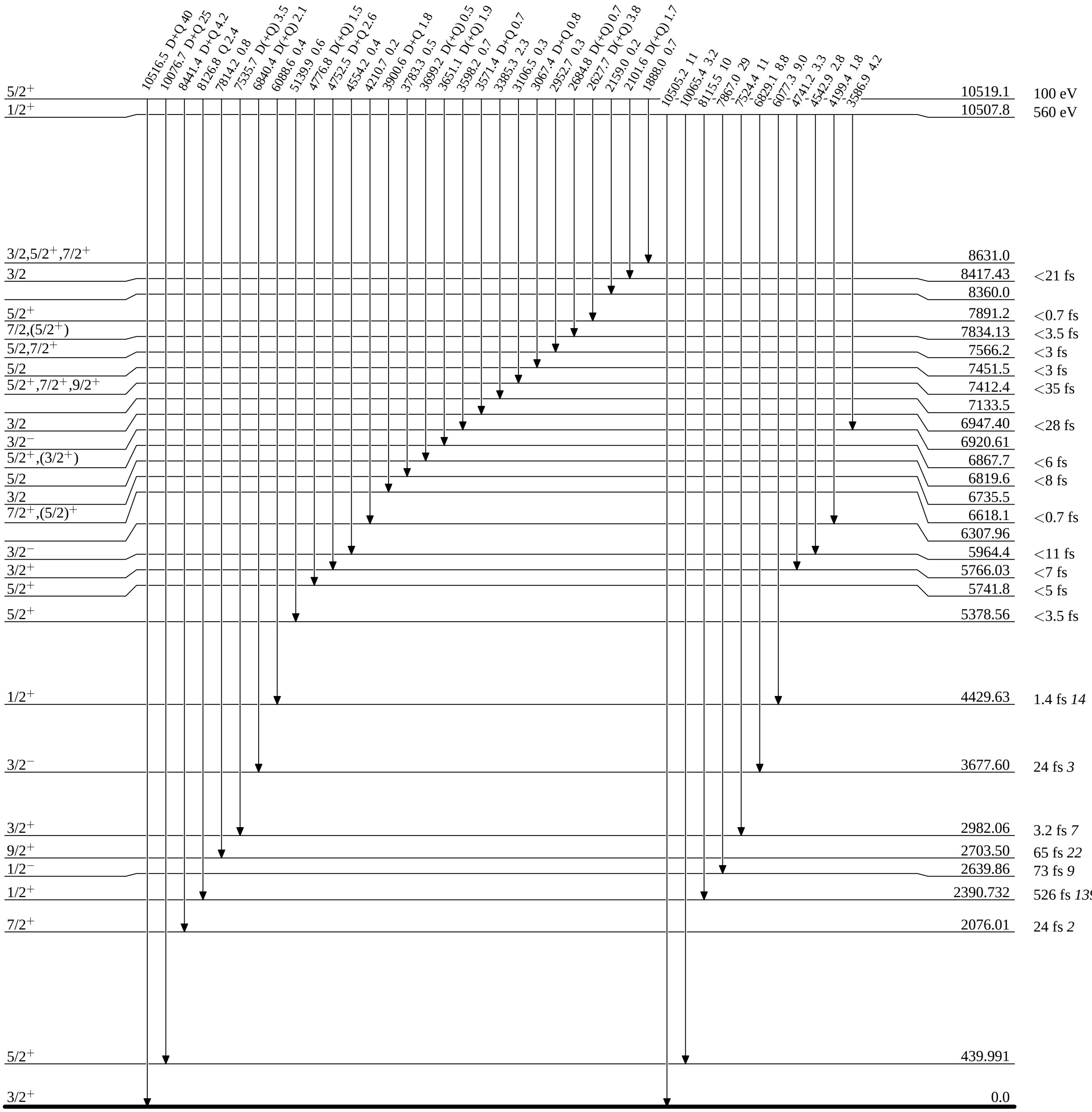
Intensities: % photon branching from each level



^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

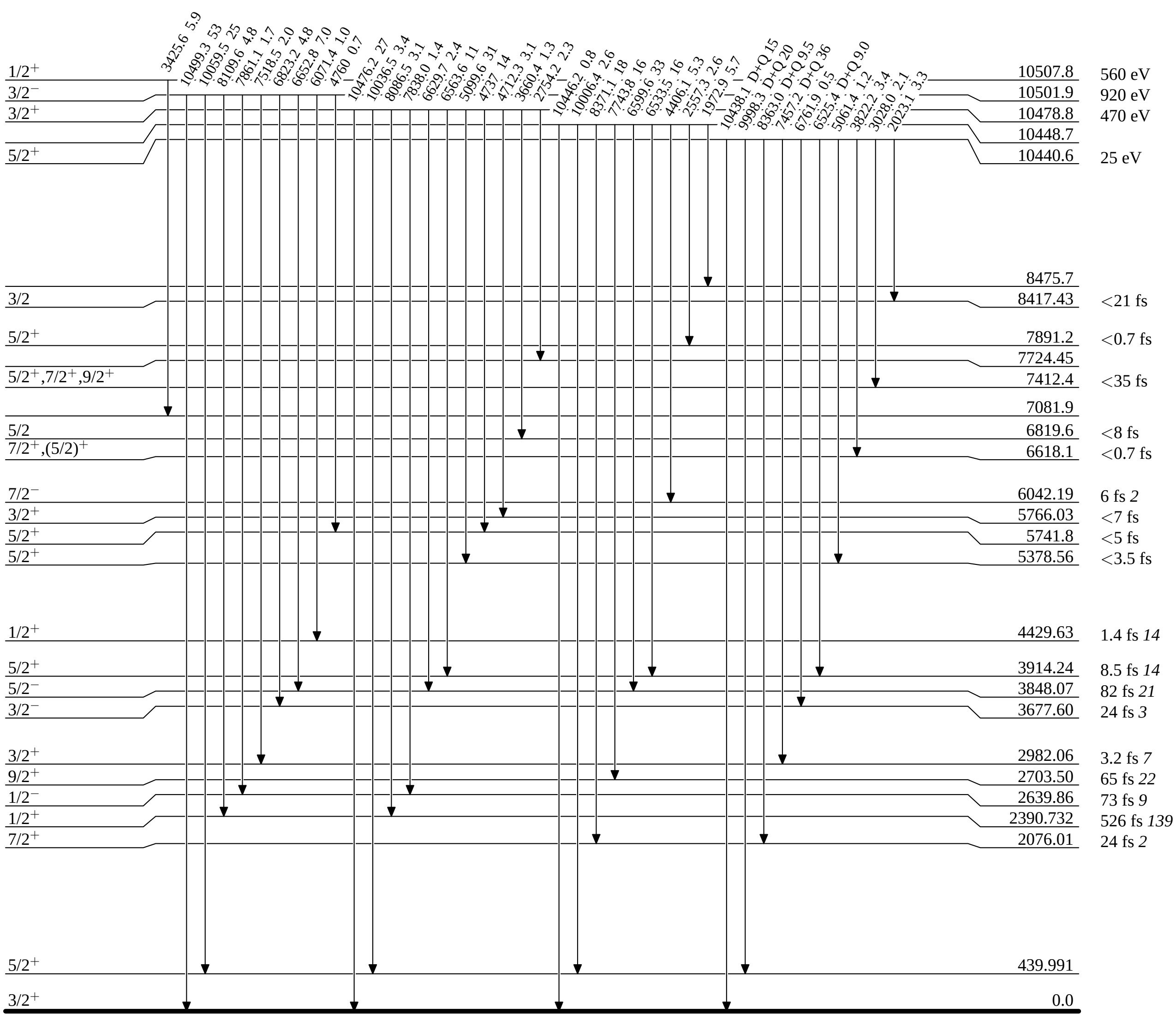


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

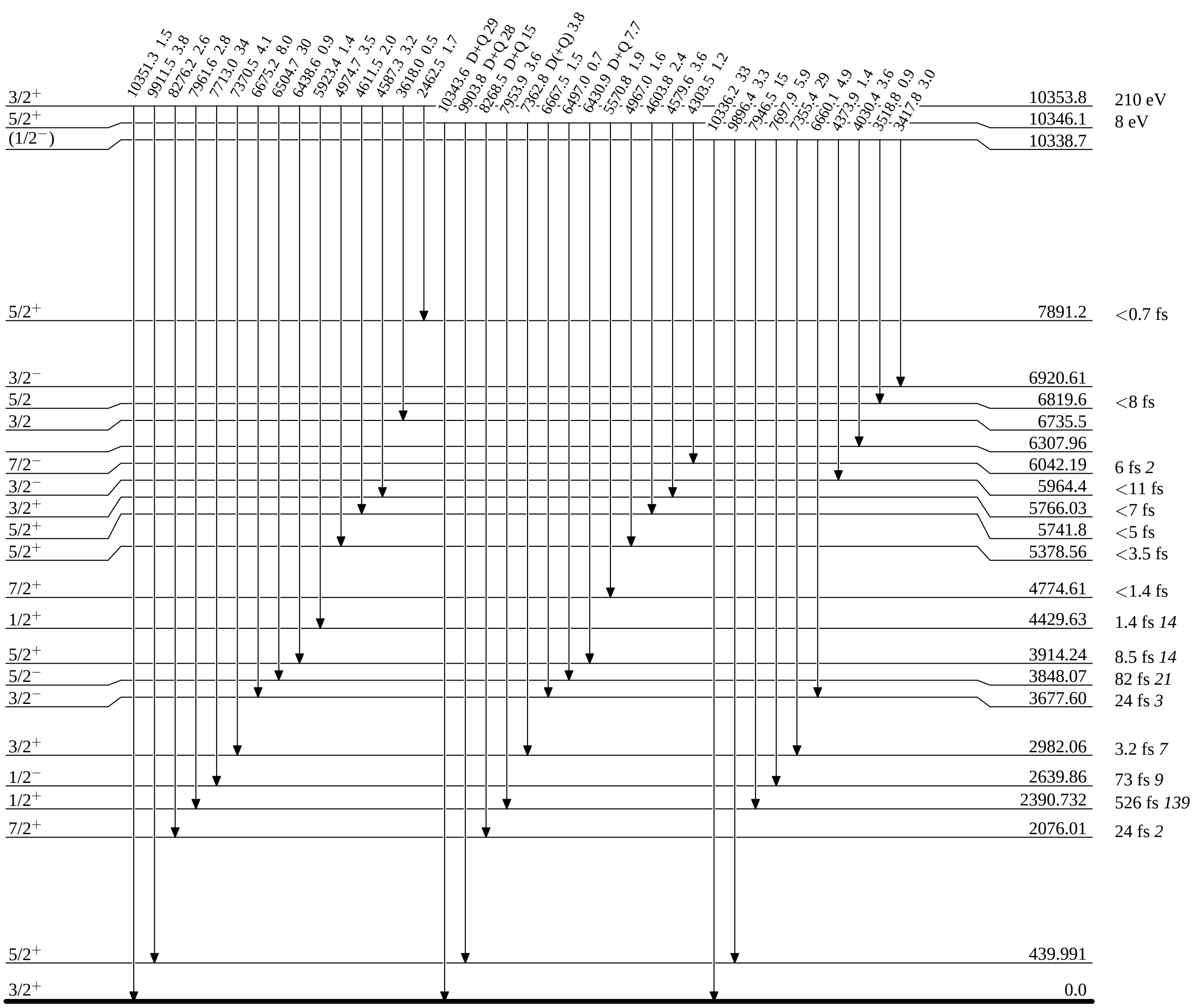


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

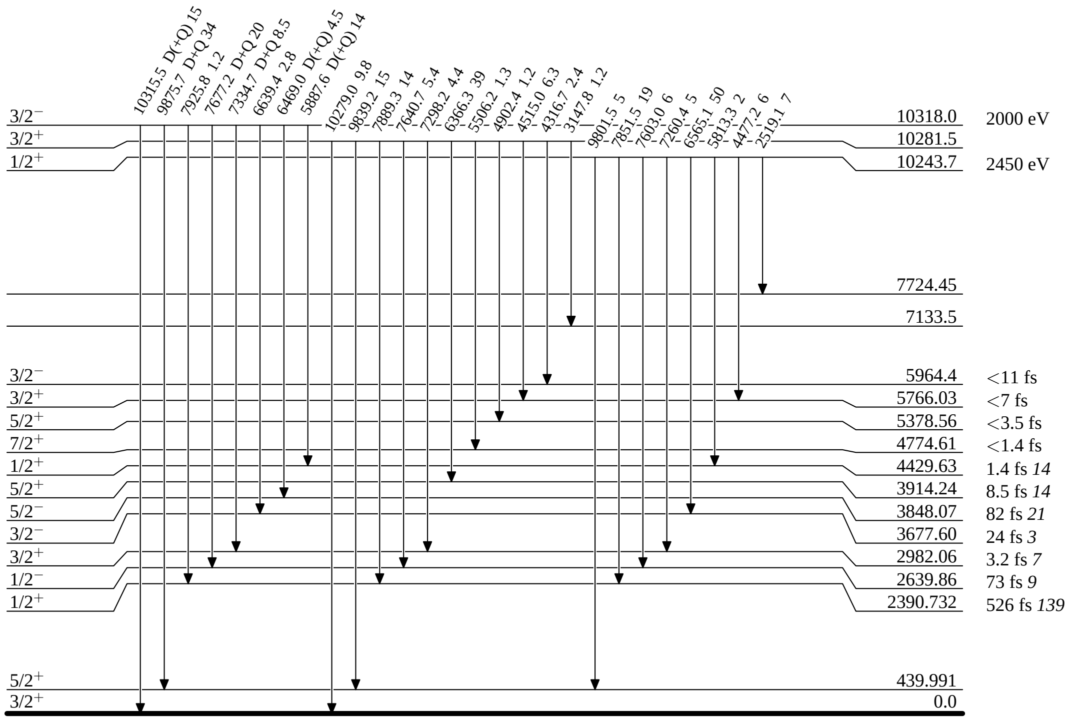


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

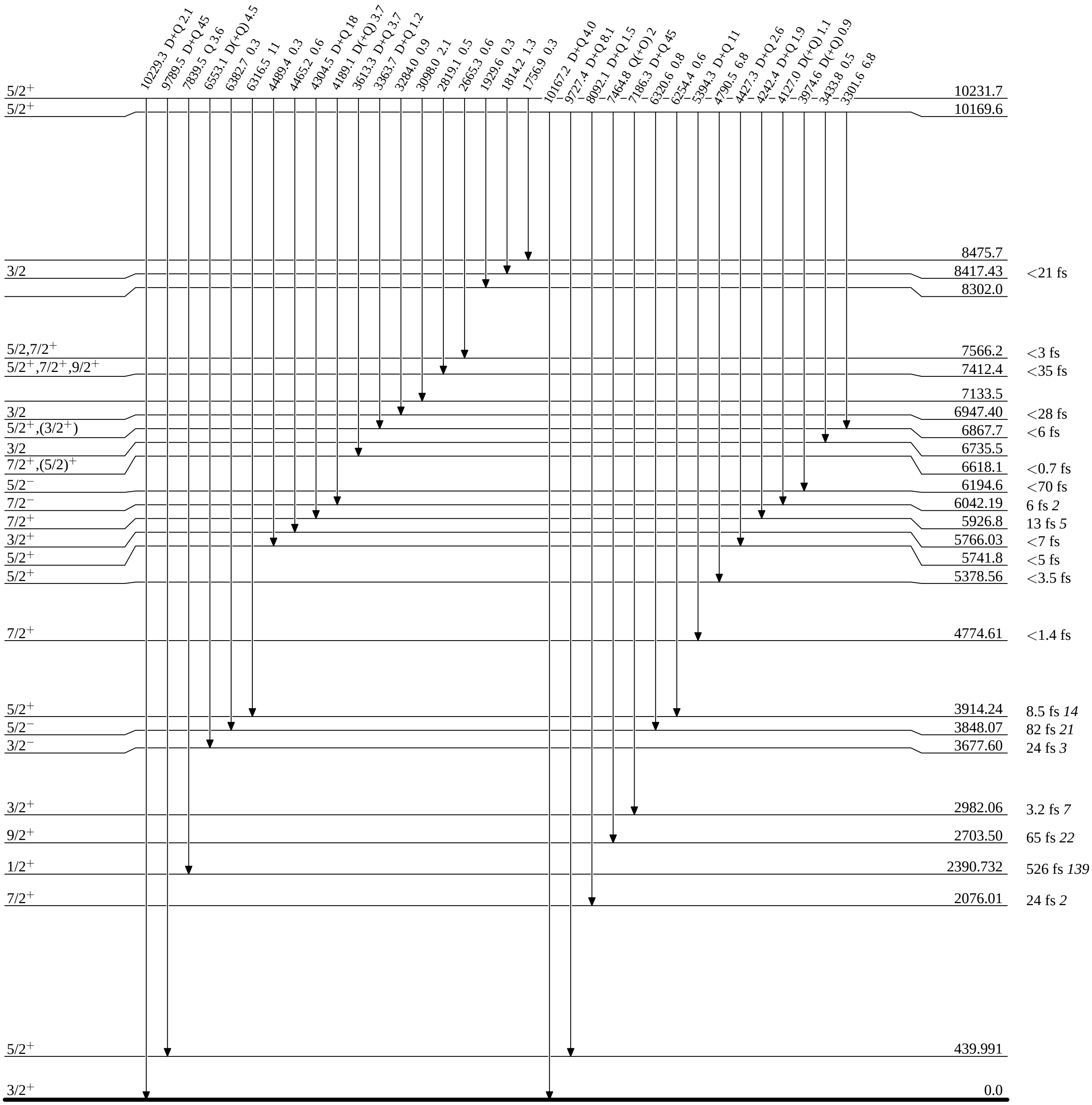


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

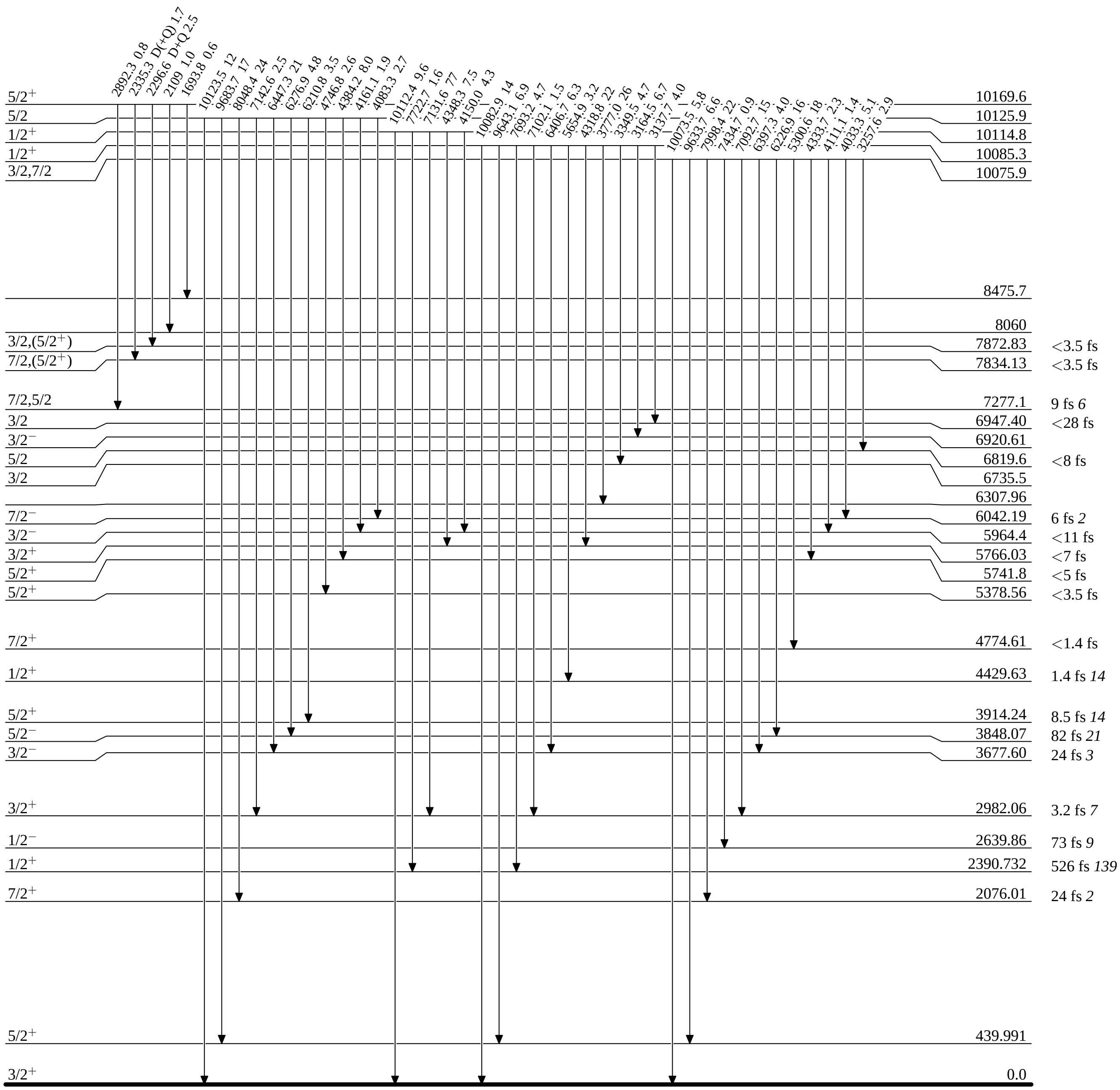


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

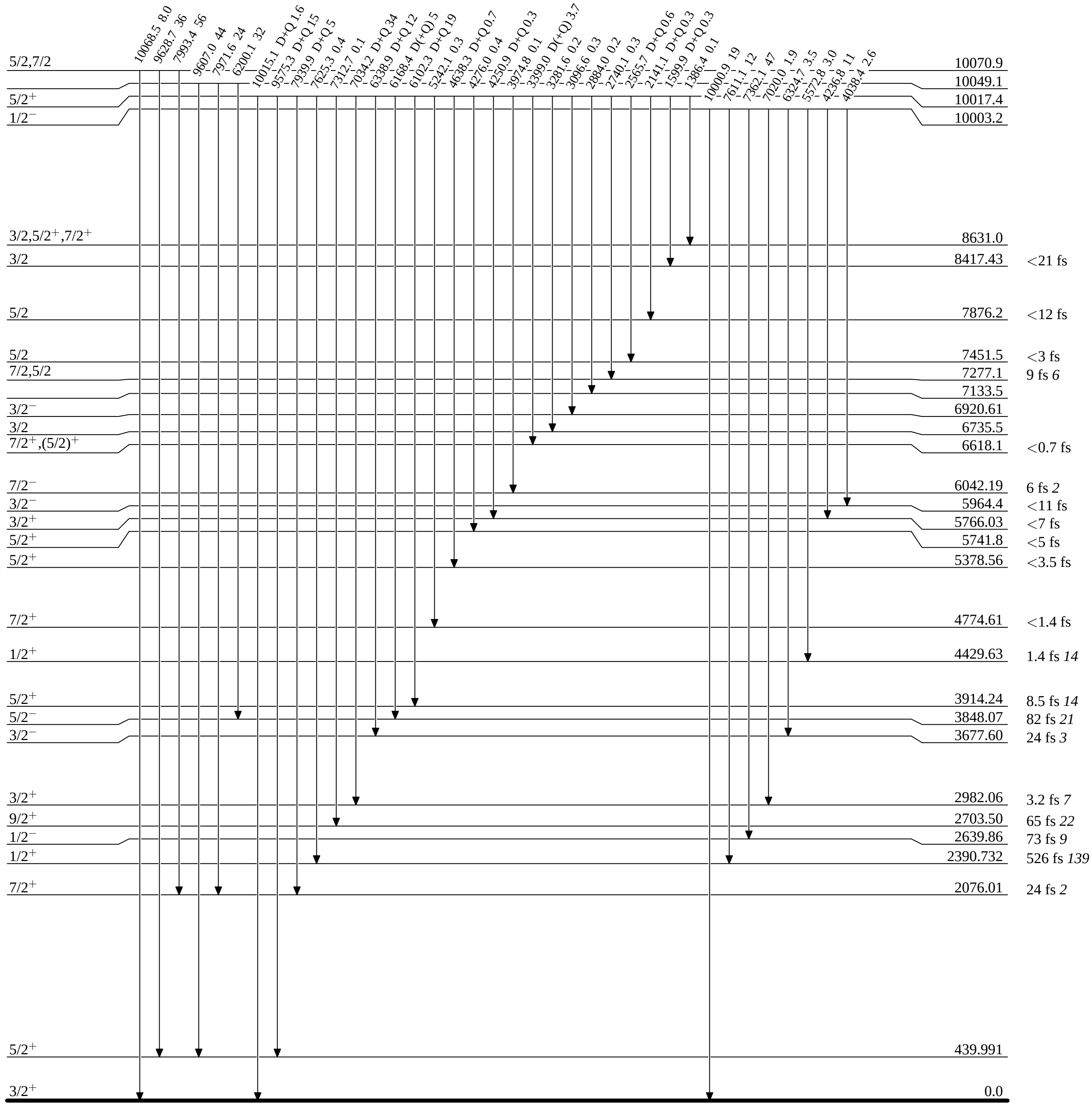


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

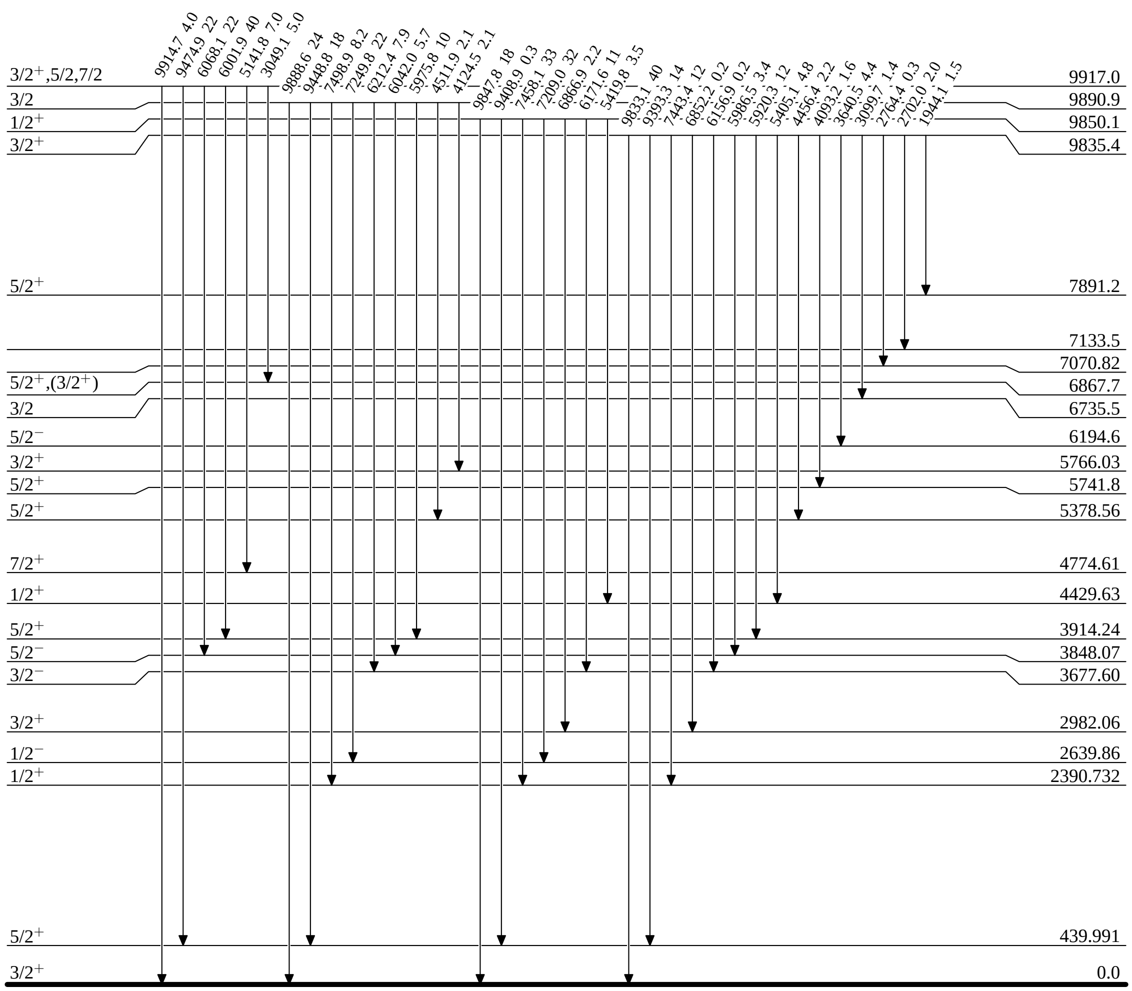


$^{23}_{11}Na_{12}$

$^{22}Ne(p,\gamma)$ 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

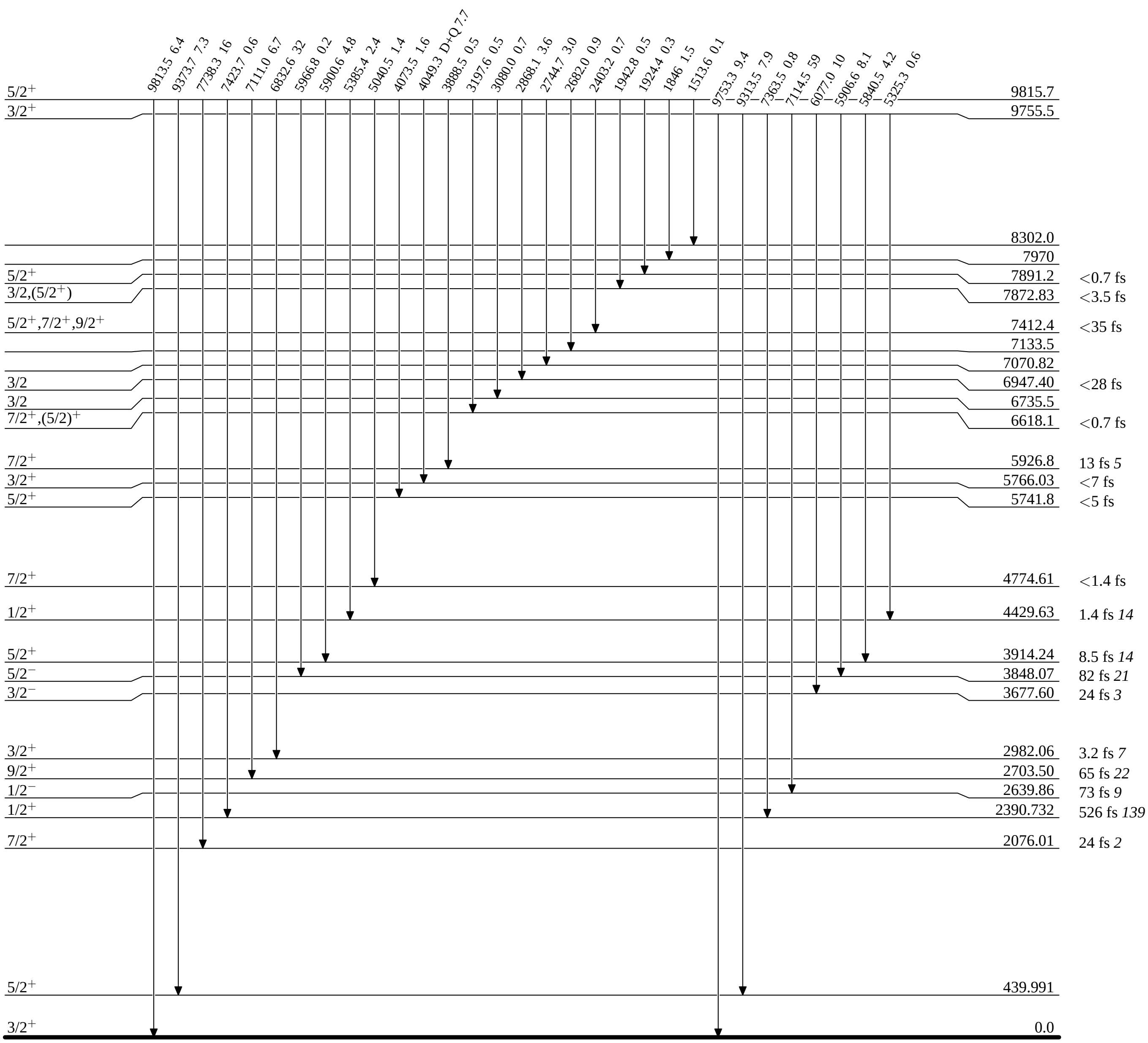


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

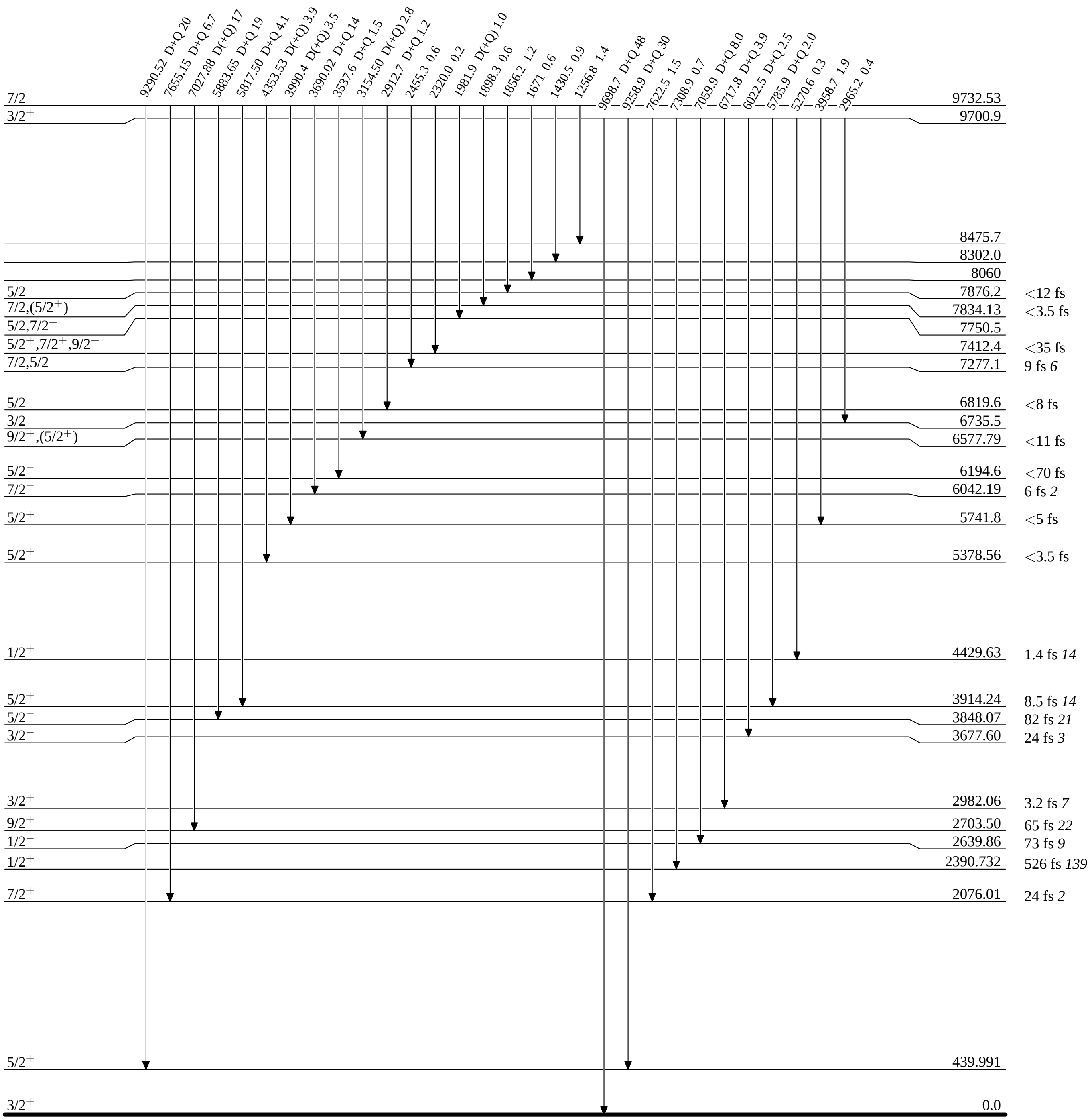


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

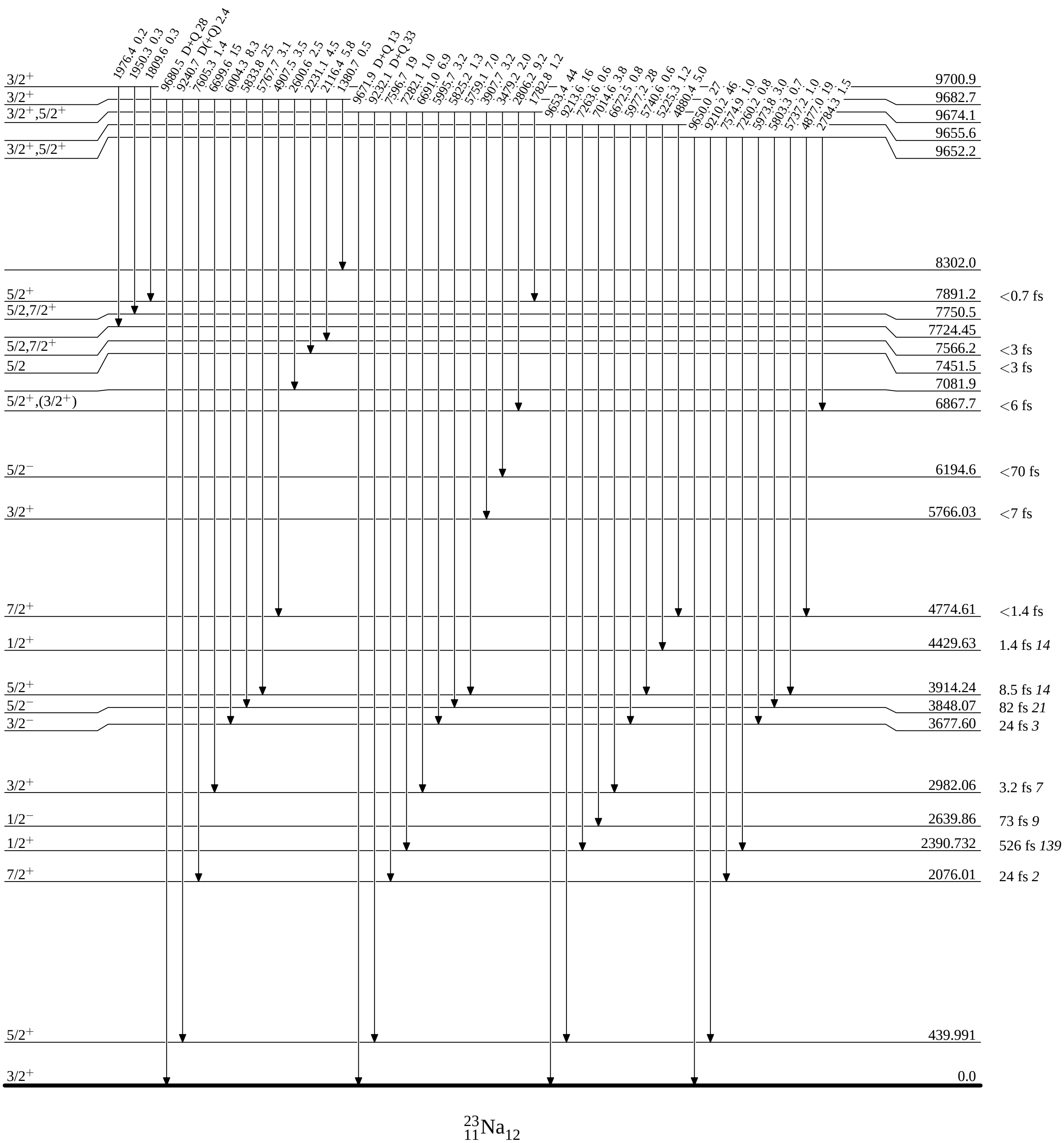


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

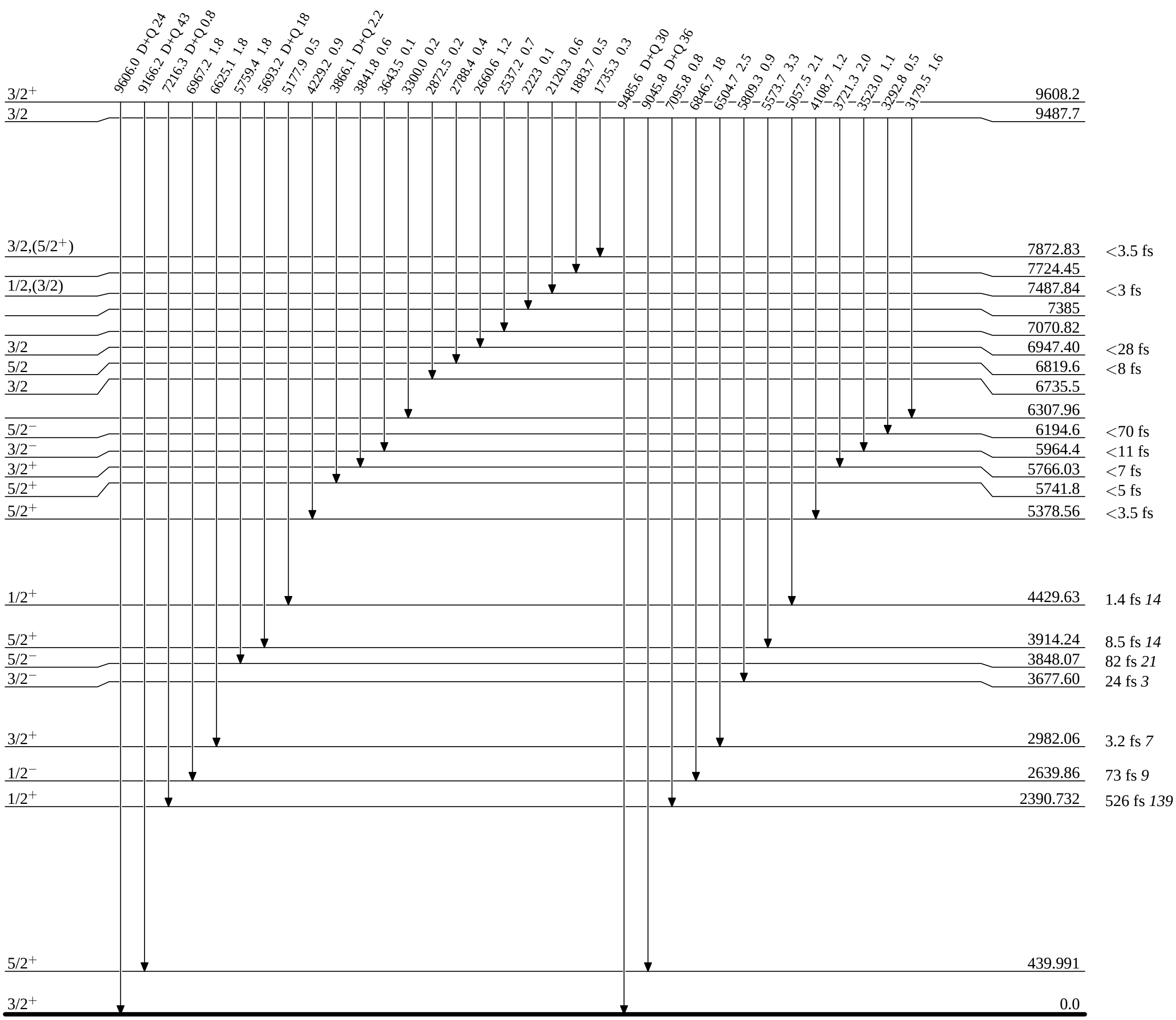
Intensities: % photon branching from each level



$^{22}Ne(p,\gamma)$ 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

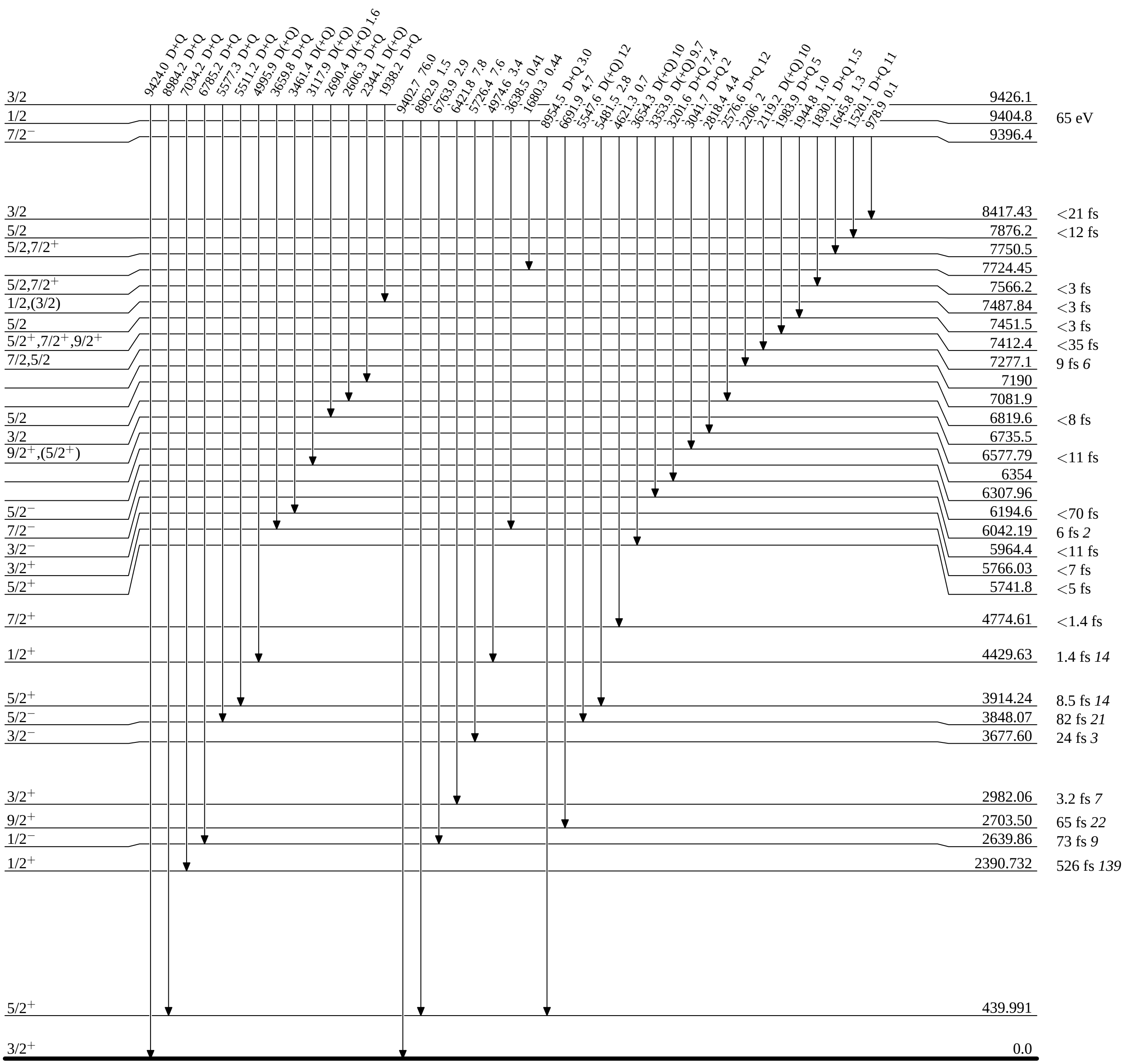


$^{23}_{11}Na_{12}$

$^{22}Ne(p,\gamma)$ 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

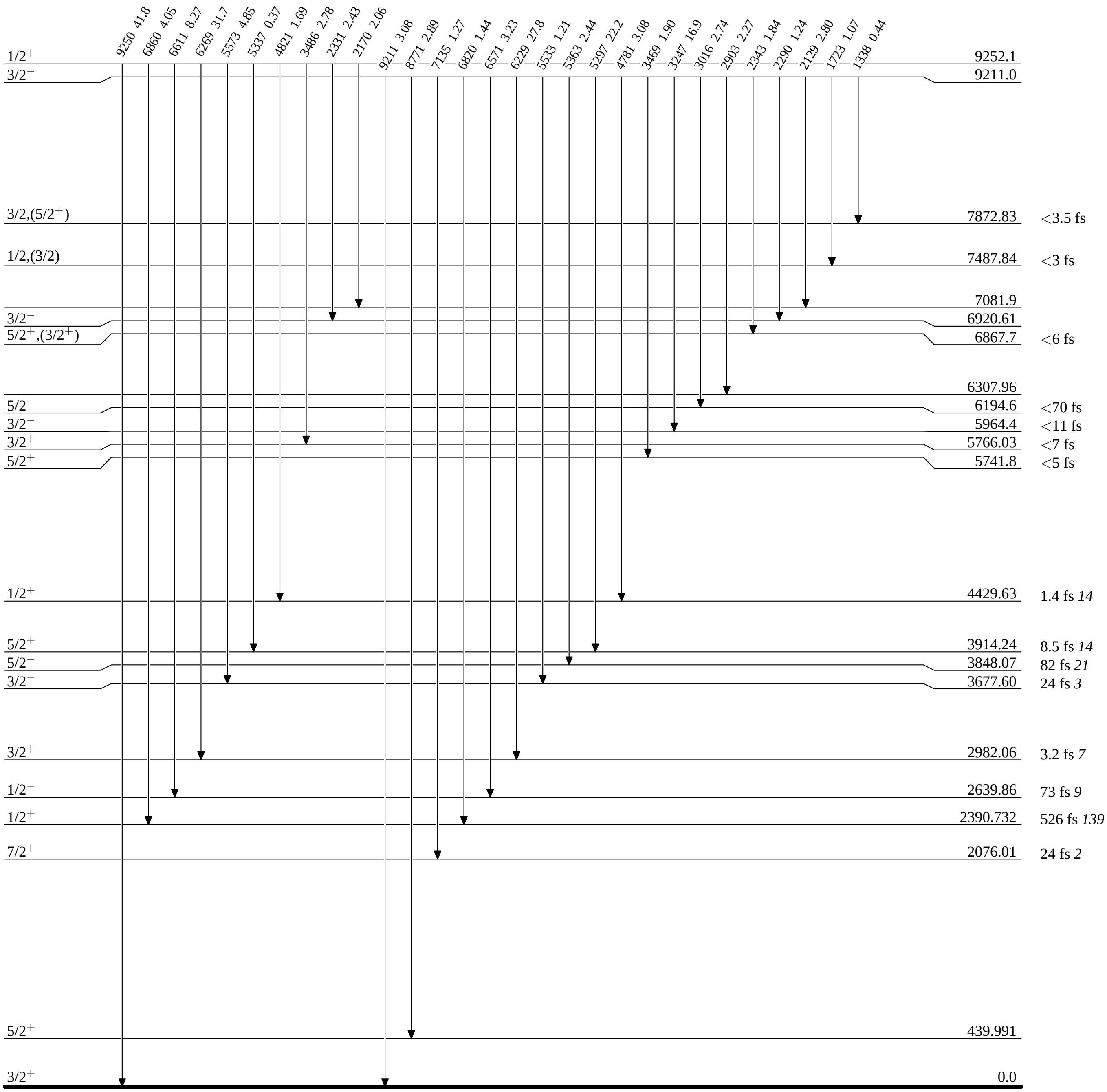


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

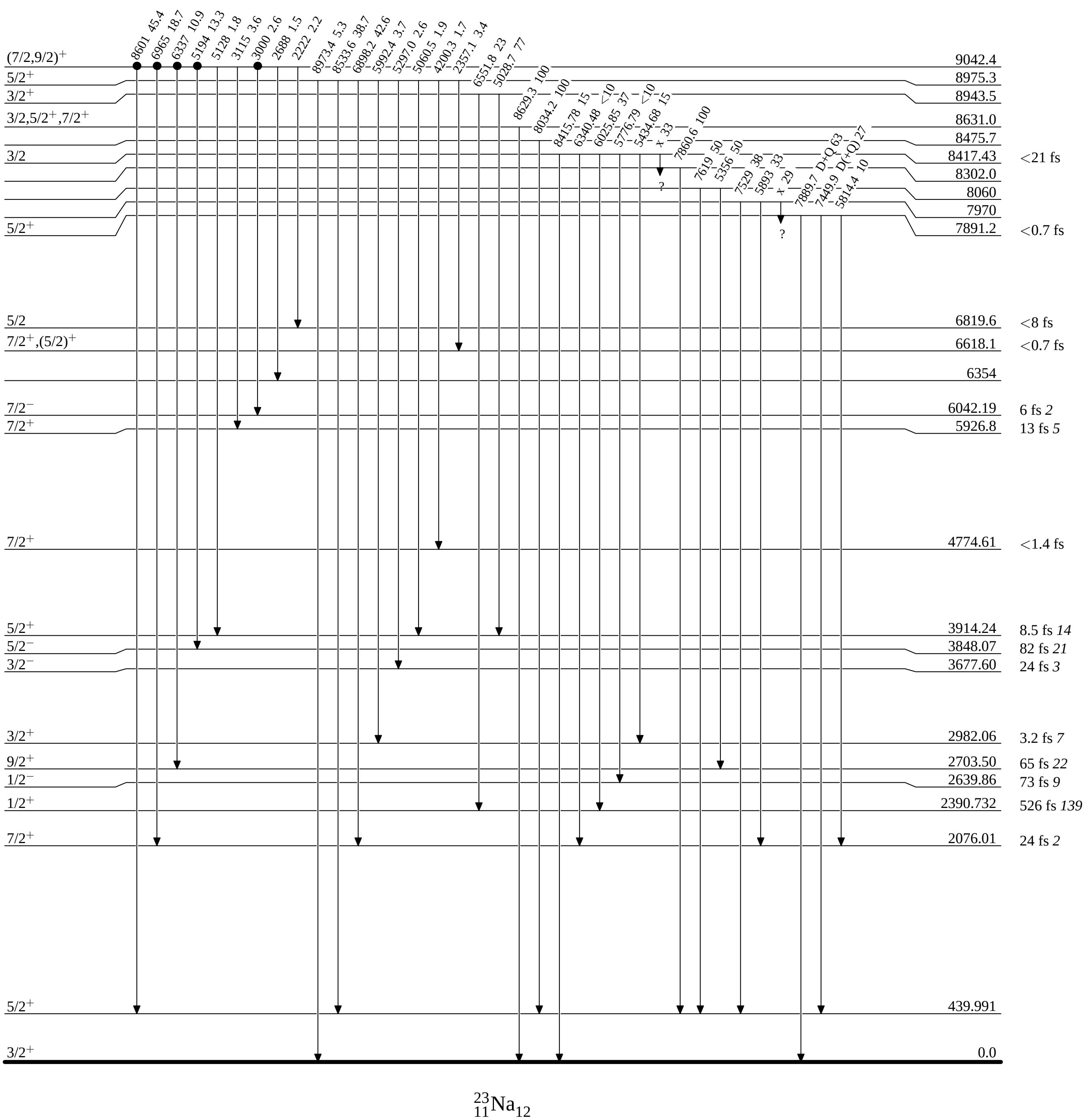
^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

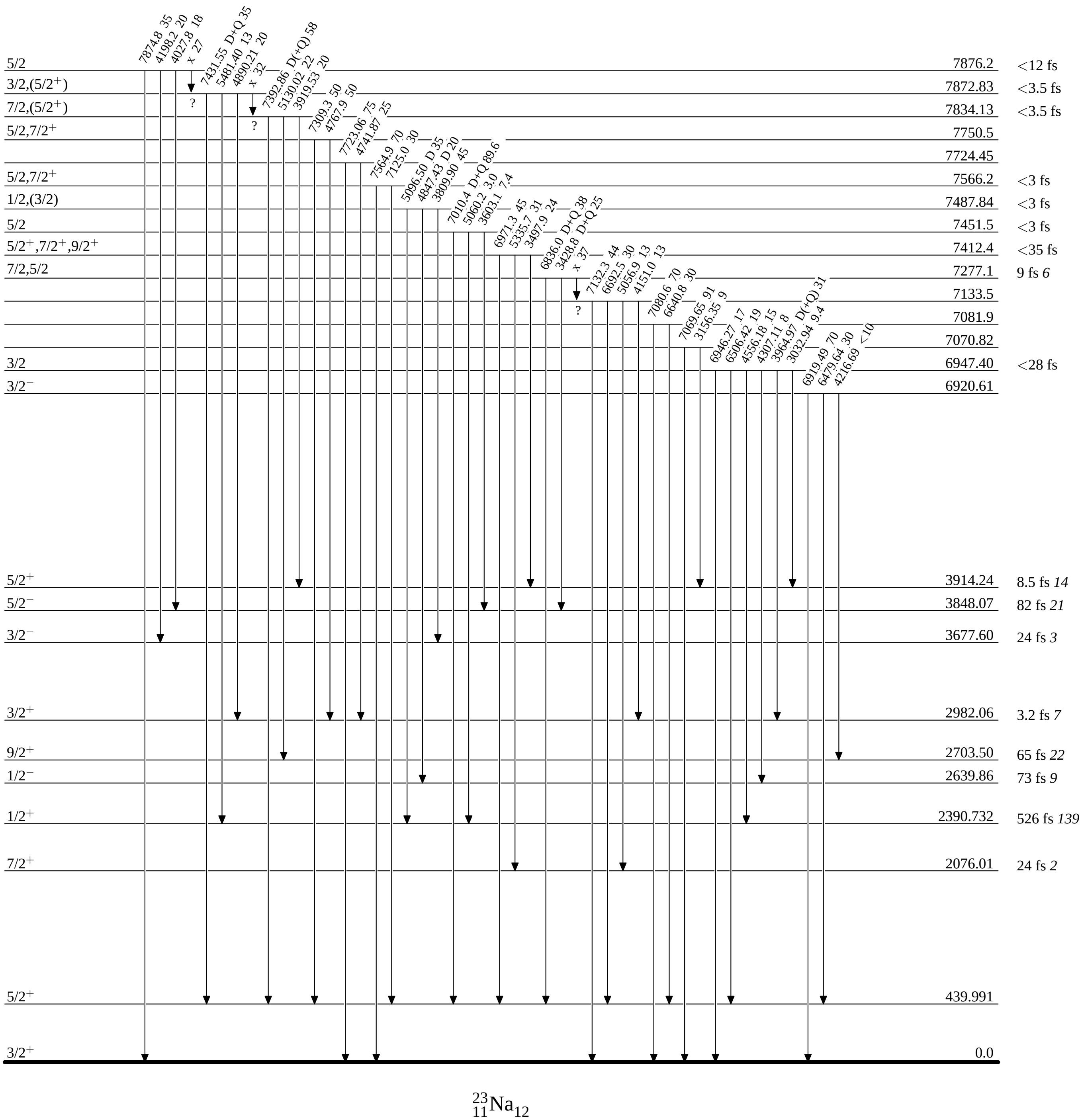
● Coincidence



$^{22}Ne(p,\gamma)$ 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

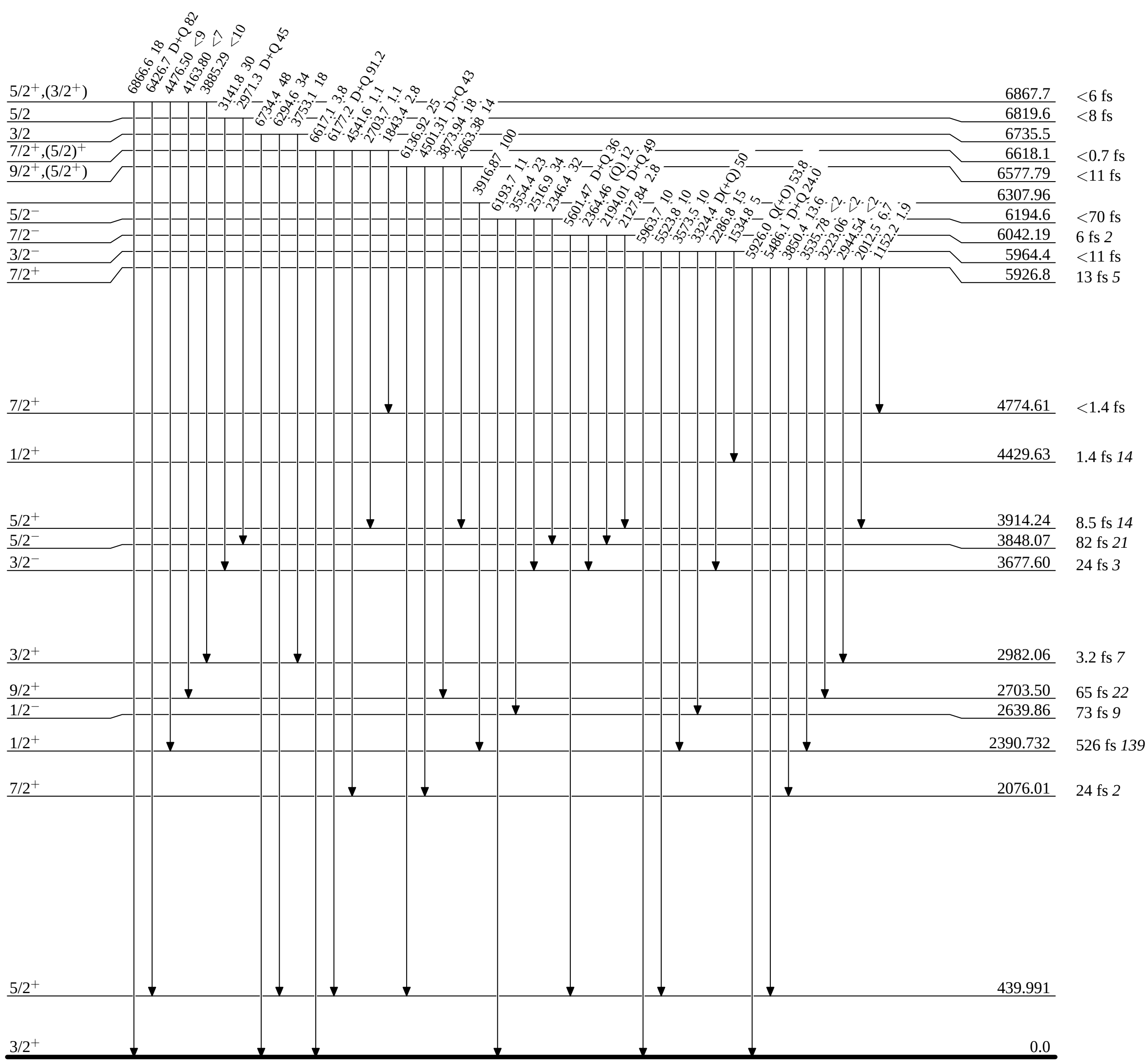
Intensities: % photon branching from each level



^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

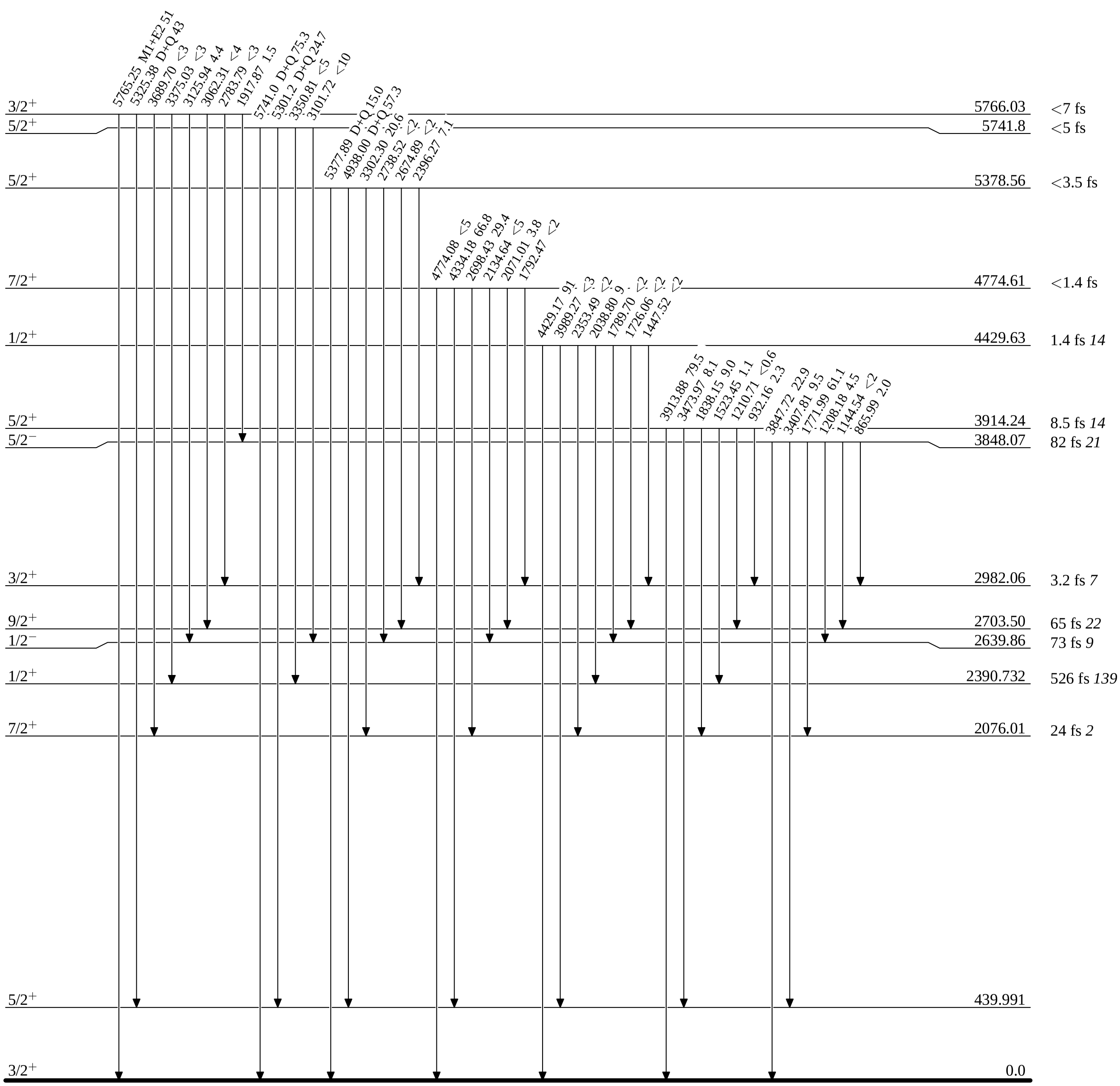


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level

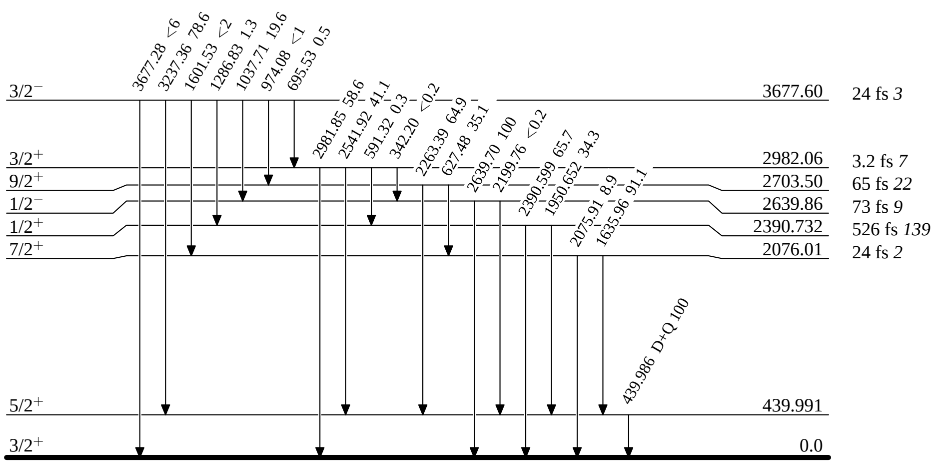


$^{23}_{11}Na_{12}$

^{22}Ne(p,γ) 1989Ba42,1979Sm02,2017Ke01

Level Scheme (continued)

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{22}Ne(d,n) 1993Te05,1973Ch07

$J^{\pi}(^{22}Ne)=0^+$.
Other references: 1973Ch07, 1967Mu13, 1964Pa08.
1993Te05: ^{22}Ne(d,n) E=25 MeV. Measured $\sigma(\theta)$. FWHM 170-200 keV.
1973Ch07: ^{22}Ne(d,n) E=2.5-5.5 MeV. Measured $\sigma(E;En,\theta)$. FWHM 50-320 keV.

^{23}Na Levels

E(level)[†]	L[‡]	(2J+1)C^{2}S[@]	Comments
0	(2)	(0.33)	(2J+1)C^{2}S: Other: (1.09) (1973Ch07).
440 *10*	2	2.91	(2J+1)C^{2}S: Other: (1.28) (1973Ch07).
2080	(4)[#]	(0.10)[#]	
2390 *10*	0	0.50	(2J+1)C^{2}S: Other: 0.28 (1973Ch07).
2980 *10*	2	1.68	(2J+1)C^{2}S: Other: 0.69 (1973Ch07).
3680 *30*	1	0.15	(2J+1)C^{2}S: Other: 0 (1973Ch07).
3910 *30*	2	0.39	
4430	(0)[#]	0[#]	
4780	(4)[#]	(0)[#]	
5380	2[#]	0.16[#]	
5740 *10*	2	0.47	(2J+1)C^{2}S: Other: 0.20 (1973Ch07).
5940	(1)[#]	0[#]	
6310 *10*	0	0.27	(2J+1)C^{2}S: Other: 0.18 (1973Ch07).
6920 *10*	1	0.53	(2J+1)C^{2}S: Other: 0.19 (1973Ch07).
7080 *10*	1	0.31	(2J+1)C^{2}S: Other: 0.08 (1973Ch07).
7450 *10*	(2)	1.62	L: Other: 1 (1973Ch07). (2J+1)C^{2}S: Other: 0.11 (1973Ch07).
7750	(2)[#]	0.05[#]	
7890 *10*	2	0.87	(2J+1)C^{2}S: Other: 0.40 (1973Ch07).
8300 *10*	3	0.44	
8420 *10*	2	0.52	L: Other: 3 (1973Ch07). (2J+1)C^{2}S: Other: 0.16 (1973Ch07).
8660 *10*	0	1.16	(2J+1)C^{2}S: Other: 0.50 (1973Ch07).
8800	0[#]	0.08[#]	(2J+1)C^{2}S: Other: (0.08) (1973Ch07).
8940	3[#]	(0.24)[#]	
9700 *10*	2	0.32	
10010 *30*	2	0.19	
10840 *30*	(1)	0.35	
10940 *10*	2	0.42	
11290 *10*	2	0.71	
11540 *10*	3	0.49	
11760 *10*	3	0.40	
11880 *10*	3	0.24	
14370 *10*	3		

[†] From 1993Te05, except where otherwise noted. Uncertainty 10 keV for prominent peaks and 30 keV for weakly populated peaks. Based on the excitation energy spectrum presented in Fig. 2, evaluators identified possible prominent and weak peaks and assigned the uncertainty. Excitation levels without uncertainty are from 1973Ch07.
[‡] From 1993Te05, except otherwise noted.
[#] From 1973Ch07.
[@] From 1993Te05, except where otherwise noted.

^{22}Ne(d,nγ) 1974Ch57

$J^{\pi}(^{22}Ne)=0^{+}$.

1974Ch57: ^{22}Ne(d,nγ) E=4.5 MeV. Measured Eγ, Iγ, nγ coincidences.

^{23}Na Levels

E(level)†	$T_{1/2}$	Comments
0		
440.1 *7*		
2390.8 *5*		
2641 *4*		
2988 *5*		
6305.5 *7*		
8666.3 *24*	116 as *22*	$T_{1/2}$: From Γ=3.9 eV *7* (1974Ch57 – Γγ=3.3 *6* to g.s.).
8831 *4*		

† From least squares fit to γ-ray energies.

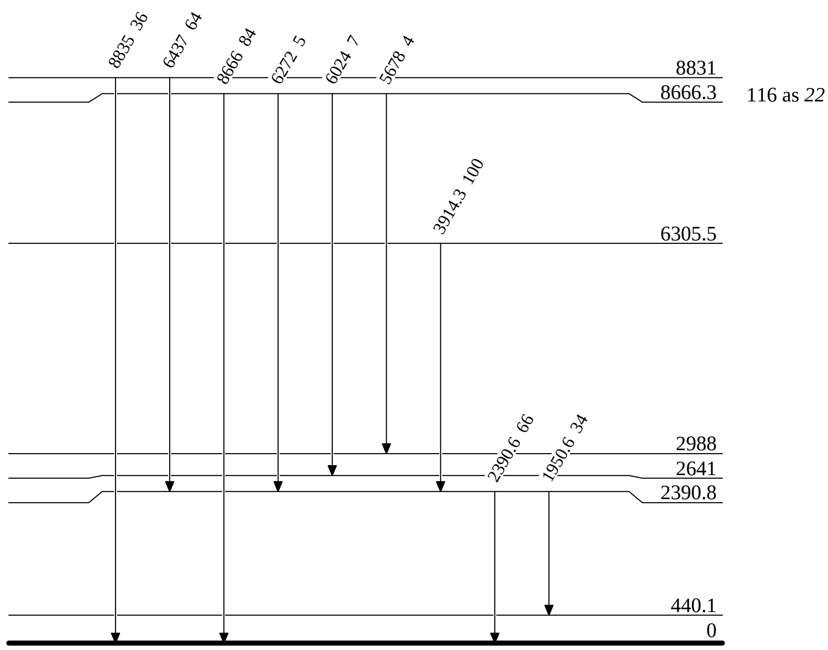
$\gamma(^{23}$Na)

E_i(level)	E_γ	I_γ	E_f
2390.8	1950.6 *5*	34 *1*	440.1
	2390.6 *5*	66 *1*	0
6305.5	3914.3 *5*	100	2390.8
8666.3	5678 *4*	4 *2*	2988
	6024 *3*	7 *3*	2641
	6272 *4*	5 *3*	2390.8
	8666 *3*	84 *2*	0
8831	6437 *4*	64 *10*	2390.8
	8835 *6*	36 *10*	0

^{22}Ne(d,nγ) 1974Ch57

Level Scheme

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{22}Ne(^{3}He,d),(^{3}He,dγ) 1971Po11,2002Ha03,1991Ho09

J^π(^{22}Ne)=0^+.
Others: 1968Du03, 1967Du08.
1971Po11: ^{22}Ne(^{3}He,d) E=15 MeV. Measured $\sigma(E_d,\theta)$. FWHM 22 keV.
2002Ha03: ^{22}Ne(^{3}He,d) E=20 MeV. Measured E_d, $\sigma(\theta)$.
1991Ho09: ^{22}Ne(^{3}He,d) E=20.2 MeV. Measured $\sigma(E_d,\theta)$.
1968Du03: ^{22}Ne(^{3}He,dγ) E=10 MeV. Measured $\sigma(E_d,E_\gamma)$.
1967Du08: ^{22}Ne(^{3}He,d) E=10, 12 MeV. Measured $\sigma(E_d,\theta)$. FWHM <60 keV.

2020Sa09: Fitted angular distribution of experimental (^{3}He,d) data in the literature with finite-range DWBA. Deduced spectroscopic factors for g.s., excited states, including the subthreshold resonance state at 8664 keV. A systematic R-matrix analysis of direct capture to the bound states and the decay of the 8664 keV to the g.s.

^{23}Na Levels

E(level)[†]	J^π	L[†]	S[a]	Comments
0.0	3/2+	2	0.32	S: Others: C^2S=0.08 (1991Ho09) and 0.082 *12* (2020Sa09).
439 *9*	5/2+	2	2.10	S: Others: C^2S=0.34 (1991Ho09) and 0.38 *8* (2020Sa09).
2078 *9*			≤0.18	E(level): Other: 2080 *10* (1967Du08).
2392 *7*	1/2+	0	0.50	E(level): Other: 2391 *5* (1967Du08). S: Others: $(2J_f+1)S$=1.1 (1967Du08). C^2S=0.25 (1991Ho09) and 0.26 *5* (2020Sa09).
2642[#] *10*	1/2−	1	0.043	S: Others: $(2J_f+1)S$=0.04 (1967Du08). C^2S=0.020 (1991Ho09).
2704[#] *6*			≤0.36	
2983[#] *7*	3/2+	2	1.28	S: Others: $(2J_f+1)S$=1.3 (1967Du08). C^2S=0.32 (1991Ho09) and 0.35 *4* (2020Sa09).
3679[#] *7*	3/2−	1	0.076	E(level): Other: 3681 *12* (1967Du08). S: Other: $(2J_f+1)S$=0.1 (1967Du08).
3852[#] *8*	5/2−	3[&]	0.033	S: Others: $(2J_f+1)S$=0.06 (1967Du08). C^2S=0.010 (1991Ho09).
3918[#] *7*	5/2+	2	0.27	S: Others: $(2J_f+1)S$=0.45 (1967Du08). C^2S=0.046 (1991Ho09).
4435[#] *8*	1/2+	0[&]	0.006	S: Others: $(2J_f+1)S$=0.002 (1967Du08). C^2S<0.0033 (1991Ho09).
4777[#] *8*			≤0.16	
5378[#] *7*	5/2+	2	0.074	S: Other: $(2J_f+1)S$=0.07 (1967Du08).
5536[#] *9*				
5740 *8*	5/2+	2[&]	0.21	E(level): Other: 5747 *20* (1967Du08) − possible doublet. S: Other: $(2J_f+1)S$ ≤0.55 (1967Du08).
5762 *10*		2,(1)		
5776 *20*				
5932[#] *7*				
5968[#] *5*				
6039[#] *7*				
6116 *5*				
6193[#] *8*				
6232 *10*				
6307[#] *5*	1/2+	0	0.27	S: Others: $(2J_f+1)S$=0.75 (1967Du08). C^2S=0.14 *2* (2020Sa09).
6343 *9*				
6576 *5*				
6618[#] *5*				
6733[#] *5*	3/2+	2	0.030	S: Other: $(2J_f+1)S$=0.04 (1967Du08).
6819 *5*				
6866 *6*	3/2+,5/2+	2	0.032	
6917 *5*	3/2−	1	0.30	E(level): Other: 6924 *30* (1967Du08) − possible doublet. S: Others: $(2J_f+1)S$ ≤1.2 (1967Du08). C^2S=0.18 *4* (2020Sa09) for J^π=1/2−.

Continued on next page (footnotes at end of table)

$^{22}Ne(^3He,d),(^3He,d\gamma)$ 1971Po11,2002Ha03,1991Ho09 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^π	L[†]	S[a]	Comments
6943 *10*	(3/2$^+$)	(2)	0.18	
7079[#] *6*	3/2$^-$	1	0.17	S: Other: $(2J_f+1)S=0.6$ (1967Du08).
7130 *6*	3/2$^+$,5/2$^+$	2	0.065	
7179 *7*				
7275[#] *7*		2,3	0.058	S: and 0.24 for L=2 and 3, respectively (1971Po11).
7386 *10*	1/2$^-$,3/2$^-$	1	0.034	
7409 *10*				
7451 *6*	(3/2$^+$,5/2$^+$)	2	0.58	E(level): Other: 7449 *30* (1967Du08) − possible doublet. S: Other: $(2J_f+1)S \leq 1.1$ (1967Du08).
7482 *9*	(1/2,3/2)$^-$	1	0.15	
7565 *6*				
7683 *6*				
7725 *11*				
7754[#] *6*		(3)	0.084	S: Others: 0.028, 0.052, and 0.33 for L=2, 3, and 4, respectively (2002Ha03).
7839 *10*				
7889[#] *5*	5/2$^+$	2	0.57[b]	S: Other: $(2J_f+1)S=0.06$ (1967Du08).
7960 *5*				
7982 *12*				
8063 *8*				
8101 *12*				
8122 *7*				
8149 *5*				
8173 *7*				
8220 *5*				
8254 *5*		(1)	0.011	
8302 *5*		3,(2)	0.49	S: 0.49 and 0.15 for L=3 and (2).
8355 *5*		3,(2)	0.16	S: 0.16 and 0.054 for L=3 and (2).
8416[#] *5*		(2)	0.18	
8468 *5*		2	0.077	
8498 *6*				
8555 *5*				
8602 *5*				
8646 *10*				
8663[#] *5*	1/2$^+$	0	0.59[b]	S: Others: $(2J_f+1)S=0.63$ (1967Du08). $(2J_f+1)C^2S=0.54$ (1971Po11). $C^2S=0.32$ *5* (2020Sa09).
8721 *7*				
8793 *5*				
8830[‡] *3*	1/2$^+$	0	0.039[b]	
8862?[‡@]	1/2$^+$	0[‡]	≤0.0015[b]	
8894?[‡@]	1/2$^+$	0[‡]	≤0.0016[b]	
8946[‡] *3*	5/2$^-$,7/2$^-$	3[‡]	≤0.0087[b]	
8973[‡] *3*	3/2$^+$,5/2$^+$	2[‡]	0.005[b]	
9000				
9044[‡] *3*		4[‡]	0.02[b]	
9108 *6*				
9167 *6*				
9215[‡] *3*		0,1[‡]		
9257[‡] *3*	1/2$^+$	0[‡]	0.079[b]	
9282 *5*				
9320 *5*				
9398 *5*		1,(2)	(0.039)	S: (0.039) and (0.032) for L=1 and (2).
9426 *6*				
9482 *5*				

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^{22}Ne(^{3}He,d),(^{3}He,dγ) 1971Po11,2002Ha03,1991Ho09 (continued)

^{23}Na Levels (continued)

E(level)[†]	Jπ	L[†]	S[a]	Comments
9540 *7*				
9588				
9608 *7*	3/2+	2[‡]	0.082[b]	Γp=6.3 eV, 2002Ha03.
9648 *7*				
9680 *7*				
9704 *5*	3/2+	2[‡]	0.084[b]	Γp=12.4 eV, 2002Ha03.
9730 *5*				
9758 *5*				
9818 *5*				
9844 *5*	3/2+	2[‡]	0.20	Γp=35.3 eV, 2002Ha03. S: Other: 0.11 ((2J$_f$+1)C^{2}S in 2002Ha03).
9887 *8*				
9925 *6*				
9944 *10*				
10018 *10*		2,(3)	(0.18)	S: (0.18) and (0.40) for L=2 and (3).
10035 *10*				
10077 *10*				
10173 *10*				
10218 *10*				

[†] From 1971Po11, except as noted. Excitation energies reported in 1967Du08 are marked by footnote and mostly in good agreement but less precise.
[‡] From 2002Ha03.
[#] Also reported in 1967Du08.
[@] Resonance level was not observed at any angle in 2002Ha03.
[&] From 1991Ho09.
[a] (2J$_f$+1)C^{2}S from 1971Po11, except where otherwise noted.
[b] From 2002Ha03.

γ(^{23}Na)

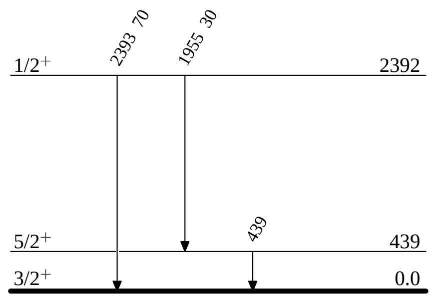
E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π
439	5/2+	439		0.0	3/2+
2392	1/2+	1955	30 *4*	439	5/2+
		2393	70 *4*	0.0	3/2+

[†] From 1968Du03.

^{22}Ne(^{3}He,d),(^{3}He,dγ) 1971Po11,2002Ha03,1991Ho09

Level Scheme

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{22}Na(n,p),(n,α): res 1982Gl07,1971Eh01

Other: 1988Ko25.
1982Gl07: ^{22}Na target of activity 500 μCi. Measured proton emission spectrum alpha from capture state with Si detector.
1971Eh01: ^{22}Na target of activity 2 μCi/cm^2. Measured proton and alpha emission from capture state with Si detector. Measured 35900 b *1200* total cross section.

^{23}Na Levels

E(level)	J^π	Γ	Comments
0.0			
1.235×10^4 *31*			E(level): Average from Ep(0)(c.m.)=4000, Ep(1275)(c.m.)=2250 for proton emission to levels in ^{22}Ne; and Eα(0)(c.m.)=1770, Eα(110+197)(c.m.)=1430 to levels in ^{19}F (1971Eh01). Overlaps three or more in Adopted Levels − not referenced.
12419.8 *2*	($7/2^+$,$5/2^+$)	116 eV *20*	E(level): From neutron resonance state at 0.145 keV *11* (1982Gl07) and Sn=12419.66 *17* (AME2016 − 2017Wa10). From Ep(Lab)=2250 keV and 3470 keV to 1st and g.s. of ^{22}Ne − would result 12421.2 keV, considering Sp=8792.10 *2* (AME2016 − 2017Wa10). J^π: Based on measured Γ_{p0}/Γ_{p1} and shell model calculations. Γ: From Γ_{n0}=1.6 eV *2*, Γ_{p1}=114 eV *20*, and Γ_{p0}=0.7 eV.

^{23}Na(γ,γ') 1984Vo02

Other references: 1962Mo17,1963Sw01,1966Sk01,1966Ra19,1969Ru01, 1970Sh08,1971Ra13,1971Sw04,1972Fr10,1972Sh07,1982Is01,1985Ba36.

1984Vo02: ^{23}Na(γ,γ') E=7.66, 10.37 MeV. Measured E_γ, I_γ.

1985Ba36: ^{23}Na(γ,γ') E=7.89, 4.43 MeV. Measured $\sigma(E_\gamma)$.

^{23}Na Levels

E(level)†	Jπ‡	$T_{1/2}$#	Comments
0.0			
440		1.14 ps *7*	$T_{1/2}$: From τ=1.64 ps *10*: Wt. ave. of 1.8 ps *2* (1969Ru01), 1.62 ps *10* (1966Sk01), 1.80 ps *28* (1962Mo17), and 1.30 ps *30* (1963Sw01).
2076			
2390 *1*			
2640 *1*			
2982 *1*	3/2+	2.6 fs *5*	$T_{1/2}$: Other value: 4.6 fs *19* (1972Sh07).
3915 *1*	5/2+	9.4 fs *16*	
4432 *15*	1/2+	0.21 fs *3*	$T_{1/2}$: Wt. ave. of 0.24 fs *5* (1984Vo02), 0.24 fs *5* (1985Ba36), and 0.17 fs *3* (1972Sh07).
5380	5/2+	143 as *21*	$T_{1/2}$: Other value: 223 as *42* (1972Sh07).
5741 *15*	5/2+	394 as *27*	$T_{1/2}$: Other value: 577 as *109* (1972Sh07).
5766 *15*	3/2+	351 as *45*	$T_{1/2}$: Other value 608 as *116* (1972Sh07).
6735 *2*	3/2+	415 as *50*	$T_{1/2}$: Other value: 1.2 fs *3* (1972Sh07).
7070 *2*			$T_{1/2}$: (109 as *11*)/($2J_f$+1) (1984Vo02).
7082 *2*	3/2−	258 as *31*	$T_{1/2}$: Other value: 400 as *80* (1972Sh07).
7122 *3*	(9/2)	13 fs *5*	
7134 *3*	3/2+,5/2+	200 as *26*	$T_{1/2}$: Weighted average of 196 as *48* (1984Vo02), 184 as *34* (1972Sh07), 300 as *80* (1971Sw04) for J_f=3/2.
7566 *2*	(5/2)+	0.26 fs *18*	
7890 *2*	5/2+	162 as *12*	$T_{1/2}$: Weighted average of 152 as *12* (1985Ba36), 187 as *21* (1984Vo02), and 166 as *35* (1972Sh07).
7992 *3*	(11/2)	19 fs *8*	
8360 *2*			$T_{1/2}$: (38 as *6*)/($2J_f$+1) (1984Vo02).
8630 *3*			$T_{1/2}$: (104 as *31*)/($2J_f$+1) (1984Vo02).
8645 *2*	1/2+	0.53 fs *7*	
8662 *2*	1/2+	141 as *23*	$T_{1/2}$: Other value 290 as *60* (1972Sh07).
8721 *2*			$T_{1/2}$: (760 as *95*)/($2J_f$+1) (1984Vo02).
8826 *2*	1/2+	211 as *70*	
9213 *3*	3/2−	4.1 fs *15*	
9626 *3*	1/2+	2.2 fs *8*	

† From 1984Vo02.

‡ From Adopted Levels.

From measured level widths $g\Gamma_0$ and Γ_0/Γ ratios of 1972Sh07, 1984Vo02 where $g=(2J_f+1)/(2J_i+1)$ and J_i=3/2. $T_{1/2}=4.562\times10^{-16}$(eV.s)/Γ(eV).

γ(^{23}Na)

E_i(level)	J_i^π	E_γ†	I_γ	E_f	Mult.	δ	Comments
2390		2390		0.0			
2640		2640		0.0			
2982	3/2+	2542		440	D+Q	+0.15 *5*	Mult.,δ: From 1971Ra13.
		2982		0.0			
3915	5/2+	3915		0.0			
4432	1/2+	4432		0.0			
5380	5/2+	3304	20 *1*	2076			

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^{23}Na(γ,γ') 1984Vo02 (continued)

γ(^{23}Na) (continued)

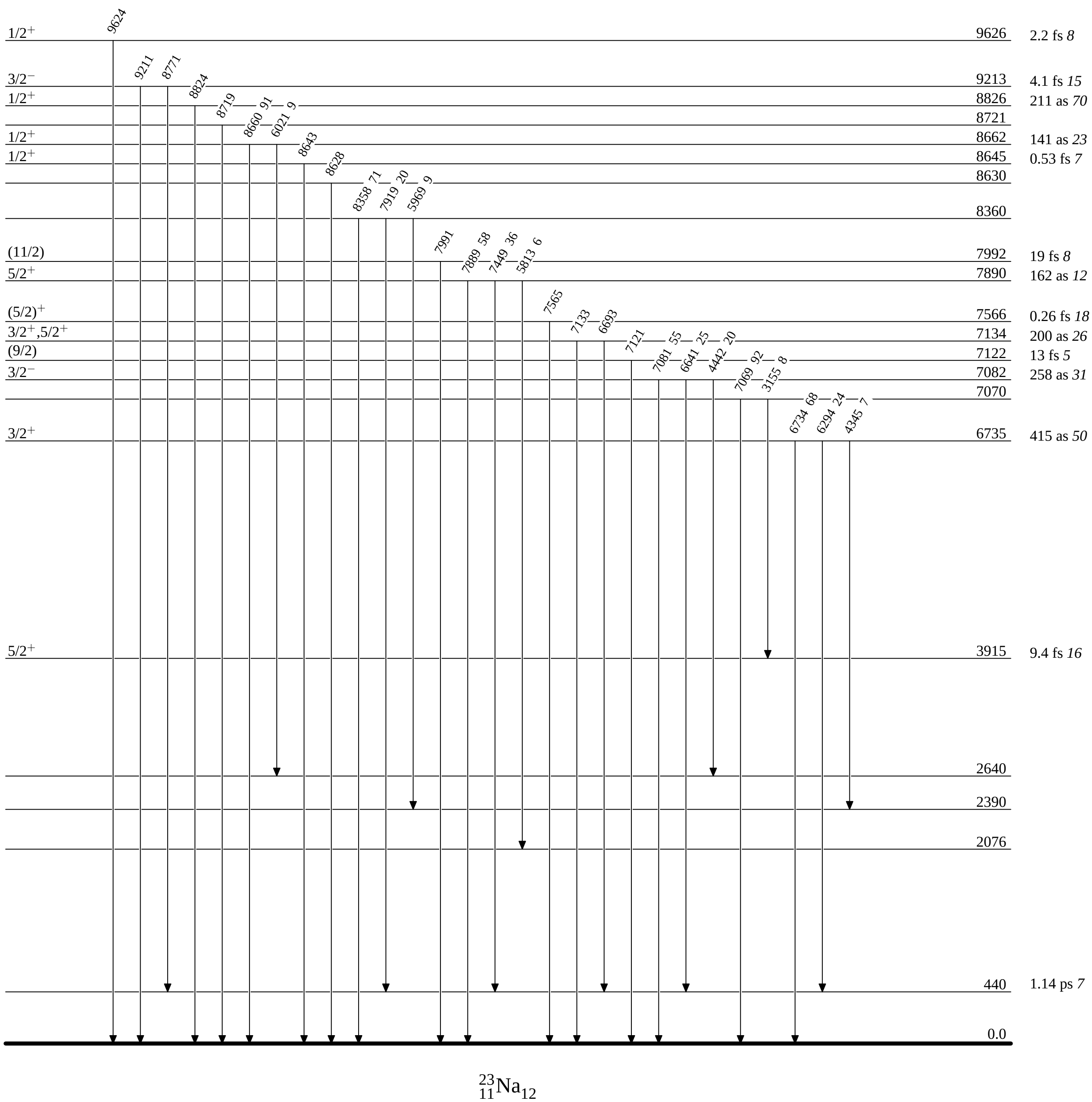
E_i(level)	J^π_i	E_γ †	I_γ	E_f	J^π_f	E_i(level)	J^π_i	E_γ †	I_γ	E_f
5380	5/2$^+$	4939	66 *6*	440		7566	(5/2)$^+$	7565		0.0
		5379	14 *1*	0.0		7890	5/2$^+$	5813	6 *1*	2076
5741	5/2$^+$	5300	30 *3*	440				7449	36 *3*	440
		5740	70 *3*	0.0				7889	58 *4*	0.0
5766	3/2$^+$	3376	6 *1*	2390		7992	(11/2)	7991		0.0
		5325	41 *4*	440		8360		5969	9 *2*	2390
		5765	53 *5*	0.0				7919	20 *1*	440
6735	3/2$^+$	4345	7 *1*	2390				8358	71 *3*	0.0
		6294	24 *3*	440		8630		8628		0.0
		6734	68 *4*	0.0		8645	1/2$^+$	8643		0.0
7070		3155	8 *1*	3915	5/2$^+$	8662	1/2$^+$	6021	9 *1*	2640
		7069	92 *3*	0.0				8660	91 *4*	0.0
7082	3/2$^-$	4442	20 *2*	2640		8721		8719		0.0
		6641	25 *4*	440		8826	1/2$^+$	8824		0.0
		7081	55 *2*	0.0		9213	3/2$^-$	8771		440
7122	(9/2)	7121		0.0				9211		0.0
7134	3/2$^+$,5/2$^+$	6693		440		9626	1/2$^+$	9624		0.0
		7133		0.0						

† From level energy differences, recoil energy subtracted and rounded to nearest keV.

^{23}Na(γ,γ') 1984Vo02

Level Scheme

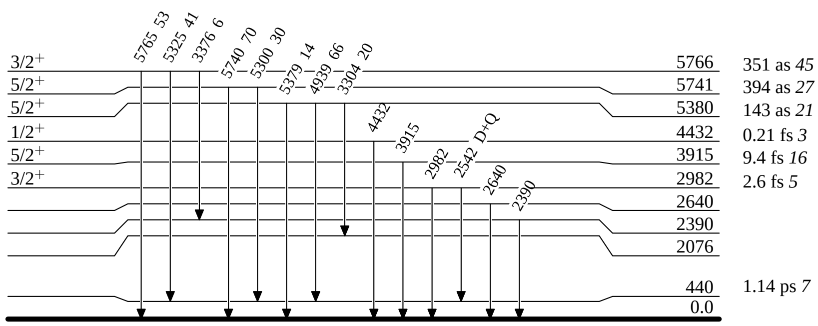
Intensities: % photon branching from each level



$^{23}Na(\gamma,\gamma')$ **1984Vo02**

Level Scheme (continued)

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{23}Na(e,e′) 1965Ba28,1969Sa16

Other references: 1968Sa24, 1969Ti06, 1977OkZV.

1965Ba28: ^{23}Na(e,e′) E=58.5 MeV; ^{23}Na target (thickness 0.230 g/cm^2) between thin Mylar foils; Measured σ(Ee′) at 180°, deduced level spin/parity, Γ_0.

1969Sa16,1968Sa24: ^{23}Na, ^{39}K(e,e′), E=100-230 MeV; measured s(E;Ee′,θ); deduced elastic, inelastic form factors, deduced B(EL).

^{23}Na Levels

E(level)	J^π	$T_{1/2}$	Comments
0.0	3/2$^+$		
2080	7/2$^+$	46 fs *7*	B(E2)↑=0.0080 *11* E(level): From 1969Sa16. J^π: From Adopted Levels. $T_{1/2}$: Using B(E2)↑ and γ-ray properties in the Adopted Gammas. B(E2)↑ – from 1969Sa16, model independent value.
4.5×10^3 *1*	1/2$^+$	0.65 fs *6*	E(level): From 1965Ba28. J^π: 4500γ M1 to 3/2$^+$ based on σ(Ee′) measurements at 180° (1965Ba28). Spin 1/2 from literature. $T_{1/2}$: From Γ_0=0.64 eV *6* (1965Ba28) and branching ratios in Adopted Gammas. $\sigma(E_{e'})$ = 0.0048 μb/sr *5* (1965Ba28).

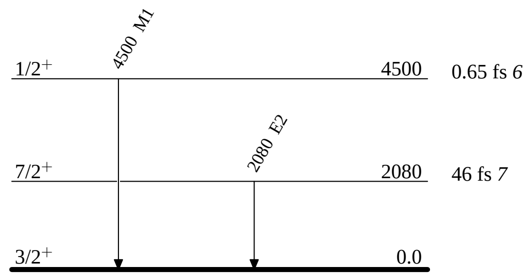
γ(^{23}Na)

E_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
2080	2080	7/2$^+$	0.0	3/2$^+$	E2	Mult.: From Adopted Gammas.
4500	4.5×10^3	1/2$^+$	0.0	3/2$^+$	M1	Mult.: From a ratio of 0.954 *4* based on measured cross sections at 58.5 and 41.5 MeV and virtual photon theory (1965Ba28).

† From level energy differences.

^{23}Na(e,e′) 1965Ba28,1969Sa16

Level Scheme



$^{23}_{11}Na_{12}$

^{23}Na(n,n′γ) 1989Ge09,1972Ni05,2012Ro04

Others: 1973Ab02, 1976Be64, 1977Do10, 1978Ko19, 2011Ro52, 2012Ro04, 2015Va07.
1989Ge09: Measured mean lifetime for excited levels by Doppler Shift Attenuation Method.
1972Ni05: Measured σ(Eγ). Deduce excited levels, γ-ray branching. Ge(Li) and NaI(Tl) detectors.
2012Ro04: Measured Eγ, Iγ(θ); Deduced σ, σ(θ) at 150° and 110 °. Eight HPGe detectors, placed 4 at 110° and other 4 at 150° with respect to beam direction.

^{23}Na Levels

E(level)[†]	$T_{1/2}$[‡]	Comments
0.0		
441		
2077	19 fs *6*	$T_{1/2}$: From mean lifetime 27 fs *9* (1989Ge09).
2392		
2640	270 fs *14*	$T_{1/2}$: From mean lifetime 390 fs *20* (1989Ge09).
2704	180 fs *76*	$T_{1/2}$: From mean lifetime 260 fs *110* (1989Ge09).
2981		
3679		
3853		
3916		
4430		
4778		
5374		
5538		
5740		
5760		
5934		
5968		
6042		

† As listed in 1972Ni05.
‡ From mean lifetime measured by 1989Ge09.

γ(^{23}Na)

Average ratios of the measured γ-ray angular distribution at 150° and 110° in 2012Ro04 are listed in comments section.

E_i(level)	E_γ[†]	I_γ[‡]	E_f	Comments
441	441	100	0.0	W(150°)/W(110°)=0.99 *1* (2012Ro04).
2077	1636	92	441	W(150°)/W(110°)=1.05 *1* (2012Ro04).
	2077	8	0.0	
2392	1951	37	441	
	2392	63	0.0	W(150°)/W(110°)=1.00 *3* (2012Ro04).
2640	2640	100	0.0	W(150°)/W(110°)=0.95 *2* (2012Ro04).
2704	627	39	2077	
	2263	61	441	W(150°)/W(110°)=1.39 *43* (2012Ro04).
2981	2540	50	441	W(150°)/W(110°)=0.94 *5* (2012Ro04).
	2981	50	0.0	
3679	1039	10	2640	
	1602[#]	10	2077	E_γ: Absent in Adopted Gammas. Not reported in other work. Evaluators assign as uncertain placement.
	3238	80	441	
3853	3412	50	441	
	3853	50	0.0	
3916	1839	20	2077	

Continued on next page (footnotes at end of table)

^{23}Na(n,n′γ) 1989Ge09,1972Ni05,2012Ro04 (continued)

γ(^{23}Na) (continued)

E_i(level)	E_γ †	I_γ ‡	E_f	Comments
3916	3475	20	441	
	3916	60	0.0	
4430	2038	8	2392	
	4430	92	0.0	
4778	1797#	15	2981	E_γ: Absent in Adopted Gammas. Not reported in other work. Evaluators assign as uncertain placement.
	2701	15	2077	
	4337	60	441	
	4777#	10	0.0	E_γ: g.s. branch not reported in other work. Evaluators assign as uncertain placement.
5374	5373	100	0.0	
5538	5537	100	0.0	
5740	5739	100	0.0	
5760	5759	100	0.0	
5934	5492	10	441	
	5933	90	0.0	
5968	5967	100	0.0	
6042	5600	100	441	

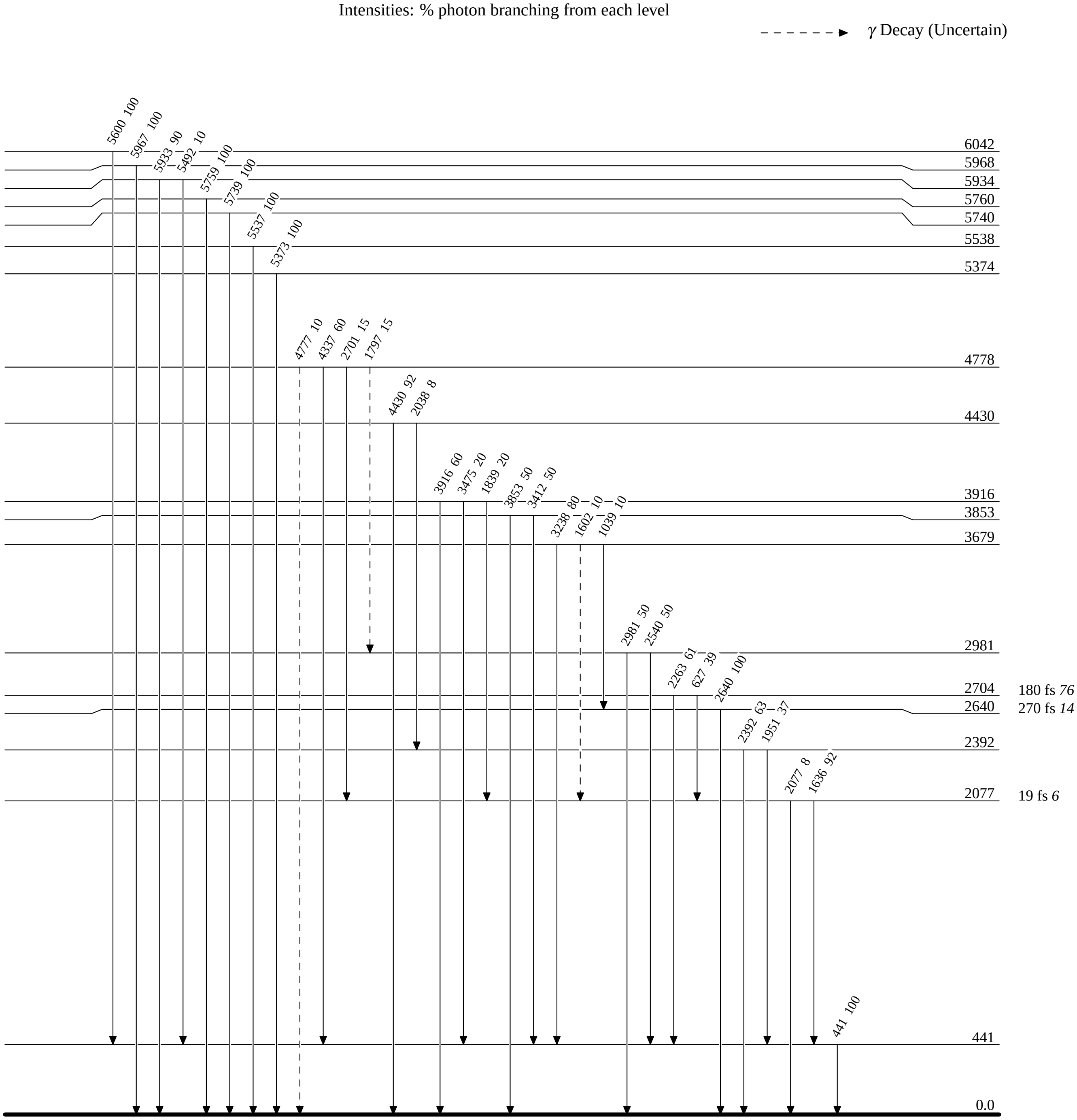
† From level energy differences, recoil energy subtracted and rounded to nearest keV.
‡ From 1972Ni05.
# Placement of transition in the level scheme is uncertain.

^{23}Na(n,n′γ) 1989Ge09,1972Ni05,2012Ro04

Legend

Level Scheme

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{23}Na(p,p′),^{22}Ne(p,p′) 1976Mo27,1968Ke11,1967Ka10

Other references: 1980Fa07, 1971Ri04.
1976Mo27: ^{23}Na(p,p′) E=20 MeV. Measured $\sigma(E_{p'})$.
1968Ke11: ^{22}Ne(p,p′) E=0.8-3.13 MeV. Measured σ(E,p′).
1967Ka10: ^{22}Ne(p,p′), E=0.94-4.2 MeV; Measured σ(E,p′).
1971Ri04: ^{22}Ne(p,p′) E=0.8-3.13 MeV. Measured σ(E,p′).

^{23}Na Levels

E(level)†
5376 *3*
5533 *3*
5741 *3*
5766 *3*
5929 *3*
5966 *3*
6044 *3*
6117 *3*
6197 *3*
6237 *3*
6310 *3*
6348 *3*
6576 *3*
6617 *3*
6734 *3*
6821 *3*
6868 *3*
6920 *3*
6946 *3*
7070 *3*
7080 *3*
7122 *3*
7131 *3*
7185 *3*
7267 *3*
7275 *3*
7393 *3*
7414 *3*
7453 *3*
7488 *3*
7565 *3*
7685 *3*
7720 *3*
7747 *3*
7833 *3*
7873 *3*
7889 *3*
7964 *3*
7990 *3*
8061 *3*
8260 *3*
8302 *3*
8329 *3*
8359 *3*
8416 *3*
8471 *3*
8505 *3*
8560 *3*
8610 *3*

Continued on next page (footnotes at end of table)

$^{23}Na(p,p'),^{22}Ne(p,p')$ 1976Mo27,1968Ke11,1967Ka10 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[‡]	Γ[@]	Comments
8630 *3*			
8648 *3*			
8662 *3*			
8720 *3*			
8799 *3*			
8822 *3*			
8945 *3*			
8972 *3*			
9040 *3*			
9072 *3*			
9103 *3*			
9113 *3*			
9171 *3*			
9209 *3*			
9248 *3*			
9288 *3*			
9323 *3*			
9396 *3*			
9421 *3*			
9472 *3*			
9483 *3*			
9541 *3*			
9582 *3*			
9606 *3*	$3/2^+,5/2^+$[#]	6 eV	E(level): Wt. ave. of 9604 *3* (1976Mo27) and 9609 *4* (Ep(Lab)=851.9 − 1968Ke11). Γ_p=6 eV.
9625 *3*			E(level): From 1976Mo27.
9650 *3*	$1/2^+$[#]	105 eV	E(level): Wt. ave. of 9647 *3* (1976Mo27) and 9655 *4* (Ep(Lab)=900.1 − 1968Ke11). Γ_p=105 eV.
9673 *3*			
9678 *3*			
9700 *3*	$3/2^+,5/2^+$[#]	29 eV	E(level): Wt. ave. of 9699 *3* (1976Mo27) and 9702 *4* (Ep(Lab)=950.0 − 1968Ke11). Γ_p=29 eV.
9728 *3*			
9738 *3*			
9751 *3*			
9798 *3*			
9810 *3*			
9833 *3*	$3/2^+$[#]	47 eV	E(level): Wt. ave. of 9831 *3* (1976Mo27), 9837 *4* (Ep(Lab)=1090.5 − 1968Ke11), and 9855 *10* (Ep(Lab)=1110 *10* − 1967Ka10). Γ_p=47 eV.
9851 *3*	$1/2^+$[#]	150 eV	E(level): Wt. ave. of 9850 *3* (1976Mo27) and 9852 *4* (Ep(Lab)=1106.3 − 1968Ke11). Γ_p=150 eV.
9872 *3*			
9885 *3*			
9912 *3*			
9939 *3*			
9958 *3*			
9984 *3*			
10001 *3*	$1/2^-$[#]	475 eV	E(level): Wt. ave. of 10001 *3* (1976Mo27) and 10001 *4* (Ep(Lab)=1261.9 − 1968Ke11). Γ_p=475 eV.
10014 *3*	$5/2^+$[#]	69 eV	E(level): Wt. ave. of 10012 *3* (1976Mo27), 10017 *4* (Ep(Lab)=1278.2 − 1968Ke11), and 10017 *10* (Ep(Lab)=1280 *10* − 1967Ka10). Γ_p=69 eV.
10036 *3*			
10070 *3*			

Continued on next page (footnotes at end of table)

^{23}Na(p,p′),^{22}Ne(p,p′) 1976Mo27,1968Ke11,1967Ka10 (continued)

^{23}Na Levels (continued)

E(level)[†]	J^{π}[‡]	Γ[@]	L[a]	Comments
10086 *4*	1/2+[#]	1270 eV		E(level): Ep(Lab)=1351.3 (1968Ke11). Other: 10090 *10* (Ep(Lab)=1355 *10* – 1967Ka10). Γ_p=1270 eV.
10113 *3*	1/2+[#]	4200 eV		E(level): Wt. ave. of 10112 *3* (1976Mo27) and 10115 *4* (Ep(Lab)=1380.9 – 1968Ke11). Γ_p=4200 eV.
10122 *3*				E(level): Other: 10125 *10* (Ep(Lab)=1392 *10* – 1967Ka10).
10160 *3*				
10173 *4*	5/2+[#]	65 eV		E(level): For Ep(Lab)=1442.2 from (1968Ke11). Γ_p=65 eV.
10183 *3*				E(level): Other: (10183) (Ep(Lab)=(1453) – 1967Ka10).
10214? *3*				E(level): Level seen at only one angle (1976Mo27).
10221 *3*				
10234 *3*	3/2+,5/2+[#]	4 eV		E(level): Wt. ave. of 10232 *3* (1976Mo27) and 10236 *4* (Ep(Lab)=1508.0 – 1968Ke11). Γ_p=4 eV.
10250 *3*	1/2+[#]	2450 eV	0	E(level): Wt. ave. of 10253 *3* (1976Mo27), 10245 *4* (Ep(Lab)=1517.8 – 1968Ke11), and 10251 *5* (Ep(lab)=1524 *5* – 1967Ka10). Γ_p=2450 eV (1968Ke11); Γ=3 keV and Γ_p=2.1 keV (1967Ka10).
10272 *3*				
10296 *3*				E(level): Other: (10292) (Ep(Lab)=(1567) – 1967Ka10).
10313 *3*	3/2−[#]	2000 eV		E(level): Wt. ave. of 10310 *3* (1976Mo27) and 10317 *4* (Ep(Lab)=1593.0 – 1968Ke11). Γ_p=2000 eV.
10328 *3*				E(level): Other: 10324 *10* (Ep(Lab)=1600 *10* – 1967Ka10).
10336 *3*	1/2−[#]	190 eV		E(level): Wt. ave. of 10336 *3* (1976Mo27) and 10336 *4* (Ep(Lab)=1612.5 – 1968Ke11). Γ_p=190 eV.
10343 *3*	3/2+,5/2+[#]			E(level): Wt. ave. of 10342 *3* (1976Mo27) and 10343 *4* (Ep(Lab)=1620.2 (1968Ke11). $T_{1/2}$=14 eV,Γ_p=14 eV for 3/2+. $T_{1/2}$=8 eV,Γ_p=8 eV for 5/2+.
10351 *4*	3/2+[#]	210 eV		E(level): Ep(Lab)=1627.9 (1968Ke11). Other: 10357 *10* (Ep(Lab)=1635 *10* – 1967Ka10). Γ_p=210 eV.
10401 *3*				
10434 *3*				
10439 *3*	5/2+[#]	25 eV		E(level): Wt. ave. of 10439 *3* (1976Mo27) and 10438 *4* (Ep(Lab)=1718.9 – 1968Ke11). Other: 10456 *10* (Ep(Lab)=1738 *10* – 1967Ka10) – possible doublet. Γ_p=25 eV.
10472 *3*	3/2+[#]	470 eV		E(level): Wt. ave. of 10469 *3* (1976Mo27) and 10477 *4* (Ep(Lab)=1759.5 – 1968Ke11). Other: 10487 *10* (Ep(Lab)=1770 *10* – 1967Ka10) – possible doublet. Γ_p=400 eV.
10496 *3*				
10501 *3*	3/2−[#]	920 eV		E(level): Wt. ave. of 10502 *3* (1976Mo27) and 10499 *4* (Ep(Lab)=1783.4 – 1968Ke11). Γ_p=880 eV.
10506 *4*	1/2+[#]	560 eV		E(level): Ep(Lab)=1789.8 (1968Ke11). Γ_p=560 eV.
10514 *3*	5/2+[#]	100 eV		E(level): Wt. ave. of 10513 *3* (1976Mo27), 10517 *4* (Ep(Lab)=1801.9 – 1968Ke11) and 10515 *10* (Ep(Lab)=1800 *10* – 1967Ka10). Γ_p=100 eV.
10529 *3*				
10545 *3*	5/2+[#]	540 eV		E(level): Wt. ave. of 10543 *3* (1976Mo27), 10546 *4* (Ep(Lab)=1832.5 – 968Ke11),

Continued on next page (footnotes at end of table)

^{23}Na(p,p′),^{22}Ne(p,p′) 1976Mo27,1968Ke11,1967Ka10 (continued)

^{23}Na Levels (continued)

E(level)†	Jπ‡	Γ@	Comments
			and 10553 *10* (Ep(Lab)=1840 *10* – 1967Ka10). Γ_p=380 eV.
10574 *3*	3/2−#	1100 eV	E(level): Wt. ave. of 10574 *3* (1976Mo27) and 10574 *4* (Ep(Lab)=1861.5 – 1968Ke11). Other: 10582 *10* (Ep(Lab)=1870 *10* – 1967Ka10) – possible doublet. Γ_p=1010 eV.
10590 *3*			
10615 *3*	5/2+,3/2+#	425 eV	E(level): Wt. ave. of 10613 *3* (1976Mo27) and 10616 *4* (Ep(Lab)=1905.1 – 1968Ke11), and 10625 *10* (Ep(Lab)=1915 *10* – 1967Ka10). Γ_p=275 eV for 5/2+, Γ_p=360 eV for 3/2+.
10665 *3*			
10677 *3*	3/2−#	23000 eV	E(level): Wt. ave. of 10678 *3* (1976Mo27) and 10675 *4* (Ep(Lab)=1967.0 – 1968Ke11), 10681 *7* (Ep(Lab)=1973 *7* – 1967Ka10). Γ_p=22000 eV (1968Ke11). Γ=40 keV (1967Ka10).
10701 *3*	3/2−#	400 eV	E(level): Wt. ave. of 10699 *3* (1976Mo27) and 10705 *4* (Ep(Lab)=1998.45 – 1968Ke11). Other: (10708) (Ep(Lab)=(2002) – 1967Ka10). Γ_p=340 eV.
10770 *3*	3/2+,5/2+#	<5 eV	E(level): Wt. ave. of 10770 *3* (1976Mo27) and 10770 *4* – (Ep(Lab)=2066.2 – 1968Ke11). Other: (10771) (Ep(Lab)=(2068) – 1967Ka10).
10824 *3*	3/2+#	1700 eV	E(level): Wt. ave. of 10825 *3* (1976Mo27) and 10823 *4* (Ep(Lab)=2121.2 – 1968Ke11). Γ_p=1000 eV.
10826 *3*	3/2−#	26000 eV	E(level): Wt. ave. of 10823 *4* (Ep(Lab)=2122.0 – 1968Ke11) and 10827 *3* (Ep(Lab)=2126 *3* – 1967Ka10). Γ_p=25000 eV (1968Ke11). Γ=12 keV (1967Ka10).
10838 *3*	3/2+,5/2+#	100 eV	E(level): Wt. ave. of 10839 *3* (1976Mo27) and 10837 *4* (Ep(Lab)=2136.6 – 1968Ke11). Γ_p=30 eV.
10869 *3*	3/2−#	21000 eV	E(level): Wt. ave. of 10867 *3* (1976Mo27) and 10873 *4* (Ep(Lab)=2174.0 – 1968Ke11). Other: 10888 *3* (Ep(Lab)=2190 *3* – 1967Ka10) – possible doublet. Γ_p=20000 eV (1968Ke11). Γ=22 keV (1967Ka10).
10903 *4*	1/2−#	53 eV	E(level): Ep(Lab)=2206.0 from (1968Ke11). 10909 *3* (doublet) (1976Mo27). Γ_p=3 eV.
10906.5 *40*	1/2−#	2850 eV	E(level): Ep(Lab)=2209.2 from 1968Ke11. Γ_p=2500 eV.
10906.8 *40*	5/2+#	900 eV	E(level): Ep(Lab)=2209.5 (1968Ke11). Other: 10914 *3* (Ep(Lab)=2217 *3* – 1967Ka10) – possible doublet/triplet. Γ_p=200 eV (1968Ke11). Γ=9 KeV (1967Ka10).
10918 *3*	1/2+#	55 eV	E(level): Wt. ave. of 10919 *3* (1976Mo27) and 10916 *4* (Ep(Lab)=2219.6 – 1968Ke11). Γ_p=5 eV.
10933 *3*	3/2+#	3500 eV	E(level): Wt. ave. of 10933 *3* (1976Mo27) and 10930 *4* (Ep(Lab)=2233.4 – 1968Ke11), 10934 *3* (Ep(Lab)=2238 *3* – 1967Ka10). Γ_p=3000 eV.
10949 *4*	1/2+#	5200 eV	E(level): Ep(Lab)=2253.6 from (1968Ke11). Others: 10956 *3* (1976Mo27), 10957 *3* (Ep(Lab)=2262 *3* – 1967Ka10) – possible doublet. Γ_p=5000 eV.
10953 *4*	7/2−#	65 eV	E(level): Ep(Lab)=2257.8 from 1968Ke11. Γ_p=15 eV.
10967 *4*	5/2+,3/2+#	400 eV	E(level): Wt. ave. of 10965 *3* (1976Mo27) and 10971 *4* (Ep(Lab)=2277.1 – 1968Ke11). Γ_p=200 eV.
10973 *3*	3/2+#	18 eV	E(level): Wt. ave. of 10972 *3* (1976Mo27) and 10974 *4* (Ep(Lab)=2280.0 – 1968Ke11). Γ_p=3 eV.
10980 *3*	3/2−#	6000 eV	E(level): Wt. ave. of 10981 *3* (1976Mo27) and 10979 *4* (Ep(Lab)=2285.0 – 1968Ke11). Γ_p=5800 eV.
10992 *4*	1/2+#	20600 eV	E(level): Ep(Lab)=2299.0 (1968Ke11). 10993 *3* (1976Mo27) – overlaps both 10992 and

Continued on next page (footnotes at end of table)

^{23}Na(p,p′),^{22}Ne(p,p′) 1976Mo27,1968Ke11,1967Ka10 (continued)

^{23}Na Levels (continued)

E(level)[†]	Jπ[‡]	Γ[@]	L[a]	Comments
				10993. Γ_p=20000 eV.
10993 *4*	3/2+[#]	60 eV		E(level): Ep(Lab)=2300.0 (1968Ke11). Other: 10993 (Ep(Lab)=2300 – 1967Ka10). Γ_p=10 eV.
11004 *3*				
11041 *3*	1/2+[#]	500 eV		E(level): Wt. ave. of 11041 *3* (1976Mo27), 11038 *4* (Ep(Lab)=2346.2 – 1968Ke11), and 11043 *3* (Ep(Lab)=2352 *3* – 1967Ka10). Γ_p=200 eV.
11088 *3*	1/2−[#]	800 eV		E(level): Wt. ave. of 11089 *3* (1976Mo27), 11086 *4* (Ep(Lab)=2397.4 – 1968Ke11), and 11089 *3* (Ep(Lab)=2400 *3* – 1967Ka10). Γ_p=500 eV.
11108 *4*	5/2+[#]	135 eV		E(level): Ep(Lab)=2420.1 (1968Ke11). Γ_p=25 eV.
11112 *3*	3/2+[#]	4100 eV	2	E(level): Wt. ave. of 11113 *3* (1976Mo27) and 11110 *4* (Ep(Lab)=2421.8 – 1968Ke11). Other: 11118 *3* (Ep(Lab)=2430 *3* – 1967Ka10). Γ_p=2450 eV (1968Ke11); Γ=7 keV and Γ_p=4.6 keV (1967Ka10).
11133 *3*				
11155 *3*				E(level): Other: (11161) (Ep(Lab)=(2475) – 1967Ka10).
11198 *4*	3/2+[#]	800 eV		E(level): Wt. ave. of 11197 *4* (Ep(Lab)=2512.8 – 1968Ke11) and 11200 *5* (Ep(Lab)=2516 *5* – 1967Ka10). Γ_p=700 eV.
11240 *3*	3/2−[#]	12200 eV		E(level): Wt. ave. of 11237 *4* (Ep(Lab)=2555.0 – 1968Ke11) and 11242 *3* (Ep(Lab)=2560 *3* – 1967Ka10). Γ_p=12000 eV (1968Ke11). Γ=16 keV (1967Ka10).
11250 *4*	3/2+[#]	20000 eV		E(level): Wt. ave. of 11249 *4* (Ep(Lab)=2567.0 – 1968Ke11) and 11253 *7* (Ep(Lab)=2572 *7* – 1967Ka10). Γ_p=19500 eV.
11266 *4*	3/2−[#]	600 eV		E(level): Ep(Lab)=2585.2 from 1968Ke11. Γ_p=120 eV.
11273 *4*	3/2+[#]	1750 eV		E(level): Ep(Lab)=2592.0 from 1968Ke11. Γ_p=250 eV.
11276 *4*	3/2+[#]	500 eV		E(level): Ep(Lab)=2595.4 from 1968Ke11. Γ_p=150 eV.
11279 *4*	3/2+[#]	4000 eV		E(level): Ep(Lab)=2598.6 from 1968Ke11. Γ_p=2000 eV.
11288 *3*	1/2+[#]	11000 eV		E(level): Wt. ave. of 11285 *4* (Ep(Lab)=2604.7 – 1968Ke11) and 11289 *3* (Ep(Lab)=2609 *3* – 1967Ka10). Γ_p=10000 eV (1968Ke11). Γ=18 keV (1967Ka10).
11302 *4*	3/2+[#]	300 eV		E(level): Ep(Lab)=2623.0 from 1968Ke11. Γ_p=50 eV.
11328 *4*	1/2−[#]	80000 eV		E(level): Ep(Lab)=2650.0 from 1968Ke11. Γ_p=75000 eV.
11333 *4*	5/2+[#]	4000 eV		E(level): Ep(Lab)=2655.5 from 1968Ke11. Γ_p=2000 eV.
11333.7 *40*	3/2−[#]	2000 eV		E(level): Ep(Lab)=2656.0 from 1968Ke11. Γ_p=1500 eV.
11335 *4*	3/2+[#]	750 eV		E(level): Ep(Lab)=2657.3 from 1968Ke11. Other: 11342 *3* (Ep(Lab)=2665 *3* – 1967Ka10) – possible doublet. Γ_p=150 eV (1968Ke11). Γ=9 keV (1967Ka10) probably for doublet.
11350 *4*	1/2−[#]	4000 eV		E(level): Ep(Lab)=2673.0 from 1968Ke11. Γ_p=3980 eV.
11354 *4*	1/2+[#]	13500 eV		E(level): Ep(Lab)=2677.0 from 1968Ke11. Other: 11366 *7* (Ep(Lab)=2690 *7* –

Continued on next page (footnotes at end of table)

^{23}Na(p,p′),^{22}Ne(p,p′) 1976Mo27,1968Ke11,1967Ka10 (continued)

^{23}Na Levels (continued)

E(level)[†]	Jπ[‡]	Γ[@]	L[a]	Comments
				1967Ka10). Γ_p=13000 eV.
11395?				E(level): Ep(Lab)=(2720) (1967Ka10).
11431 *3*	1/2−[#]	35000 eV		E(level): Wt. ave. of 11425 *4* (Ep(Lab)=2751.0 – 1968Ke11) and 11435 *3* (Ep(Lab)=2762 *3* – 1967Ka10). Γ_p=27000 eV.
11458?				E(level): Ep(Lab)=(2786) (1967Ka10).
11469?				E(level): Ep(Lab)=(2798) (1967Ka10).
11495 *4*	7/2−[#]	5500 eV		E(level): Ep(Lab)=2825.0 from 1968Ke11. Other: 11506 *3* (Ep(Lab)=2836 *3* – 1967Ka10) – possible doublet. Γ_p=900 eV (1968Ke11). Γ=15 keV (1967Ka10) probably for doublet.
11519 *4*	5/2+[#]	3050 eV		E(level): Ep(Lab)=2850.0 from 1968Ke11. Γ_p=550 eV.
11528 *3*	5/2+[#]	6900 eV		E(level): Wt. ave. of 11525 *4* (Ep(Lab)=2855.5 – 1968Ke11) and 11529 *3* (Ep(Lab)=2860 *3* – 1967Ka10). Γ_p=1700 eV (1968Ke11). Γ=19 keV (1967Ka10).
11538 *4*	5/2+[#]	130 eV		E(level): Ep(Lab)=2869.5 from 1968Ke11. Γ_p=40 eV.
11556 *3*	1/2+[#]	3100 eV		E(level): Wt. ave. of 11553 *4* (Ep(Lab)=2885.0 – 1968Ke11) and 11557 *3* (Ep(Lab)=2890 *3* – 1967Ka10). Γ_p=2300 eV.
11580 *3*	5/2+[#]	600 eV		E(level): Wt. ave. of 11584 *4* (Ep(Lab)=2917.6 – 1968Ke11) and 11578 *3* (Ep(Lab)=2912 *3* – 1967Ka10). Γ_p=350 eV.
11612 *4*	3/2−[#]	3200 eV		E(level): Ep(Lab)=2946.5 from 1968Ke11. Other: 11600 *3* (Ep(Lab)=2934 *3* – 1967Ka10). Γ_p=1000 eV.
11622 *3*				E(level): Ep(Lab)=2958 3 (1967Ka10).
11664 *4*	1/2−,3/2−[#]	14000 eV		E(level): Ep(Lab)=3001.0 from 1968Ke11. 11682 *7* (Ep(Lab)=3020 *7* (2020 *7* appears to be a typo – 1967Ka10) – possible doublet. Γ_p=500 eV if 1/2−. Γ=9800 eV, Γ_p=800 eV if 3/2−.
11691 *4*	1/2+[#]	1900 eV		E(level): Ep(Lab)=3030.0 from 1968Ke11. Γ_p=500 eV.
11700 *4*	3/2−[#]	7000 eV	1	E(level): Ep(Lab)=3039.5 (1968Ke11). Other: 11714 4 (Ep(Lab)=3054 4 – 1967Ka10). Γ_p=3000 eV (1968Ke11); Γ=12 keV and Γ_p=6.0 keV (1967Ka10).
11708 *4*	5/2+[#]	3200 eV		E(level): Ep(Lab)=3047.4 (1968Ke11). Γ_p=200 eV.
11747 *4*	7/2−[#]	2300 eV		E(level): Ep(Lab)=3088.5 (1968Ke11). Γ_p=700 eV.
11762 *4*	1/2−[#]	15000 eV		E(level): Wt. ave. of 11764 *4* (Ep(Lab)=3106.0 – 1968Ke11) and 11760 *4* (Ep(Lab)=3102 *4* – 1967Ka10). Γ_p=13000 eV (1968Ke11). Γ=28 keV (1967Ka10).
11777?				E(level): Ep(Lab)=(3120) (1967Ka10).
11820 *4*				E(level): Ep(Lab)=3165 *4* (1967Ka10).
11840 *7*				E(level): Ep(Lab)=3186 *7* (1967Ka10).
11865 *4*	(3/2)+	16[&] keV	2	E(level): Ep(Lab)=3212 *4* (1967Ka10). Γ: Γ_p=7.2 keV.
11897 *4*				E(level): Ep(Lab)=3245 *4* (1967Ka10).
11980 *4*				E(level): Ep(Lab)=3332 *4* (1967Ka10).
12018 *4*				E(level): Ep(Lab)=3372 *4* (1967Ka10).
12074 *4*				E(level): Ep(Lab)=3430 *4* (1967Ka10).
12105 *4*		16[&] keV		E(level): Ep(Lab)=3463 *4* (1967Ka10).

Continued on next page (footnotes at end of table)

^{23}Na(p,p′),^{22}Ne(p,p′) 1976Mo27,1968Ke11,1967Ka10 (continued)

^{23}Na Levels (continued)

E(level)[†]	Jπ[‡]	Γ[@]	L[a]	Comments
12129 *7*				E(level): Ep(Lab)=3488 *7* (1967Ka10).
12189 *4*	(3/2)+	12[&] keV	2	E(level): Ep(Lab)=3550 *4* (1967Ka10). Γ: $Γ_p$=4.2 keV.
12203 *4*		28[&] keV		E(level): Ep(Lab)=3565 *4* (1967Ka10).
12255?				E(level): Ep(Lab)=(3620) (1967Ka10).
12290 *4*				E(level): Ep(Lab)=3656 *4* (1967Ka10).
12318 *4*				E(level): Ep(Lab)=3685 *4* (1967Ka10).
12334?				E(level): Ep(Lab)=(3702) (1967Ka10).
12351 *4*				E(level): Ep(Lab)=3720 *4* (1967Ka10).
12378 *4*		11[&] keV		E(level): Ep(Lab)=3748 *4* (1967Ka10).
12424 *4*		14[&] keV		E(level): Ep(Lab)=3796 *4* (1967Ka10).
12453 *4*		9[&] keV		E(level): Ep(Lab)=3827 *4* (1967Ka10).
12533 *7*				E(level): Ep(Lab)=3910 *7* (1967Ka10).
12557?				E(level): Ep(Lab)=(3935) (1967Ka10).
12584 *5*		34[&] keV		E(level): Ep(Lab)=3964 *5* (1967Ka10).
12625 *5*		25[&] keV		E(level): Ep(Lab)=4006 *5* (1967Ka10).
12667?				E(level): Ep(Lab)=(4050) (1967Ka10).
12705?				E(level): Ep(Lab)=(4090) (1967Ka10).
12734 *5*		24[&] keV		E(level): Ep(Lab)=4120 *5* (1967Ka10).
12796 *7*				E(level): Ep(Lab)=4185 *7* (1967Ka10).

[†] From 1976Mo27 and 1968Ke11, except otherwise noted. Resonance level energies deduced from Sp=8794.10 *2* (2017Wa10) + Ep(c.m.) using Ep(Lab), m_p=1.00738 and m(^{22}Ne)=21.9914. ΔEp(Lab)=4 keV (1968Ke11).

[‡] From Adopted Levels, except otherwise noted.

[#] In 1968Ke11, based on measured $\sigma(\theta)$ mb/sr and fitting with single-level, Breit-Wigner formula for resonances <2.1 MeV and multilevel, multichannel R-matrix code for resonances above >2.1 MeV.

[@] From 1968Ke11. $Γ_p$ listed in comments section.

[&] From 1967Ka10. $Γ_p$ (if available) listed in comments section.

[a] From 1967Ka10.

^{23}Na(p,p′γ) 1972Du05,1968So07,1970Ma15

Other references: 1959Ra10, 1969Po06, 1973Eh01.
1972Du05: ^{23}Na(p,p′γ) E=3.6-7.0 MeV. Measured mean lifetime by DSA.
1968So07: ^{23}Na(p,p′γγ) E=4.71, 5.12 MeV; measured γγ(θ). Deduced spin, γ-ray mixing ratios.
1970Ma15: ^{23}Na(p,p′γ) E=4.12, 5.15 MeV. Measured mean lifetime by DSA.

^{23}Na Levels

E(level)[†]	J^{π}[#]	$T_{1/2}$[†]	Comments
0.0	3/2+		
440.2[‡] *4*	5/2+	1.25 ps *+28−21*	$T_{1/2}$: From mean lifetime of 1.8 ps *+4−3* (1959Ra10).
2076.7 *5*	7/2+	146 fs *42*	J^{π}: 7/2 from γ-ray angular correlation studies (1968So07). $T_{1/2}$: From τ=210 fs *60* in Table 2 (1972Du05) − two values are given − other one τ=210 fs *25* (25%) (syst) in Table 1 yields 210 fs *31*. Evaluators list the one with larger uncertainty. Other values: <230 fs (1970Ma15), <160 fs (1969Po06).
2391.7 *7*	1/2+	652 fs *139*	$T_{1/2}$: From τ=940 fs *200*; Wt. ave. of τ=950 fs *200* (1969Po06), 700 fs *250* (1970Ma15), and 1550 fs *400* in Table 2 (1972Du05). 1972Du05 also give τ=1550 fs *90* (25%) (syst) in Table 1 − yields 1550 fs *113*.
2639.4 *7*	1/2−	147 fs *55*	$T_{1/2}$: From τ=212 fs *80*; Wt. ave. of τ=200 fs *80* (1969Po06), 100 fs *+80−40* (1970Ma15), and 370 fs *90* in Table 2 (1972Du05). 1972Du05 also give τ=365 fs *40* (25%) (syst) in Table 1 − yields 365 fs *50*.
2704.4 *7*	9/2+	85 fs *17*	J^{π}: 9/2 from γ-ray angular correlation studies (1968So07). $T_{1/2}$: From τ=122 fs *25*; Wt. ave. of τ=200 fs *100* (1969Po06), 100 fs *+80−40* (1970Ma15), and 100 fs *25* (1972Du05).
2983.0 *5*	3/2+	<17 fs	$T_{1/2}$: From 1972Du05. Other values: <79 fs (1970Ma15), <50 fs (1969Po06).
3678.9 *7*	3/2−	49 fs *28*	A γ branch to g.s. in 1972Du05 was not confirmed by later studies − evaluators did not list the transition in this data set. $T_{1/2}$: From 1972Du05. Other value: 617 fs *110* (1970Ma15), <120 fs (1969Po06).
3849.5 *7*	5/2−	118 fs *28*	
3915.6 *7*	5/2+	42 fs *10*	$T_{1/2}$: From 1972Du05. Other value <70 fs (1969Po06).
4432.7 *7*	1/2+	<31 fs	
4776.2 *7*	7/2+	<24 fs	

† From 1972Du05, except where otherwise noted.
‡ From 1969Po06.
\# From Adopted Levels, except otherwise noted.

γ(^{23}Na)

E_i(level)	J^{π}_i	E_{γ}[†]	I_{γ}[‡]	E_f	J^{π}_f	Mult.[#]	δ[#]	Comments
440.2	5/2+	441.1 *4*	100	0.0	3/2+	D+Q	+0.06 *4*	δ: From 1968So07.
2076.7	7/2+	1637.4 *12*	93 *3*	440.2	5/2+	D+Q	+0.18 *2*	δ: From 1970Ma15. Other value: +0.24 *7* (1968So07).
		2077.5 *11*	7 *3*	0.0	3/2+			
2391.7	1/2+	1950.4 *7*	35 *2*	440.2	5/2+	E2		I_{γ}: Weighted average of 34 *2* (1972Du05) and 38 *3* (1970Ma15).
		2390.1 *9*	65 *2*	0.0	3/2+			I_{γ}: Weighted average of 66 *2* (1972Du05) and 62 *3* (1970Ma15).
2639.4	1/2−	2639.3 *14*	100	0.0	3/2+			
2704.4	9/2+	627.9 *4*	36 *4*	2076.7	7/2+	D(+Q)	+0.05 *9*	I_{γ}: Other: 37 *4* (1970Ma15). δ: Average of +0.07 *9* (1970Ma15) and +0.02 *9* (1968So07).
		2263.9 *13*	64 *4*	440.2	5/2+	E2		I_{γ}: Other: 63 *4* (1970Ma15).
2983.0	3/2+	2540.2 *12*	39 *2*	440.2	5/2+	D(+Q)	−0.09 *9*	I_{γ}: Other: 52 *4* (1970Ma15). δ: or +4.5 *20* (1970Ma15).
		2980.9 *15*	61 *2*	0.0	3/2+			I_{γ}: Other: 48 *4* (1970Ma15).

Continued on next page (footnotes at end of table)

^{23}Na(p,p′γ) 1972Du05,1968So07,1970Ma15 (continued)

γ(^{23}Na) (continued)

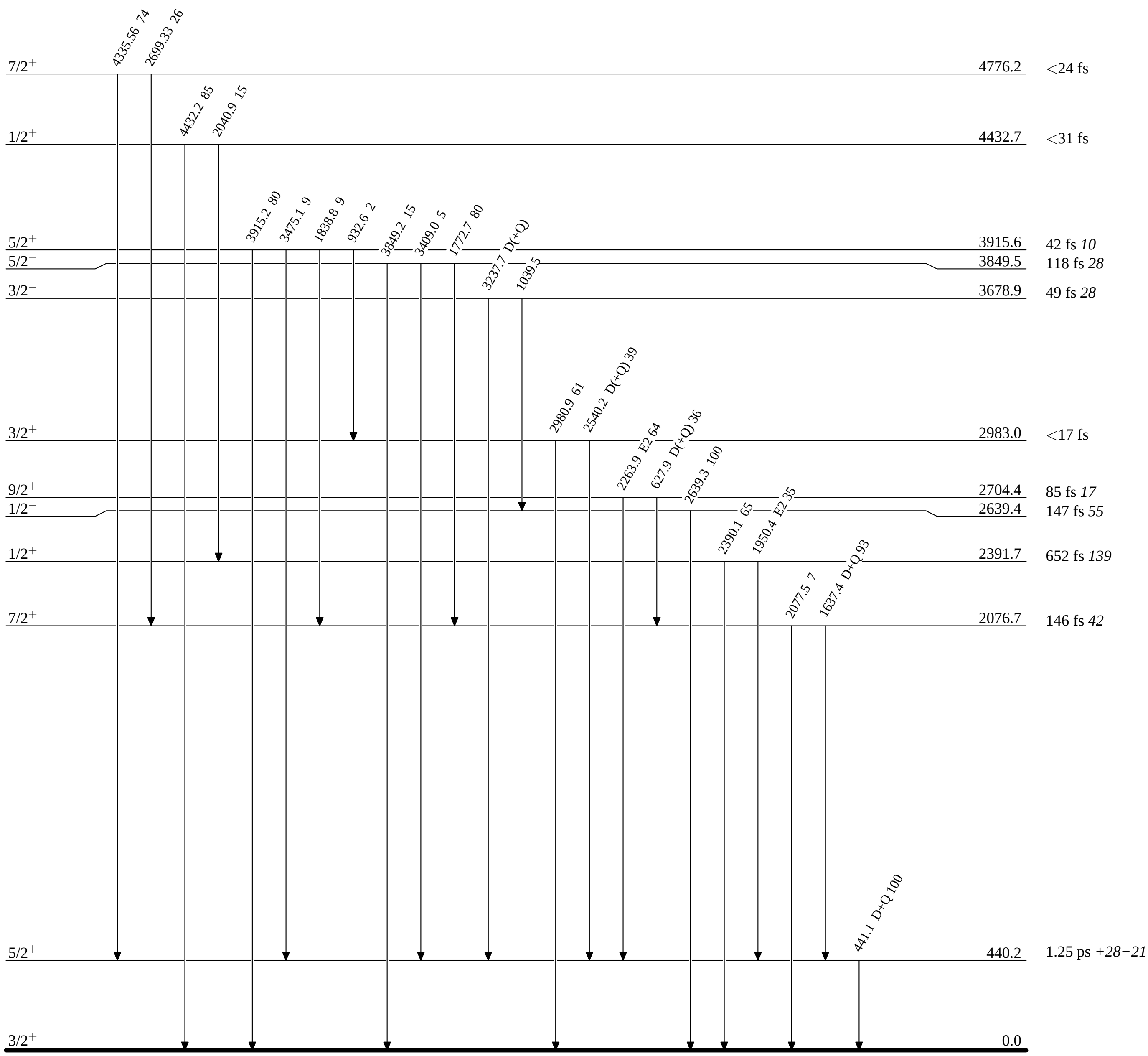
E_i(level)	J^π_i	E_γ†	I_γ‡	E_f	J^π_f	Mult.#	δ#	Comments
3678.9	3/2−	1039.5		2639.4	1/2−			
		3237.7 *16*		440.2	5/2+	D(+Q)	−0.04 *10*	δ: or +3.7 *2* (1970Ma15).
3849.5	5/2−	1772.7	80 *5*	2076.7	7/2+			
		3409.0	5 *2*	440.2	5/2+			
		3849.2	15 *3*	0.0	3/2+			
3915.6	5/2+	932.6	2 *1*	2983.0	3/2+			
		1838.8	9 *3*	2076.7	7/2+			
		3475.1	9 *3*	440.2	5/2+			
		3915.2	80 *5*	0.0	3/2+			E_γ: Other: 3911.4 *21* (1969Po06).
4432.7	1/2+	2040.9	15 *10*	2391.7	1/2+			
		4432.2	85 *10*	0.0	3/2+			
4776.2	7/2+	2699.33	26 *4*	2076.7	7/2+			
		4335.56	74 *4*	440.2	5/2+			

† From 1969Po06. Those without uncertainty are from level energy difference − recoil energy subtracted.
‡ From 1972Du05.
# From γ-ray angular correlation studies by 1968So07, 1970Ma15 and RUL.

^{23}Na(p,p′γ) 1972Du05,1968So07,1970Ma15

Level Scheme

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{23}Na(α,α') 1988Ma35

Other references: 1991Fr02 (E=48.7 MeV), 1981La06 (E=12-15 MeV), 1974Le01 (E=22 MeV), 1972Li02 (also studied (p,$\alpha\gamma$)).
1988Ma35: ^{23}Na(α,α') E=42 MeV; ^{23}Na target (thickness 140 μg/cm^2) in the form of NaCl deposition on a 10 μg/cm^2 carbon foil. QMG/2 magnetic spectrometer, gas filled ionization chamber; Measured α' particles at five different angles; Deduced excited levels, deformation lengths.

^{23}Na Levels

E(level)†	J$^\pi$‡
0.0	3/2$^+$
440	5/2$^+$
2076	7/2$^+$
2704	9/2$^+$

† From 1988Ma35.
‡ From Adopted Levels.

Coulomb excitation 1977Sc36,1996Tu02,1956Te33

1977Sc36: ^{23}Na(^{32}S,^{32}S′), E=47-51 MeV, natural NaCl target; ^{23}Na(^{35}Cl,^{35}Cl′), E=53-56 MeV, Na (100%) target; Measured σ(Eγ), mean lifetime by Doppler-shift attenuation (DSA) method, deduced B(E2).
1996Tu02: ^{12}C(^{23}Na,^{23}Na′), E=20,23 MeV; Measured $\sigma(\theta)$, deduced B(E2).
1956Te33: ^{23}Na(α,α'), E=2.5 MeV; Measured $\gamma(\theta)$; Deduced 440γ multipolarity and spin-parity of 440-keV level.

^{23}Na Levels

E(level)†	J$^\pi$†	$T_{1/2}$	Comments
0.0	3/2$^+$		
440.2 *4*	5/2$^+$	1.17 ps *15*	B(E2)↑=0.01515 *16* (1996Tu02) B(E2)↑=0.0157 *12* (1977Sc36) J$^\pi$: From 1956Te33, based on $\gamma(\theta)$ measurements. $T_{1/2}$: From mean lifetime τ=1.69 ps *22* (DSA – 1977Sc36). Others: 1.42 ps *22* and 1.37 ps *24*, using B(E2)↑=0.01515 *16* (1996Tu02) and 0.0157 *12* (1977Sc36), respectively, and adopted γ-ray properties.
2076.2 *4*	7/2$^+$	35 fs *5*	B(E2)↑=0.0073 *10* (1996Tu02) $T_{1/2}$: Using B(E2)↑=0.0073 *10* (1996Tu02) and adopted γ-ray properties. Other: 83 fs *42* from τ=120 fs *60* (DSA – 1977Sc36).

† From Adopted Levels, except where otherwise noted.

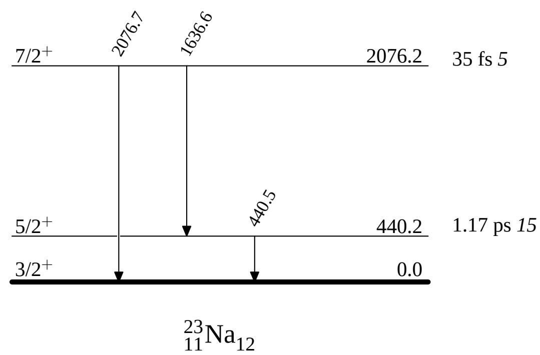
γ(^{23}Na)

E$_\gamma$†	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
440.5 *6*	440.2	5/2$^+$	0.0	3/2$^+$
1636.6 *8*	2076.2	7/2$^+$	440.2	5/2$^+$
2076.7 *8*	2076.2	7/2$^+$	0.0	3/2$^+$

† From Adopted Gammas.

Coulomb excitation 1977Sc36,1996Tu02,1956Te33

Level Scheme



^{24}Mg(d,^{3}He) 1971Kr04,1971Ar08,1972Ne18

J^{π}(^{24}Mg)=0^{+}.
Other reference: 1978Co13.
Other reactions:
^{24}Mg(α,^{5}Li): 1978Sa26 (65 MeV) – measured relative energy distribution of correlated decay products.
^{24}Mg(^{9}Be,^{10}B): 1985Wi18 (E=43 MeV) – deduced spectroscopic factors for g.s. and 1st excited state.
1971Kr04: ^{24}Mg(d,^{3}He) E=52 MeV, 99% enriched ^{24}Mg target. Measured $\sigma(\theta)$, deduced excited levels, L, spectroscopic factors. FWHM 80 keV.
1971Ar08: ^{24}Mg(d,^{3}He) E=80 MeV. Measured σ(E(^{3}He),θ). Deduced spectroscopic factors. FWHM 120 to 180 keV.
1972Ne18: ^{24}Mg(d,^{3}He) E=21.1 MeV. Measured σ(E(^{3}He),θ). FWHM 80 to 100 keV.
1978Co13: ^{24}Mg(pol d,^{3}He) E=29 MeV, 99% enriched ^{24}Mg target. Measured $\sigma(\theta)$, vector analyzing power. DWBA calculations. Deduced spectroscopic factors. FWHM better than 350 keV.

^{23}Na Levels

E(level)[†]	L[&]	S[@&]	Comments
0	2	0.47	S: Other values: 0.08 and 0.09 (1978Co13), 0.26 (1972Ne18), 0.24 (1971Kr04).
442 *10*	2	2.90	S: Other values: 0.47 and 0.70 (1978Co13), 2.1 (1972Ne18), 3.78 (1971Kr04).
2093[‡] *18*			
2397 *10*	0	0.25	S: Other: 0.19 (1972Ne18), 0.30 (1971Kr04).
2644 *11*	1	1.9[a] *3*	S: Other: 1.6 (1972Ne18), 2.64 (1971Kr04).
2710[‡]			
2983 *10*		0.15[‡]	S: Other: 0.17 (1971Kr04).
3678 *10*	1	0.98[a] *14*	S: Other: 0.43 (1972Ne18), 0.93 (1971Kr04).
3850[‡]			
3914 *25*		0.014[‡]	S: Other: 0.02 (1971Kr04).
4440 *12*	0	0.08	S: Other: 0.064 (1972Ne18), 0.12 (1971Kr04).
4780[‡]			
5380 *7*	2	0.52[a] *10*	S: Other: 0.49 (1971Kr04).
5530[‡]			
5778 *26*	2	≈0.04	L,S: From 1971Kr04.
5965 *11*	1	0.9[a] *2*	S: Other: 0.60 (1971Kr04).
6263 *14*	0[b]	0.04[b]	
6917 *28*	1[b]	0.37[b]	
7092 *22*	1[b]	0.08[b]	
9223 *10*	1[b]	0.18[b]	
9433 *32*	1[b]	<0.1[b]	
9728 *10*	1[b]	0.44[b]	
10490 *12*	1[b]	<0.22[b]	
11050[#] *36*	1[b]	<0.29[b]	

[†] From 1971Kr04, except otherwise noted.
[‡] From 1972Ne18.
[#] Overlaps three or more Adopted Levels energies, not referenced.
[@] $C^{2}S$.
[&] From 1971Ar08, except where noted.
[a] Values given as a range in 1971Ar08.
[b] From 1971Kr04.

^{24}Mg(t,α),(t,$\alpha\gamma$) 1970Po08,1971Da14,1976Sh03

Other references: 1988Ma23, 1990PiZW, and 1991Pi09.
$J^\pi(^{24}Mg)=0^+$.
1970Po08: ^{24}Mg(t,$\alpha\gamma$) E=2.80 MeV. Measured γ angular distribution with NaI(Tl) detectors.
1971Da14: ^{24}Mg(t,$\alpha\gamma$) E=4.0-4.5 MeV. Measured $\sigma(E_p, E_\gamma, \theta(\alpha\gamma))$, NaI(Tl).
1976Sh03: ^{24}Mg(t,α) E=15, 23.5 MeV. Measured $\sigma(E_\alpha,\theta)$, DWBA analysis. FWHM 18- and 80-keV for E_t=15- and 23.5-MeV, respectively.
1988Ma23: ^{24}Mg(t,α) E=33 MeV. Measured $\sigma(\theta)$, deduced excited levels, spectroscopic factors. FWHM 30 keV.

^{23}Na Levels

E(level)†	Jπ#	L†	C²S‡	Comments
0	3/2+	2	0.39	C²S: Others: 0.43 (1976Sh03 for E_t=23.5 MeV), 0.28 (1988Ma23).
438 *5*	5/2+	2	2.3	C²S: Others: 2.2 (1976Sh03 for E_t=23.5 MeV), 2.29 (1988Ma23).
2081 *5*	7/2+	4	(0.12)	C²S: Others: (0.16) (1976Sh03 for E_t=23.5 MeV), (0.06) (1988Ma23).
2392 *5*	1/2+	0	0.19	C²S: Others: 0.19 (1976Sh03 for E_t=23.5 MeV), 0.16 (1988Ma23).
2641 *5*	1/2−	1	1.8	C²S: Others: 1.9 (1976Sh03 for E_t=23.5 MeV), 1.56 (1988Ma23).
2706 *5*	9/2+	4	(0.10)	C²S: Other: (0.09) (1988Ma23).
2984 *5*	3/2+	2	0.39	C²S: Others: 0.30 (1976Sh03 for E_t=23.5 MeV), 0.19 (1988Ma23).
3680 *5*	3/2−	1	0.56	C²S: Others: 0.52 (1976Sh03 for E_t=23.5 MeV), 0.71 (1988Ma23).
3851 *5*	5/2−	3	(0.17)	C²S: Others: (0.20) (1976Sh03 for E_t=23.5 MeV), (0.05) (1988Ma23).
3916 *5*	5/2+	2	0.04	C²S: Other: 0.01 (1988Ma23). Jπ: 5/2 from 1970Po08, based on γ-ray transition strength analysis.
4436 *10*	1/2+	0	0.11	C²S: Others: 0.12 (1976Sh03 for E_t=23.5 MeV), 0.08 (1988Ma23).
4778 *10*	7/2+	4	(0.17)	C²S: Others: (0.20) (1976Sh03 for E_t=23.5 MeV), 0.05 (1988Ma23).
5383 *10*	3/2+,5/2+	2	0.61,0.40	C²S: Others: 0.72,0.50 (1976Sh03 for E_t=23.5 MeV), 0.39 (1988Ma23).
5537 *10*	11/2+	6	(0.17)	C²S: Other: (0.09) (1988Ma23).
5748 *10*	3/2+,5/2+	2		
5773 *10*		(3)	(0.06)	
5931 *10*		(0)	(0.03)	
5971 *10*	1/2−,3/2−	1	0.40	
6050 *10*				
6124 *10*				
6197 *10*				
6237 *10*		(6)	(0.25)	
6311 *10*	1/2+	0	0.03	
6358 *10*		(5)	(0.64)	

† From 1976Sh03.
‡ From 1976Sh03 for E_t=15 MeV. Values for E_t=23.5 MeV (1976Sh03) and 1988Ma23 are listed in comments. In 1976Sh03 values extracted from measured cross section using the relation: $(d\sigma/d\Omega)_{exp}= NC^2S(\sigma_{DWUCK}/(2j+1))$, N=9.3 and 12.7 for 15- and 23.5-MeV, respectively. In 1988Ma23: $(d\sigma(\theta)/d\Omega)_{exp}= 2.0C^2S(l,j)((d\sigma(\theta)/d\Omega)_{FRUCK-2}$.
# From 1976Sh03, except where otherwise noted, based on $\sigma(\theta)$ and DWBA calculations.

γ(^{23}Na)

E_i(level)	J^π_i	E_γ†	I_γ#	E_f	J^π_f	Mult.‡	δ#	Comments
438	5/2+	438	100	0	3/2+	D+Q	+0.07 *3*	A_2=−0.22 *3*; A_4=−0.06 *4* (1970Po08) δ: Wt. ave. of +0.08 *3* (1970Po08) and +0.05 *3* (1971Da14).
2081	7/2+	1643	93 *2*	438	5/2+	D+Q	+0.16 *2*	A_2=+0.01 *3*; A_4=+0.07 *5* (1970Po08) I_γ: Wt. ave. of 94 *2* (1970Po08) and 92 *2* (1971Da14). δ: Wt. ave. of +0.18 *4* (1970Po08) and +0.16 *2* (1971Da14).
		2081	7 *2*	0	3/2+			I_γ: Wt. ave. of 6 *2* (1970Po08) and 8 *2* (1971Da14).

Continued on next page (footnotes at end of table)

^{24}Mg(t,α),(t,$\alpha\gamma$) 1970Po08,1971Da14,1976Sh03 (continued)

$\gamma(^{23}Na)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[#]	E_f	J^π_f	Mult.[‡]	δ[#]	Comments
2392	1/2+	311	<2	2081	7/2+			
		1954	34 3	438	5/2+			I_γ: Wt. ave. of 36 4 (1970Po08) and 33 3 (1971Da14).
		2392	66 3	0	3/2+			I_γ: Wt. ave. of 64 4 (1970Po08) and 67 3 (1971Da14).
2641	1/2−	2641	100	0	3/2+			
2706	9/2+	314	<6	2392	1/2+			
		625	38 4	2081	7/2+			A_2=−0.30 6; A_4=+0.09 9 (1970Po08)
		2268	62 4	438	5/2+	Q(+O)	−0.01 3	A_2=+0.43 3; A_4=−0.27 6 (1970Po08)
		2706	<2	0	3/2+			
2984	3/2+	343	<6	2641	1/2−			
		592	<1	2392	1/2+			
		903	<4	2081	7/2+			
		2546	42 2	438	5/2+	D+Q	−0.05 7	A_2=−0.03 7; A_4=−0.06 11 (1970Po08) I_γ: Wt. ave. of 41 4 (1970Po08) and 42 2 (1971Da14). δ: Other value −0.07 21 (1970Po08).
		2984	58 2	0	3/2+	D+Q	+0.03 6	A_2=+0.44 3; A_4=−0.02 4 (1970Po08) I_γ: Wt. ave. of 59 2 (1970Po08) and 58 2 (1971Da14). δ: Other value +0.30 6 or +3.5 8 (1971Da14).
3680	3/2−	1039	18 1	2641	1/2−	D+Q	−0.11 6	A_2=−0.65 6; A_4=−0.02 7 (1970Po08) I_γ: Wt. ave. of 19 4 (1970Po08) and 18 1 (1971Da14).
		1288	2 1	2392	1/2+			I_γ: From 1970Po08. Same value in 1971Da14.
		1599	<3	2081	7/2+			
		3242	76 2	438	5/2+	D+Q	−0.01 5	A_2=−0.08 3; A_4=−0.01 3 (1970Po08) I_γ: Wt. ave. of 77 4 (1970Po08) and 76 2 (1971Da14).
		3680	4 1	0	3/2+			I_γ: From 1971Da14 to satisfy $\sum I\gamma$=100 from this level. Other: 2 1 (1970Po08).
3851	5/2−	1770	50	2081	7/2+			
		3851	50	0	3/2+			
3916	5/2+	236	<2	3680	3/2−			
		932	2 1	2984	3/2+			
		1210	<4	2706	9/2+			
		1275	<4	2641	1/2−			
		1524	<4	2392	1/2+			
		1835	11 3	2081	7/2+	D(+Q)	+0.12 12	A_2=−0.32 8; A_4=−0.04 8 (1970Po08)
		3478	6 3	438	5/2+			
		3916	81 4	0	3/2+	D+Q	+0.22 3	A_2=+0.07 2; A_4=+0.02 2 (1970Po08)
4436	1/2+	2044	7 3	2392	1/2+			I_γ: Other value 5 (1970Po08).
		4436	93 3	0	3/2+			I_γ: Other value 95 (1970Po08).
4778	7/2+	862	<3	3916	5/2+			
		1098	<3	3680	3/2−			
		1794	<5	2984	3/2+			
		2072	15 4	2706	9/2+			
		2137	<6	2641	1/2−			
		2386	<2	2392	1/2+			
		2697	28 5	2081	7/2+	D(+Q)	−0.06 12	A_2=+0.42 5; A_4=−0.01 7 (1970Po08) I_γ: Other value 26 4 (1971Da14).
		4340	57 4	438	5/2+	D+Q	+0.15 4	A_2=−0.05 2; A_4=+0.00 3 (1970Po08) I_γ: Other value 74 4 (1971Da14).
5383	3/2+,5/2+	1467	<2	3916	5/2+			
		1703	<10	3680	3/2−			
		2399	<5	2984	3/2+			
		2677	<3	2706	9/2+			
		2742	<2	2641	1/2−			
		2991	<2	2392	1/2+			
		3302	29 2	2081	7/2+	D+Q	−0.19 12	A_2=+0.05 7; A_4=−0.01 8 (1970Po08) A_2=−0.17 12, A_4=−0.15 16 (1971Da14).

Continued on next page (footnotes at end of table)

^{24}Mg(t,α),(t,$\alpha\gamma$) 1970Po08,1971Da14,1976Sh03 (continued)

γ(^{23}Na) (continued)

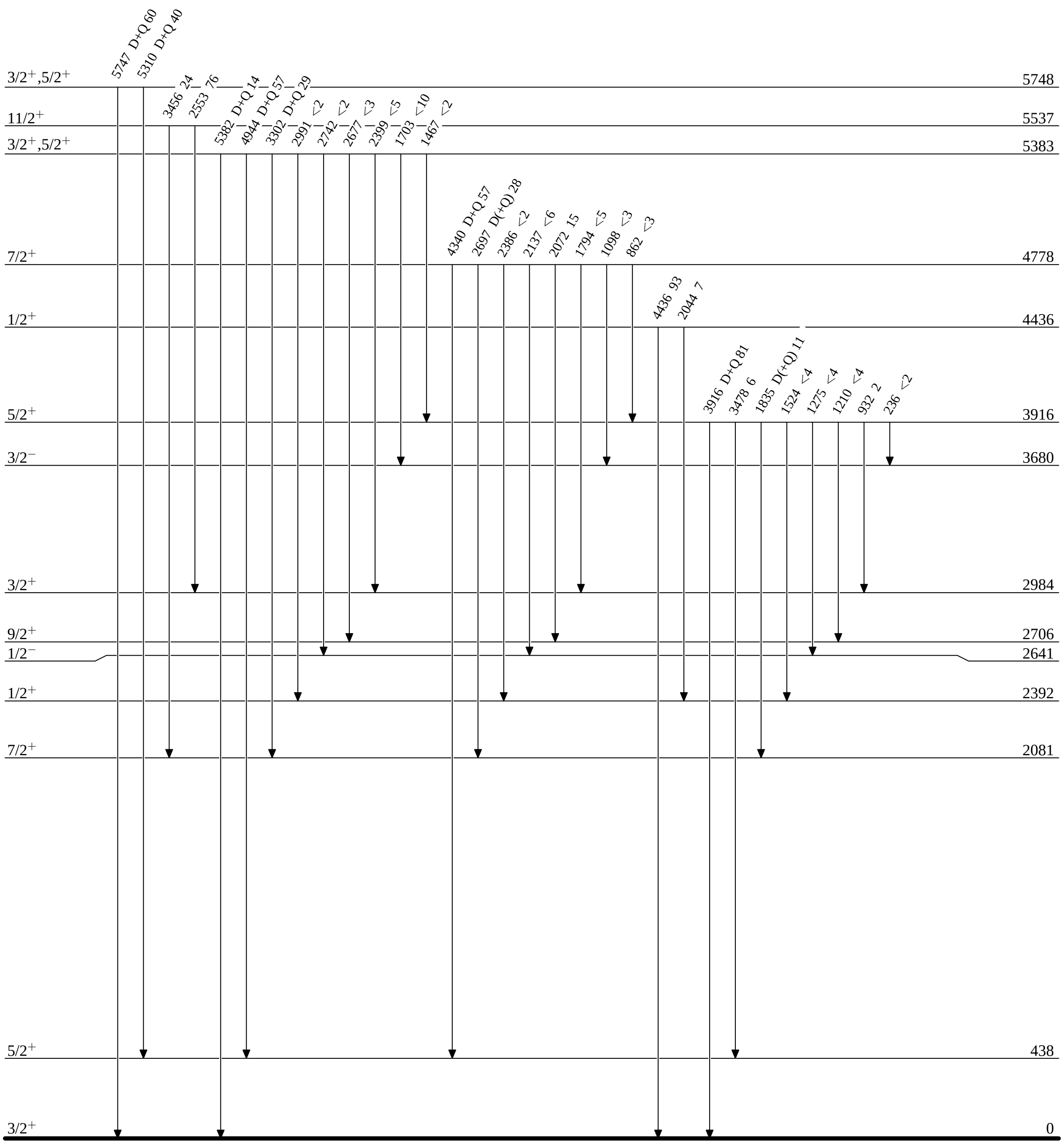
E_i(level)	J^π_i	E_γ†	I_γ#	E_f	J^π_f	Mult.‡	δ#	Comments
								I_γ: Wt. ave. of 23 *5* (1970Po08) and 30 *2* (1971Da14). δ: Other value +0.03 *8* for 5/2 or <−8 for 3/2 (1971Da14).
5383	3/2$^+$,5/2$^+$	4944	57 *2*	438	5/2$^+$	D+Q	−0.10 *4*	A_2=+0.24 *3*; A_4=+0.00 *4* (1970Po08) I_γ: Wt. ave. of 63 *7* (1970Po08) and 57 *2* (1971Da14). δ: Average of −0.16 *7* (1970Po08) and −0.08 *4* for 5/2 (1971Da14).
		5382	14 *1*	0	3/2$^+$	D+Q	+0.04 *4*	A_2=−0.32 *9*; A_4=0.12 *14* (1971Da14) δ: From 1971Da14 for 5/2, or −3.0 *8* for 3/2. I_γ: Unweighted ave. of 14 *4* (1970Po08) and 13 *1* (1971Da14) to satisfy $\sum$=100 from this level.
5537	11/2$^+$	2553	76	2984	3/2$^+$			E_γ: Not observed by others and appears to be a (11/2)$^+$ to 3/2$^+$ transition, not adopted.
		3456	24	2081	7/2$^+$			
5748	3/2$^+$,5/2$^+$	5310	40 *10*	438	5/2$^+$	D+Q	−0.19 *12*	A_2=+0.21 *4*; A_4=+0.07 *6* (1970Po08)
		5747	60 *10*	0	3/2$^+$	D+Q	+0.30 *14*	A_2=+0.20 *9*; A_4=−0.01 *14* (1970Po08)

† From level energy differences, recoil energy subtracted and rounded to nearest keV.
‡ From γ-ray angular correlation coefficients (1970Po08, 1971Da14) by evaluators.
# From 1970Po08, except as noted.

$^{24}Mg(t,\alpha),(t,\alpha\gamma)$ 1970Po08,1971Da14,1976Sh03

Level Scheme

Intensities: % photon branching from each level

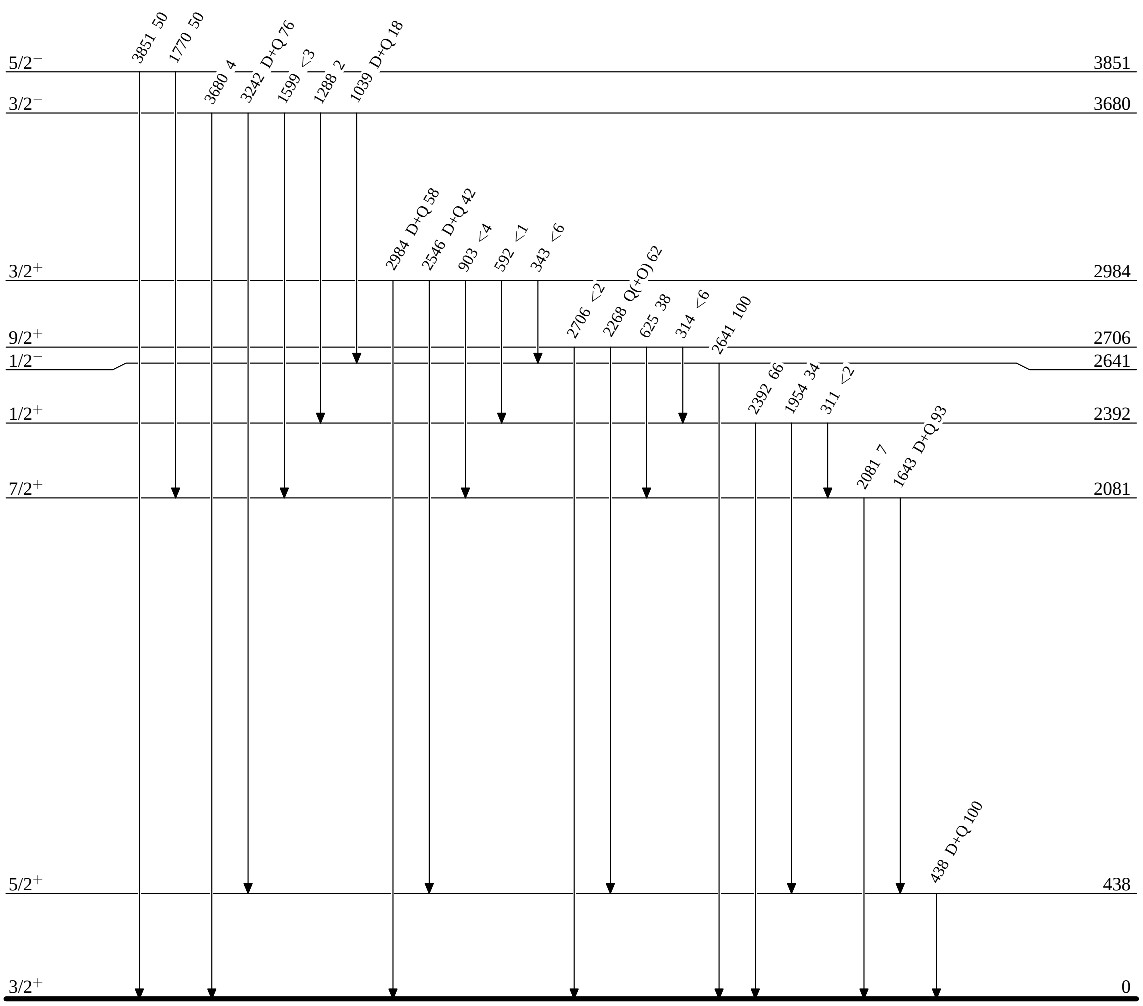


$^{23}_{11}Na_{12}$

^{24}Mg(t,α),(t,$\alpha\gamma$) 1970Po08,1971Da14,1976Sh03

Level Scheme (continued)

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{25}Mg(d,α) 1978Po03,1967Ha17,1967Du02

Other references: 1974Ta03, 1969Ho08, 1969Bo30, 1968Ne08, 1967Wa15, 1967Du02, 1966Ja05, 1965Go03.
$J^\pi(^{25}Mg)=5/2^+$.
1978Po03: ^{25}Mg(d,α) E=12.07,11.82,11.57 MeV. Measured $\sigma(E_\alpha)$ Measured integrated σ.
1967Ha17: ^{25}Mg(d,α) E=8,10 MeV. Measured $\sigma(E_\alpha)$. Deduced excited level energies.
1967Du02: ^{25}Mg(d,α) E=10 MeV. 93% enriched target. Measured α particle energy spectrum; Deduced excited level energies.

^{23}Na Levels

E(level)[†]	J^π[#]	Average σ[&]	Comments
0	3/2$^+$	124 *4*	σ/(2J+1)=31.0 μb *10* (1978Po03).
438 *3*	5/2$^+$	191 *13*	E(level): Other: 438 *6* (1967Du02). σ/(2J+1)=31.8 μb *22* (1978Po03).
2076 *3*	7/2$^+$	231 *15*	E(level): Other: 2079 *8* (1967Du02). σ/(2J+1)=28.9 μb *19* (1978Po03).
2395 *4*	1/2$^+$	36 *4*	E(level): Other: 2393 *8* (1967Du02). σ/(2J+1)=18.0 μb *20* (1978Po03).
2643 *5*	1/2$^-$	44 *3*	E(level): Other: 2640 *10* (1967Du02). σ/(2J+1)=22.0 μb *15* (1978Po03).
2707 *5*	9/2$^+$	245 *8*	E(level): Other: 2705 *8* (1967Du02). σ/(2J+1)=24.5 μb *8* (1978Po03).
2983 *5*	3/2$^+$	113 *4*	E(level): Other: 2988 *8* (1967Du02). σ/(2J+1)=28.2 μb *10* (1978Po03). J^π: 5/2 in 1969Bo30.
3678 *3*	3/2$^-$	76 *6*	E(level): Other: 3681 *10* (1967Du02). σ/(2J+1)=19.0 μb *15* (1978Po03).
3849 *3*	5/2$^-$	174 *6*	E(level): Other: 3851 *12* (1967Du02). σ/(2J+1)=29.0 μb *10* (1978Po03).
3915 *3*	5/2$^+$	124 *7*	E(level): Other: 3951 *12* (1967Du02). σ/(2J+1)=20.7 μb *12* (1978Po03).
4431 *4*	1/2$^+$	51 *3*	E(level): Other: 4433 *12* (1967Du02). σ/(2J+1)=25.5 μb *15* (1978Po03).
4774 *5*	7/2$^+$	169 *4*	E(level): Other: 4772 *12* (1967Du02). σ/(2J+1)=21.1 μb *5* (1978Po03).
5380 *4*	5/2[@]	149 *8*	E(level): Other: 5380 *15* (1967Du02).
5535 *3*	11/2$^+$	264 *4*	E(level): Other: 5535 *12* (1967Du02). σ/(2J+1)=22.0 μb *10* (1978Po03).
5742 *3*			E(level): Other: 5741 *20* (1967Du02).
5762 *6*	7/2,(3/2,9/2)[@]	225 *8*	E(level): Other: 5759 *20* (1967Du02).
5776 *6*			E(level): Other: 5779 *20* (1967Du02).
5928 *3*	5/2,7/2[@]	167 *7*	E(level): Other: 5930 *15* (1967Du02).
5964 *3*	1/2[@]	63 *5*	E(level): Other: 5965 *15* (1967Du02).
6042 *3*	5/2,7/2[@]	167 *7*	E(level): Other: 6046 *12* (1967Du02).
6115 *2*		480 *27*	E(level): Other: 6114 *12* (1967Du02). J^π: 15/2 to 23/2 (1978Po03).
6193 *4*	3/2,5/2[@]	114 *9*	E(level): Other: 6194 *15* (1967Du02).
6234 *3*	(13/2$^+$)	273 *19*	E(level): Other: 6236 *15* (1967Du02). σ/(2J+1)=19.5 μb *14* (1978Po03).
6308 *4*	1/2$^+$	65 *7*	E(level): Other: 6311 *20* (1967Du02). σ/(2J+1)=32.5 μb *35* (1978Po03).
6351 *3*		344 *4*	E(level): Other: 6347 *15* (1967Du02). J^π: 11/2 to 15/2 (1978Po03).
6577 *5*	5/2,7/2,9/2[@]	188 *15*	E(level): Other: 6583 *12* (1967Du02).
6619 *5*	5/2,(7/2)[@]	152 *6*	E(level): Other: 6621 *15* (1967Du02).
6737 *3*	3/2[@]	93 *2*	E(level): Other: 6738 *15* (1967Du02).

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^{25}Mg(d,α) 1978Po03,1967Ha17,1967Du02 (continued)

^{23}Na Levels (continued)

E(level)†	J$^{\pi}$#	Average σ&	Comments
6820 *3*	3/2,5/2@	127 *4*	E(level): Other: 6825 *15* (1967Du02).
6868 *3*	5/2@	181 *18*	E(level): Other: 6870 *15* (1967Du02).
6917 *5*	3/2@	73 *2*	E(level): Other: 6913 *20* (1967Du02).
6947 *3*	3/2@	74 *6*	E(level): Other: 6944 *20* (1967Du02).
7069 *4*		200 *14*	Average σ: For doublet (1978Po03).
7080 *4*			E(level): Other: 7077 *15* (1967Du02).
7131 *3*		384 *28*	E(level): Other: 7131 *15* (1967Du02). Average σ: For doublet (1978Po03).
7150 *3*			
7187 *3*		164 *9*	E(level): Other: 7188 *15* (1967Du02).
7271 *3*		385 *11*	E(level): Other: 7272 *15* (1967Du02).
7386 *5*		383 *20*	E(level): Other: 7394 *20* (1967Du02). Average σ: For doublet (1978Po03).
7403 *6*			E(level): Other: 7409 *20* (1967Du02).
7448 *4*	3/2,5/2@	125 *8*	E(level): Other: 7448 *15* (1967Du02).
7482 *5*	1/2@	30 *5*	E(level): Other: 7481 *20* (1967Du02).
7568 *3*	3/2@	97 *9*	E(level): Other: 7565 *20* (1967Du02).
7689 *4*	5/2,7/2@	167 *16*	E(level): Other: 7686 *15* (1967Du02).
7718 *8*	1/2@	35 *4*	E(level): Other: 7713 *25* (1967Du02).
7759 *3*	5/2,(3/2)@	138 *11*	E(level): Other: 7746 *15* (1967Du02).
7842 *3*		312 *21*	J$^{\pi}$: 9/2 to 15/2 (1978Po03).
7873 *7*		216 *9*	E(level): Other: 7882 *3* (1978Po03) – possible doublet in comparison to the energies of Adopted Levels. Average σ: For doublet (1978Po03).
7961 *8*			
7983 *8*			
8057 *7*			
8100 *9*			
8123 *10*			
8151 *10*			
8177 *10*			
8220 *10*			
8251 *8*			
8320 *8*			
8357 *8*			
8413 *8*			
8469 *8*			
8501 *8*			
8555 *8*			
8605 *8*			
8643 *7*			
8715 *10*			E(level): Possible doublet.
8796 *9*			
8819 *10*			
8942 *10*			
8965 *10*			
9037 *9*			
9071 *9*			
9104 *10*			
9170 *9*			
9210 *9*			
9280?‡ *11*			
9320?‡ *11*			
9400 *9*			

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^{25}Mg(d,α) 1978Po03,1967Ha17,1967Du02 (continued)

^{23}Na Levels (continued)

E(level)[†]	E(level)[†]	E(level)[†]
9425 *10*	9537?[‡] *11*	9675?[‡] *11*
9478 *10*	9629?[‡] *11*	9732?[‡] *11*
		9802?[‡] *11*

[†] From 1978Po03 for energies up to 7842 keV, and above from 1967Ha17.
[‡] Observed at one angle only (1967Ha17).
[#] From Adopted Levels, except where otherwise noted.
[@] From 1978Po03, based on measured cross sections and the proportionality established in their work, i.e. σ/(2J+1)σ=25 μb *5*.
[&] In units of μb (1978Po03).

^{26}Mg(p,$\alpha\gamma$) 1972Li02,1966Po06

Other references: 1967Ri04, 1971Ph01, 1974Pr12, 1987Do06.

1972LI02: ^{26}Mg(p,$\alpha\gamma$) E=14.25 MeV. Measured $\alpha\gamma(\theta)$, p$\gamma(\theta)$, Iγ, multigap magnetic spectrometer, NaI(Tl). Also limited data for ^{23}Na(α,$\alpha\gamma$).

1966Po06: 95% enriched ^{26}Mg metallic target, E_p=9.3-10.5 MeV; α particle were detected by annular surface barrier and γ by NaI detectors. Measured α-γ coincidence, angular correlations, deduced excited level spin, multipole mixing ratio of γ transitions.

All data from 1972Li02, except otherwise noted.

^{23}Na Levels

E(level)	J$^{\pi}$†	Comments
0	3/2	
440 *2*	5/2	
2077 *2*	7/2	
2391 *2*	1/2	
2640 *2*	1/2	
2703 *2*	9/2	
2981 *2*	3/2,(5/2)	
3679 *3*	3/2	
3851 *4*	5/2	J$^{\pi}$: From transition strength analysis (1972Li02).
3912 *4*	5/2	
4430 *6*		
4775 *6*	5/2,7/2	
5380 *6*	3/2,5/2	
5538 *9*	11/2	
5740 *7*	5/2,3/2	
5926 *6*		
5967 *5*		
6043 *5*		
6124 *10*		
6200 *7*		
6238 *7*	(13/2,9/2)	
6311 *5*	1/2	
6356 *9*		
6584 *5*	9/2,5/2	

† From γ ray angular correlation studies (1972Li02), except where otherwise noted.

γ(^{23}Na)

E_i(level)	J_i^{π}	E_γ†	I_γ	E_f	J_f^{π}	Mult.‡	δ	Comments
440	5/2	440	100	0	3/2	D+Q	+0.09 *1*	A_2=−0.21 *2*; A_4=+0.06 *3* A_2=−0.229 *15*; A_4=+0.004 *3* (1966Po06) δ: Other: +0.08 *2* (1966Po06).
2077	7/2	1637	90 *2*	440	5/2	D+Q	+0.22 *2*	A_2=+0.10 *2*; A_4=+0.02 *3* A_2=+0.06 *4*; A_4=+0.03 *7* (1966Po06) I_γ: Other: 91 *2* (1966Po06). δ: Other: +0.20 *3* for 7/2 and −0.14 *8* for (3/2) (1966Po06).
		2077	10 *2*	0	3/2	Q+O	−0.14 *11*	A_2=−0.27 *8*; A_4=−0.51 *12* I_γ: Other: 9 *2* (1966Po06).
2391	1/2	1951	37 *3*	440	5/2			A_2=−0.06 *6*; A_4=−0.04 *9* (1966Po06) I_γ: Wt. ave. of 39 *3* (1972Li02) and 33 *4* (1966Po06).
		2391	63 *3*	0	3/2			A_2=+0.08 *6*; A_4=−0.03 *6* (1966Po06) I_γ: Wt. ave. of 61 *3* (1972Li02) and 67 *4* (1966Po06).

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^{26}Mg(p,$\alpha\gamma$) 1972Li02,1966Po06 (continued)

γ(^{23}Na) (continued)

E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Mult.‡	δ	Comments
2640	1/2	2640	100	0	3/2			A_2=+0.03 2; A_4=+0.01 2 (1972Li02) A_2=+0.00 3; A_4=−0.02 5 (1966Po06)
2703	9/2	626	35 2	2077	7/2	D+Q	+0.10 2	A_2=−0.14 4; A_4=+0.10 6 A_2=−0.09 9; A_4=−0.02 2 (1966Po06) I_γ: Wt. ave. of 37 2 (1972Li02) and 32 2 (1966Po06). δ: Other: +0.12 4 (1966Po06) for 9/2.
		2263	65 2	440	5/2	Q(+O)	−0.04 7	A_2=+0.53 10; A_4=−0.32 17 A_2=+0.41 9; A_4=−0.34 13 (1966Po06) I_γ: Wt. ave. of 63 2 (1972Li02) and 68 2 (1966Po06). δ: Wt. ave. of −0.02 13 (1972Li02) and −0.05 7 (1966Po06) for 9/2.
2981	3/2,(5/2)	2541	45 2	440	5/2	D+Q	−0.05 5	A_2=+0.06 4; A_4=−0.11 7 A_2=+0.22 20; A_4=+0.33 30 (1966Po06) I_γ: Other: 40 5 (1966Po06). δ: Others: −0.3 3 or −3 2 for 3/2 (1966Po06).
		2981	55 2	0	3/2	D(+Q)	−0.01 2	A_2=+0.35 2; A_4=−0.06 4 A_2=+0.52 6; A_4=−0.01 10 (1966Po06) I_γ: Other: 60 5 (1966Po06). δ: Others: +0.11 5 or +2.7 4 for 3/2 and +0.54 11 for (5/2) (1966Po06). The other higher value of −4.1 7 in 1972Li02 can be rejected on the basis of unlikely high quadrupole transition strength.
3679	3/2	1039	14 2	2640	1/2	D+Q	−0.22 10	A_2=−0.77 5; A_4=−0.06 8
		1288	2 1	2391	1/2			
		3239	81 2	440	5/2	D(+Q)	−0.02 6	A_2=−0.07 2; A_4=−0.10 3
		3679	3 2	0	3/2			
3851	5/2	1211	7 2	2640	1/2			
		1774	53 6	2077	7/2	D(+Q)	−0.02 5	A_2=−0.13 4; A_4=+0.08 7
		3411	17 5	440	5/2	D+Q	−0.21 14	A_2=−0.05 4; A_4=−0.11 7
		3851	23 5	0	3/2			
3912	5/2	931		2981	3/2,(5/2)			
		1835		2077	7/2			
		3472		440	5/2			
		3912		0	3/2			
4430		4430	100	0	3/2			
4775	5/2,7/2	2072	15 2	2703	9/2			
		2698	25 2	2077	7/2	D(+Q)	−0.01 16	A_2=+0.44 9; A_4=−0.24 14 δ: −0.01 16 or +1.2 4 for 7/2, and −0.06 3 for 5/2 (1972Li02). Larger value +1.2 4 rejected by the evaluators for RUL using data in the adopted dataset.
		4335	54 2	440	5/2	D+Q	+0.19 3	A_2=+0.02 3; A_4=+0.03 4 δ: +0.19 3 for 7/2, −0.37 3 for 5/2 (1972Li02).
		4774	6 2	0	3/2			
5380	3/2,5/2	3303	25 2	2077	7/2	D+Q	+0.15 8	A_2=−0.12 6; A_4=−0.08 9 δ: +0.15 8 for 5/2, and −0.10 5 or −2.00 3 for 3/2 (1972Li02).
		4939	63 2	440	5/2	D+Q	−0.27 5	A_2=+0.14 3; A_4=−0.05 5 δ: −0.27 15 for 5/2, and −0.23 6 or −2.1 3 for 3/2 (1972Li02).
		5379	12 2	0	3/2	D+Q	−0.05 5	A_2=−0.54 12; A_4=+0.23 18 δ: −0.05 15 for 5/2, and 0.6 $\leq\delta\leq$ 3.2 for 3/2 (1972Li02).
5538	11/2	2835	76 6	2703	9/2	D+Q	+0.17 3	A_2=+0.6 4; A_4=−0.04 6
		3461	24 5	2077	7/2	Q(+O)	−0.06 20	A_2=−0.45 13; A_4=−0.45 31

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^{26}Mg(p,$\alpha\gamma$) 1972Li02,1966Po06 (continued)

$\gamma(^{23}$Na) (continued)

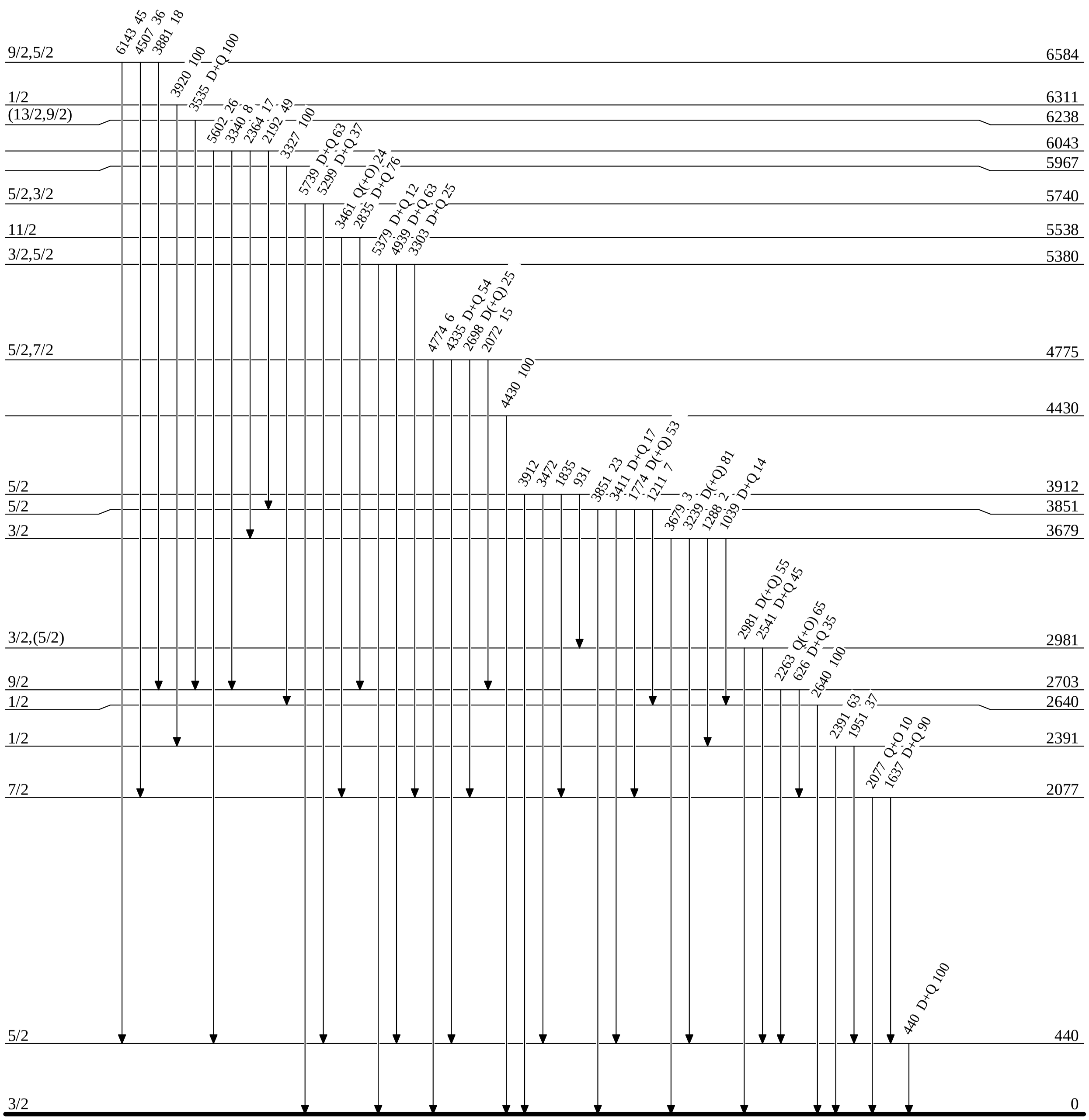
E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Mult.‡	δ	Comments
5740	5/2,3/2	5299	37 *2*	440	5/2	D+Q	−0.7 *9*	A_2=+0.23 *7*; A_4=−0.21 *11* δ: −0.7 *9* or 3.0 ≤δ≤ 59 for 5/2, and −0.38 *20* or −1.7 *6* for 3/2 (1972Li02).
		5739	63 *2*	0	3/2	D+Q	+0.21 *3*	A_2=+0.02 *5*; A_4=+0.11 *7* δ: +0.21 *3* for 5/2, and −0.25 *5* for 3/2 (1972Li02).
5967		3327	100	2640	1/2			I_γ: (100) in 1972Li02.
6043		2192	49 *8*	3851	5/2			
		2364	17 *10*	3679	3/2			I_γ: (17±10) in 1972Li02.
		3340	8 *3*	2703	9/2			I_γ: (8±3) in 1972Li02.
		5602	26 *4*	440	5/2			
6238	(13/2,9/2)	3535	100	2703	9/2	D+Q		A_2=+0.20 *8*; A_4=−0.38 *13* I_γ: (100) in 1972Li02. δ: δ=−0.15 14 for 13/2 or +1.6 5 for 9/2 (1972Li02).
6311	1/2	3920	100	2391	1/2			A_2=−0.02 *5*; A_4=+0.05 *8* I_γ: (100) in 1972Li02.
6584	9/2,5/2	3881	18 *3*	2703	9/2			
		4507	36 *3*	2077	7/2			A_2=−0.59 *9*; A_4=−0.29 *13* δ: δ=+0.44 14 for 5/2 or +0.13 7 for 9/2.
		6143	45 *4*	440	5/2			A_2=+0.30 *7*; A_4=−0.34 *9* δ: δ=+2.6 4 for D+Q from 5/2 or −0.10 4 for Q+O from 9/2.

† From level energy difference. Recoil energy subtracted and rounded to nearest keV.
‡ Based on angular distribution coefficients (1972Li02) − assigned by evaluators.

^{26}**Mg(p,$\alpha\gamma$) 1972Li02,1966Po06**

Level Scheme

Intensities: % photon branching from each level



$^{23}_{11}Na_{12}$

^{27}Al(d,^{6}Li) 1981Ve13

$J^{\pi}(^{27}Al)=5/2^{+}$.

Self-supporting metallic ^{27}Al target (thickness ~80 μg/cm^2) bombarded by 55 MeV deuteron; Outgoing ^{6}Li ions were detected and analyzed with a QMG/2 magnetic spectrograph; Measured differential cross section $\sigma(E(^{6}Li),\theta)$ from 10° to 37° (Lab). Deduced excited level energies, spectroscopic factor. DWBA analysis. FWHM ~40 MeV.

^{23}Na Levels

Maximum differential cross section $(d\sigma/d\Omega')_{max}$ in unit of μb/sr listed in comments section.

E(level)[†]	Jπ[a]	L[b]	S[b]	Comments
0.0	3/2+	2	0.59 *7*	S: 0.42 *11* (FR) for L=2; 0.39 *8* (ZR)) and 0.90 *18* (FR) for L=4. 2.8 μb/sr.
440[‡]	5/2+	0	1.00 *13*	S: 1.00 *14* (FR) for L=0; 1.43 *12* (ZR)); 1.80 *27* (FR) for L=2; 0.55 *18* (ZR) 0.26 *29* (FR) for L=4. 12 μb/sr.
2079 *7*	7/2+	2	0.33 *6*	S: 0.25 *6* (ZR) and 0.52 *10* (FR) for L=4; 0.86 *28* for L=6. 1.5 μb/sr.
2388 *15*	1/2+	2	0.12	S: 0.10 (FR) for L=2. 0.4 μb/sr.
2640[@] *20*	1/2−	3	0.58	S: 0.94 (FR) for L=3. 1.4 μb/sr.
2706[‡]	9/2+	2	0.76 *7*	S: 1.02 *9* (ZR) and 1.97 *14* (FR) for L=4; 1.09 *37* (FR) for L=6. 4.5 μb/sr.
2970 *20*	3/2+			E(level): 2.97 MeV *20* in 1981Ve13. 0.2 μb/sr.
3680 *7*	3/2−	1	0.17 *15*	S: 0.18 *21* (FR) for L=1; 0.76 *20* (ZR) and 1.14 *31* (FR) for L=3. 2.0 μb/sr.
3863 *7*	5/2−	1	0.35 *24*	S: 0.74 *21* (FR) for L=1; 0.49 *23* (ZR) and 0.31 *34* (FR) for L=3; 0.1 *6* (ZR) for L=5. 2.2 μb/sr.
3922 *7*	5/2+	0	0.01 *8*	S: 0.02 *5* (FR) for L=0; 0.33 *10* (ZR) and 0.36 *14* (FR) for L=2; 0.21 *15* (ZR) and 0.08 *21* (FR) for L=4. 1.8 μb/sr.
4439 *15*	1/2+	2	0.17	S: 0.14 (FR) for L=2. 0.5 μb/sr.
4779 *7*	7/2+	2	0.15 *4*	S: 0.16 *7* (FR) for L=2; 0.17 *5* (ZR) and 0.13 *12* (FR) for L=4. 1.1 μb/sr.
5378 *7*	5/2+	2	0.28 *5*	S: 0.26 *6* (FR) for L=2; 0.11 *5* (ZR) and 0.04 *11* (FR) for L=4. 1.3 μb/sr.
5532 *10*	11/2+	4	0.00 *4*	S: 0.09 *5* (FR) for L=4; 0.96 *27* (ZR) and 1.09 *28* (FR) for L=6; 2.8 *14* (ZR) for L=8. 0.8 μb/sr.
5748[&] *7*				2.8 μb/sr.
5910[@] *20*				0.4 μb/sr.
5950[@] *20*				0.8 μb/sr.
6038 *7*				1.3 μb/sr.
6111 *7*	(11/2)+	4	0.35 *6*	S: 0.63 (FR) for L=4; 0.63 *20* (ZR) for L=6. 1.4 μb/sr.
6233 *7*	(13/2+)	4	0.10 *6*	S: 0.31 *8* (FR) for L=4; 2.20 *34* (ZR) and 1.69 *31* (FR) for L=6; 2.8 *27* (ZR) for L=8. 1.6 μb/sr.
6349 *7*	9/2−	3	0.08 *15*	S: 0.63 *19* (FR) for L=3; 1.87 *53* (ZR) and 2.46 *97* (FR) for L=5; 11.7 *35* (ZR) and 1.3 *80* (FR) for L=7. 1.9 μb/sr.
6577 *15*				0.5 μb/sr.
6602 *10*				1.0 μb/sr.
6830[#] *20*				1.0 μb/sr.

Continued on next page (footnotes at end of table)

^{27}Al(d,^{6}Li) 1981Ve13 (continued)

^{23}Na Levels (continued)

E(level)[†]	L[b]	S[b]	Comments
7070[#] *20*			0.4 μb/sr.
7120[#] *20*			1.3 μb/sr.
7176[&] *7*	3	3.65	S: 3.71 (FR) for L=3. 6.3 μb/sr.
7250[#] *20*			0.6 μb/sr.
7387 *10*			1.6 μb/sr.
7850[#] *20*			2.7 μb/sr.
7970[#] *20*			0.6 μb/sr.
8060[#] *20*			0.6 μb/sr.
8335 *10*			1.3 μb/sr.
8480 *20*			0.5 μb/sr.
8540[@] *20*			0.4 μb/sr.
8628 *10*			0.8 μb/sr.
8705 *10*			0.5 μb/sr.
8794 *10*			1.0 μb/sr.
8941 *10*			0.2 μb/sr.
9058[&] *15*			1.9 μb/sr.
9201 *15*			1.3 μb/sr.
9280[@] *20*			0.6 μb/sr.
9382[&] *10*			0.9 μb/sr.

[†] From 1981Ve13.
[‡] Used for calibration.
[#] Listed in 100th of an MeV, appears to be a typo considering the doublet indicated by a curly bracket with the overlapping literature data in Table 6. Assuming in 1000th – evaluators list level energy in keV. The assumption reduces the uncertainty by a digit.
[@] Listed in 100th of an MeV. Based on the absence of a curly bracket, which authors used to indicate a doublet compared with the literature data, the evaluators considers in 1000th of an MeV and list in keV. The assumption reduces the uncertainty of the level energy by a digit.
[&] Doublet (1981Ve13).
[a] From Adopted Levels.
[b] Relative spectroscopic factor from contributions of different L-transfer with zero-range (ZR) and finite-range (FR) DWBA calculations.

^{150}Nd(^{26}Mg,^{23}Naγ) 2005Ke08,2005Ke11

2005Ke08,2005Ke11: ^{26}Mg beam, E=160 MeV, bombarded onto a ^{150}Nd target of thickness 0.4 mg/cm^2, 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 Eγ, $\gamma\gamma$ coin, deduced level scheme.

^{23}Na Levels

E(level)†	J$^\pi$‡
0.0	3/2$^+$
440	5/2$^+$
2076	7/2$^+$
2703	9/2$^+$
3678	3/2$^-$
5378	5/2$^+$
5533	11/2$^+$
6236	(13/2,9/2)$^+$

† From γ-ray energies.
‡ As listed in 2005Ke11.

γ(^{23}Na)

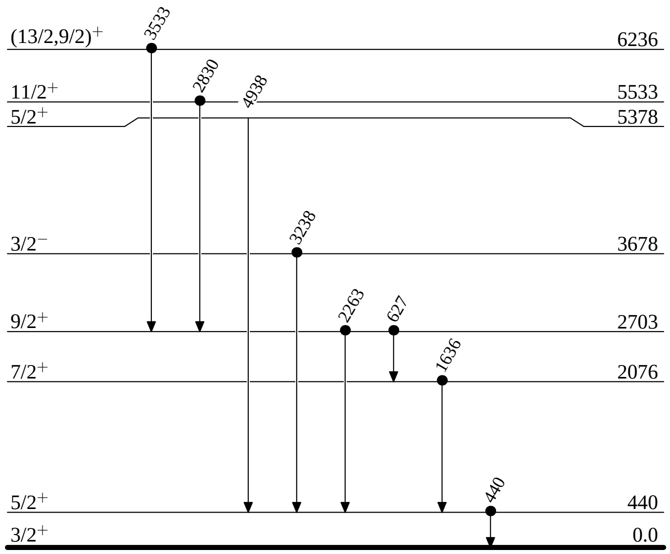
E$_\gamma$	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
440	440	5/2$^+$	0.0	3/2$^+$
627	2703	9/2$^+$	2076	7/2$^+$
1636	2076	7/2$^+$	440	5/2$^+$
2263	2703	9/2$^+$	440	5/2$^+$
2830	5533	11/2$^+$	2703	9/2$^+$
3238	3678	3/2$^-$	440	5/2$^+$
3533	6236	(13/2,9/2)$^+$	2703	9/2$^+$
4938	5378	5/2$^+$	440	5/2$^+$

^{150}Nd(^{26}Mg,^{23}Naγ) 2005Ke08,2005Ke11

Level Scheme

Legend

● Coincidence



$^{23}_{11}Na_{12}$

$^{20}Ne(^{7}Li,\alpha)$ **1984Fo14**

Target: Enriched ^{20}Ne in a gas cell with no entrance window; Projectile: ^{7}Li, E=22.0 MeV; outgoing α particles were momentum analyzed in a multiangle spectrograph and detected in nuclear emulsion plates. Mylar foil stopped all particles heavier than α's. Deduced excitation energy and differential cross section. FWHM ~50 keV.

^{23}Na Levels

E(level)[†]	$(d\sigma/d\Omega)_{max}$[@]	Comments
0.0		
2082 *7*	12.3	
2389 *2*	39.6	
2647 *8*	11.2	
2705 *6*	8.5	
2984 *2*	42.8	
3668 *5*	24.5	
3842 *7*	13.1	
3914 *5*	8.2	
4426 *3*	29.2	
4770 *3*	24.4	
5378 *2*		
5528 *6*	17.1	
5742[#] *4*	29.4	
5923 *10*	14.5	
5958 *14*	13.3	
6030 *8*	10.1	
6117 *6*	5.2	
6182 *10*	11.2	
6235 *6*	14.6	
6320[‡] *2*	67.4	
6588[‡] *10*	55.0	
6729 *12*	12.7	
6928[‡] *9*	275	
7079[‡] *13*	142	
7279[‡] *10*	33.4	
7463[‡] *8*	348	E(level): 1984Fo14 identify as doublet of 7448 and 7489 – there is one additional level 7477.4 within the range in Adopted dataset. Not referenced (XREF) in Adopted dataset.
7575 *7*	52.6	
7751 *10*	655	
7862 *10*	72.6	
8304 *10*	208	
8478 *8*	165	
8570 *14*	43.9	
8644 *11*	105	
8801[‡] *19*	37.4	
8965[‡] *10*	223	E(level): 1984Fo14 identify as doublet of 8945 and 8972 – but there is one additional level 8963.9 within the range in Adopted dataset. Not referenced (XREF) in Adopted dataset.
9024 *17*	37.4	
9107[‡] *14*	39.8	

[†] From 1984Fo14.
[‡] Doublet.
[#] Triplet (1984Fo14), not referenced in the Adopted Levels.
[@] In units of μb/sr.

Adopted Levels, Gammas

$Q(\beta^-)=-12221.6$ *4*; S(n)=13144.9 *4*; S(p)=7580.97 *23*; $Q(\alpha)=-9650.48$ *23* 2017Wa10
Other reaction: ^{20}Ne(^{3}He,γ): 1983Wa05 (E=3-19 MeV).

^{23}Mg Levels

Cross Reference (XREF) Flags

A	^{23}Al ε decay	F	^{12}C(^{16}O,αnγ)	K	^{24}Mg(d,t)
B	^{24}Si εp decay	G	^{22}Na(p,γ)	L	^{24}Mg(^{3}He,α)
C	^{1}H(^{22}Na,p):res	H	^{22}Na(^{3}He,d)	M	^{24}Mg(^{3}He,$\alpha\gamma$)
D	^{9}Be,C(^{22}Mg,^{23}Mgγ)	I	^{23}Na(^{3}He,t)	N	^{25}Mg(p,t)
E	^{12}C(^{12}C,nγ)	J	^{24}Mg(p,d),(pol p,d)		

E(level)[†]	J$^\pi$	T$_{1/2}$[b]	XREF	Comments
0.0[d]	3/2$^+$	11.3046 s *45*	AB DEFG IJKLMN	%ε+%β^+=100 $\mu=-0.5366$ *3*; Q=0.114 *3* δ<r^2>(^{26}Mg,^{23}Mg)=+0.053 fm^2 *6* (stat) *34* (syst) (2012Yo01). <r^2>$^{1/2}$=3.0428 fm *10* (stat) *61* (syst) (2012Yo01). Also <r^2>$^{1/2}$=2.96 fm *14* and 3.00 fm *19* (1998Su07). J$^\pi$: L=2 (pol p,d) and vector analyzing power ((p,d),(pol p,d) – 1986Mi01). T$_{1/2}$: Weighted average of 11.3027 s *33* (2017Ma18), 11.317 s *11* (1977Az01 – revised value 11.327 s *14* (1975Az01)), 11.41 s *5* (1968Go10), 11.36 s *4* (1974Al03), and 11.26 s *8* (1974Az01). Other: 12.1 s *1* (1958Mi85). μ: From 2017Yo05, 2019StZV – collinear laser spectroscopy. Other: 0.5364 *3* (βNMR – 1993Fu06). Q: From 1999Mb13, 2016St14 – βNMR. Other: 0.125 *5* (1996MaZV).
450.70[d] *15*	5/2$^+$[&]	1.15 ps *8*	AB DEFG IJKLMN	J$^\pi$: L=2 in (p,d) and vector analyzing power ((p,d),(pol p,d) – 1986Mi01). T$_{1/2}$: From τ=1.66 ps *12*: Wt. ave. of τ=1.57 ps *12* (1990Ti02) and 2.00 ps 24 (1973Wa26) – both in (^{12}C,nγ), τ=1.65 ps *25* (^{3}He,$\alpha\gamma$), and 3.6 ps *+91–24* (1971It02 – DSA).
2051.6[d] *4*	7/2$^+$	65[c] fs *12*	A DEFG JKLMN	J$^\pi$: L=4 and vector analyzing power in (^{3}He,α). T$_{1/2}$: Other: 21 fs *14* from τ=30 fs *20*, tabulated in earlier evaluations 1998En04 and 1990En08 by P.M. Endt – source missing.
2357.0 *7*	1/2$^+$	575[c] fs *118*	AB DE IJKLMN	J$^\pi$: L=0 in (p,d).
2714.5[d] *5*	9/2$^+$	65 fs *8*	DEFG KLMN	J$^\pi$: 9/2,5/2 proposed by 1970Ha02 (^{3}He,$\alpha\gamma$) from angular correlation studies of 2263γ. L=4 in (p,t) from 5/2$^+$. 9/2$^+$ in (^{22}Mg,^{23}Mgγ) from measurements and CCBA calculations. Band assignment. T$_{1/2}$: From τ=94 fs *12*: Wt. ave. of τ=91 fs *12* (1990Ti02) and 80 fs *20* (1973Wa26) – both in (^{12}C,nγ), and τ=140 fs *30* (^{3}He,$\alpha\gamma$).
2771.2[e] *7*	1/2$^-$	75[c] fs *10*	E JKLMN	J$^\pi$: L=1 and vector analyzing power in (p,d),(pol p,d).
2905.2 *7*	(3/2)$^+$	10.4[c] fs *21*	DE I LMN	J$^\pi$: L=2 in (pol p,d) and vector analyzing power (poorly resolved).
3794.1 *4*	3/2$^-$	28.4[c] fs *42*	E JKLMN	J$^\pi$: L=1 and vector analyzing power in (p,d),(pol p,d).
3860.6 *7*	3/2$^+$,5/2$^+$	8.3 fs *21*	E I KL N	J$^\pi$: L=2 in (^{3}He,α) and γ to 7/2$^+$.
3971.7[e] *6*	5/2$^-$	<14 ns	E JKLMN	J$^\pi$: L=3 in (p,t) and 5/2 from correlation studies in (^{3}He,α) 1970Ha02. T$_{1/2}$: Upper limit estimated from the coincidence resolving time

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Adopted Levels, Gammas (continued)

^{23}Mg Levels (continued)

E(level)[†]	J$^{\pi}$	$T_{1/2}$[b]	XREF	Comments
				in (^{3}He,$\alpha\gamma$) measurements (1970Ha02).
4356.4 *20*	1/2$^+$	<7.6[c] fs	IJKLMN	E(level): From (^{3}He,$\alpha\gamma$). J$^{\pi}$: L=0 in (p,d).
4681.5 *7*	(7/2)$^+$	6.9 fs *21*	E JKL N	J$^{\pi}$: M1+E2 to 9/2$^+$ and 5/2$^+$. L=2 in (p,t).
5287.5 *8*	3/2$^+$,5/2$^+$	3.5 fs *14*	E IJKLMN	J$^{\pi}$: L=2 in (p,d). $T_{1/2}$: Other: <9.7 fs (^{3}He,$\alpha\gamma$).
5453.7[d] *6*	(11/2)$^+$	<10.4[c] fs	EF JKLMN	J$^{\pi}$: L≥4 in (p,t) from 5/2$^+$ target implies ≥3/2$^+$; E2 γ to 7/2$^+$.
5658[@] *4*	5/2$^+$		I L N	J$^{\pi}$: L=0 in (p,t).
5690.7 *6*	(1/2 to 9/2)$^+$		E J L N	J$^{\pi}$: L=2 in (p,t).
5712[@] *8*	1/2$^+$,3/2$^+$,5/2$^+$		I L N	J$^{\pi}$: L=0 in (^{3}He,t) from 3/2$^+$ target.
5937.9 *7*	(11/2$^+$)		EF L N	J$^{\pi}$: D+Q γ to 9/2$^+$. Based on decay scheme and yrast/yrare band structure (^{16}O,αnγ).
5992.8 *9*	1/2$^-$,3/2$^-$		E J L N	J$^{\pi}$: L=1 in (p,d).
6129.3 *7*	(7/2$^-$)	12.5 fs *21*	E I L N	XREF: I(6138). J$^{\pi}$: 5677γ (E1) to 5/2$^+$, 2158γ (M1+E2) to 5/2$^-$.
6132.3 *13*	3/2$^+$,5/2$^+$		E J	XREF: J(6144). J$^{\pi}$: L=2 in (p,d).
6194.7[d] *7*	(13/2$^+$)	11.9 fs *21*	EF L N	J$^{\pi}$: 3480γ E2 to 9/2$^+$, 740γ M1+E2 to (11/2)$^+$.
6240.0 *11*	(9/2)$^+$	<27.7[c] fs	E H LMN	J$^{\pi}$: 4188γ D+Q to 7/2$^+$. L=2 in (p,t).
6246 *4*			J	
6372.5 *10*	(7/2$^+$)		E H LMN	J$^{\pi}$: 5921γ D+Q to 5/2$^+$.
6377.0 *11*	(7/2$^+$)	<31.2[c] fs	E	J$^{\pi}$: 4325γ to 7/2$^+$.
6391 *2*	(3/2$^+$,5/2$^+$)		J	J$^{\pi}$: L=2 in (p,d).
6447.5 *12*	(9/2$^-$)		E L N	J$^{\pi}$: 1766γ to (7/2$^+$).
6449.8[e] *6*	(9/2$^-$)	24.3 fs *55*	E	J$^{\pi}$: E1 to 7/2$^+$, E2 to 5/2$^-$, band assignment.
6513.6 *10*	(7/2)$^+$		E H L N	J$^{\pi}$: L=2 in (p,t), L=2+0 in (^{3}He,d) from 3$^+$, 6062γ D+Q to 5/2$^+$.
6540 *3*	3/2$^+$,5/2$^+$		HIJ L N	E(level): Unweighted average of data from (p,d), (p,t), (^{3}He,α), (^{3}He,t), and (^{3}He,d). J$^{\pi}$: L=2 in (p,d). Other: L=0 in (^{3}He,t) from 3/2$^+$ target.
6574.6 *10*	5/2$^+$		E H L N	J$^{\pi}$: L=0 in (p,t).
6775.4 *13*			E L N	
6803.9 *12*	3/2$^+$,5/2$^+$		E J l N	J$^{\pi}$: L=2 in (p,d). 5/2$^-$ in (^{12}C,nγ).
6804.6 *10*			E l N	J$^{\pi}$: (7/2$^+$) in (^{12}C,nγ).
6818 *3*	1/2$^+$,3/2$^+$,5/2$^+$		I l	J$^{\pi}$: L=0 in (^{3}He,t) from 3/2$^+$ target.
6908 *3*	5/2$^+$	<6.9[c] fs	HIJ LMN	E(level): From (^{3}He,$\alpha\gamma$). J$^{\pi}$: L=0 in (p,t).
6984 *5*	5/2$^+$		H L N	E(level): Weighted average of data from (p,t), (^{3}He,α), and (^{3}He,d). J$^{\pi}$: L=0 in (p,t).
7007 *5*	(3/2$^+$,5/2$^+$)		J	J$^{\pi}$: L=2 in (p,d).
7021.5 *8*	(9/2)$^+$		E H L N	J$^{\pi}$: L=2 in (p,t), 4969γ D+Q to 7/2$^+$.
7111.7 *10*	(3/2 to 11/2)$^+$		E HI L N	J$^{\pi}$: L=0+2 in (^{3}He,d) from 3$^+$ target; L=4 in (p,t) from 5/2$^+$ target. (7/2$^+$) in (^{12}C,nγ).
7145.2 *7*	(13/2$^+$)		EF l	J$^{\pi}$: γ to 9/2$^+$ and (11/2)$^+$ and (13/2$^+$) states.
7149.0 *8*	(5/2$^+$)		E J l N	XREF: J(7144). J$^{\pi}$: From L=2 in (p,d); L=0+2 in (p,t) from 5/2$^+$ target implies (5/2)$^+$; γ to 7/2$^+$ and 9/2$^+$ ((9/2$^+$) in (^{12}C,nγ)).
7228.5 *13*			E L N	
7260 *6*	(3/2$^+$,5/2$^+$)		J	J$^{\pi}$: L=2 in (p,d).
7261.9 *9*	(11/2$^+$)	1.4 fs *7*	E H L N	J$^{\pi}$: 4547γ M1+E2 to 9/2$^+$. $T_{1/2}$: From τ=2 fs *1* (2013Je04 – (^{12}C,nγ)).
7382.8 *10*	(7/2$^+$)		E N	J$^{\pi}$: 6931γ D+Q to 5/2$^+$.

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Adopted Levels, Gammas (continued)

^{23}Mg Levels (continued)

E(level)[†]	J^{π}	$T_{1/2}$[b]	XREF	Comments
7450.5 *8*	$(9/2)^+$	<9.7[c] fs	E IJ MN	J^{π}: 5399γ D+Q to $7/2^+$, 6998γ Q to $5/2^+$. L=2 in (p,t).
7497.2 *11*	$(9/2)^+$	<13.9[c] fs	E H MN	J^{π}: L=2 in (p,t), 5445γ to $(9/2^+)$.
7583 *6*	$5/2^+$[&]		H J L N	E(level): Weighted average of data from (p,t), (^{3}He,d), and (p,d),(pol p,d). J^{π}: L=0 in (p,t).
7624.4 *9*	$(9/2)^+$	2.8 fs *14*	E H J N	J^{π}: L=4 in (p,d), L=2 in (p,t), E2 γ to $5/2^+$.
7648 *3*	$3/2^+,5/2^+$		E H J L	XREF: H(7641)L(7635). J^{π}: L=2 in (p,d).
7770.4 *6*		1.4 fs *7*	E L	J^{π}: $(9/2^-)$ in (^{12}C,nγ). L=3 (preliminary) in (^{3}He,α) yields $5/2^-,7/2^-$.
7781.8 *9*	$(11/2^+)$	<0.7 fs	E H	J^{π}: E2 to $7/2^+$, γ to $9/2^+$.
7784.7 *8*	$3/2^+,5/2^+$	6.9 fs *21*	A E G J MN	J^{π}: L=2 in (p,d), 7333γ M1+E2 to $5/2^+$. L=4 in (p,t), $7/2^{(+)}$ in (^{12}C,nγ). $T_{1/2}$: Other: <8.3 fs (^{3}He,αγ).
7803.0 *6*	$5/2^+$		A HIJ L N	%p=0.17 *8* T=3/2 XREF: I(7790)L(7793). J^{π}: L=0 in (p,t).
7855.5 *7*	$(7/2^+)$		A E GHIJ L N	%p<100 J^{π}: L=4 (preliminary) in (^{3}He,α). log *ft*=5.2 from $5/2^+$ in ^{23}Al ε decay.
7918 *15*			A	
8015.6 *7*	(5/2,7/2)		A E GH j L N	%p<100 J^{π}: γ to $7/2^+$ and $9/2^+$; log *ft* 6.0 from $5/2^+$ in the ^{23}Al ε decay. (5/2 to 11/2) in (^{12}C,nγ).
8044 *4*			J	
8062 *2*			GH L N	E(level): From (p,γ). Others: 8055 *10* (p,d),(pol p,d), 8058 *7* (p,t).
8074 *8*			A HIJ L N	E(level): Weighted average of data from (p,t), (^{3}He,d), (p,d)(pol p,d), (^{3}He,t), and ^{23}Al ε decay.
8141 *5*			J	
8163.1 *12*	$5/2^+$		A E G IJ L N	%p<100 J^{π}: L=0 in (p,t).
8193 *8*			J N	E(level): From (p,t). Other: 8197 *5* (p,d) (estimated uncertainty by evaluators).
8288 *3*			A G N	E(level): From (p,γ).
8330 *6*	$3/2^+,5/2^+$		J	J^{π}: L=2 in (p,d).
8342 *2*			G	
8393 *6*			N	
8427[‡] *8*			J N	E(level): Wt. ave. of data from (p,d) and (p,t).
8449[#] *2*	$3/2^+,5/2^+$		A I N	%p=100 J^{π}: L=0 in (^{3}He,t) from $3/2^+$ target. log *ft*=4.4 from $5/2^+$ in ^{23}Al ε decay.
8557 *6*			N	
8578 *2*	3/2,5/2,7/2		A	J^{π}: log *ft*=6.1 from $5/2^+$ in ^{23}Al ε decay.
8617[‡] *6*	$(5/2,7/2,9/2)^-$[a]		C J N	
8762 *6*			J N	XREF: J(8770). E(level): Wt. ave. of data from (p,d) and (p,t).
8793[‡] *8*	$(7/2^+)$[a]		A C N	XREF: A(8781).
8840 *3*	3/2,5/2,7/2		A	J^{π}: log *ft*=6.0 from $5/2^+$ in ^{23}Al ε decay.
8870 *8*			N	
8908 *3*	$(5/2^+)$[a]		A C N	E(level): Weighted average of data from (p,t), ^{23}Al ε decay, (p,d),(pol p,d), and ^{1}H(^{22}Na,p):res.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Mg Levels (continued)

E(level)[†]	J$^{\pi}$	$T_{1/2}$[b]	XREF	Comments
8924 *5*	1/2$^-$,3/2$^-$		J	J$^{\pi}$: L=1 in (p,d).
8941.6 *10*		<70 fs	EF N	%p<100
8993[#] *6*	3/2$^+$,5/2$^+$,7/2$^+$		A N	J$^{\pi}$: L=2 in (p,t). log *ft*=5.3 from 5/2$^+$ in ^{23}Al ε decay.
9020 *30*	1/2$^-$,3/2$^-$		J	J$^{\pi}$: L=1 in (p,d).
9022[#] *4*	3/2,5/2,7/2		A N	J$^{\pi}$: log *ft*=6.1 from 5/2$^+$ in ^{23}Al ε decay.
9060 *8*			N	
9102[#] *6*	3/2,5/2,7/2		A N	J$^{\pi}$: log *ft*=6.0 from 5/2$^+$ in ^{23}Al ε decay.
9135 *6*	3/2,5/2,7/2		A J N	E(level): Unweighted average of data from (p,t), ^{23}Al ε decay, and (p,d),(pol p,d). J$^{\pi}$: log *ft*=5.0 from 5/2$^+$ in ^{23}Al ε decay.
9159 *6*	1/2$^+$,3/2$^+$,5/2$^+$		I	J$^{\pi}$: L=0 in (^{3}He,t) from 3/2$^+$ target.
9253 *8*			N	
9325 *5*	3/2,5/2,7/2		A J N	E(level): Weighted average of data from (p,t), ^{23}Al ε decay, and (p,d),(pol p,d). J$^{\pi}$: log *ft*=5.0 from 5/2$^+$ in ^{23}Al ε decay.
9374 *8*			N	
9403 *8*			N	
9421[‡] *4*	3/2$^+$,5/2$^+$,7/2$^+$		A N	J$^{\pi}$: log *ft*=4.5 from 5/2$^+$ in ^{23}Al ε decay.
9468 *5*	3/2$^+$,5/2$^+$,7/2$^+$		A J N	E(level): Weighted average of data from (p,t), ^{23}Al ε decay, and (p,d),(pol p,d). J$^{\pi}$: L=2 in (p,t). log *ft*=5.2 from 5/2$^+$ in ^{23}Al ε decay.
9502 *6*	1/2$^+$,3/2$^+$,5/2$^+$		I	J$^{\pi}$: L=0 from 3/2$^+$ in (^{3}He,t).
9596.7 *10*	(15/2$^+$,17/2$^+$)	<70 fs	EF N	J$^{\pi}$: 15/2$^+$ in (^{16}O,$\alpha n\gamma$) and (17/2$^+$) in (^{12}C,n). γ to (13/2$^+$).
9604 *5*	3/2,5/2,7/2		A	%p=100 J$^{\pi}$: log *ft*=5.6 from 5/2$^+$ in ^{23}Al ε decay.
9642 *8*			J N	
9673[#] *7*	3/2$^-$		A J N	E(level): Wt. ave. of data from ^{23}Al ε decay, (p,t) and (p,d). J$^{\pi}$: L=1 in (p,d) and log *ft*=6.0 from 5/2$^+$ in ^{23}Al ε decay.
9717 *8*			N	
9750 *50*			J	
9850 *30*	(3/2$^+$,5/2$^+$)		J	J$^{\pi}$: L=(2) in (p,d).
9970 *40*	(1/2$^-$,3/2$^-$)		J	J$^{\pi}$: L=(1) in (p,d).
10120 *50*			J	
10270 *30*	(1/2$^-$,3/2$^-$)		J	J$^{\pi}$: L=(1) in (p,d).
10290 *7*	1/2$^+$,3/2$^+$,5/2$^+$		I	J$^{\pi}$: L=0 in (^{3}He,t) from 3/2$^+$ target.
10440 *50*	(1/2$^-$,3/2$^-$)		J	J$^{\pi}$: L=(1) in (p,d).
10570 *20*	1/2$^-$,3/2$^-$		J	J$^{\pi}$: L=1 in (p,d).
10750 *40*	(3/2$^+$,5/2$^+$)		J	J$^{\pi}$: L=(2) in (p,d).
10920 *70*			J	
11030 *60*			E J	
11132 *8*	1/2$^+$,3/2$^+$,5/2$^+$		I	J$^{\pi}$: L=0 in (^{3}He,t) from 3/2$^+$ target.
11210 *60*			E J	
11380 *60*			J	
11540 *60*			E J	
11800 *40*			E J	XREF: E(11760).
11990 *50*			J	
12480 *80*			J	
12690 *80*			J	
12940 *80*			J	
13280 *80*			J	
14130 *20*			E	%p=100
14560 *20*			E	%p=100

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Mg Levels (continued)

† From least squares fit to γ-ray energies (measured and reported), assuming ΔE=1 keV for γ rays without uncertainty. Calculated Eγ from level energy differences were deduced after the fit and marked by footnote.

‡ From (p,t).

Weighted average of data from ^{23}Al ε decay and (p,t).

@ From (^{3}He,t).

& From vector analyzing power in (pol p,d) (1986Mi01).

[a] Proposed by 2013Ji13 – ^{1}H(^{22}Na,p):res, based on R-matrix analysis of measured excitation function.

[b] From ((^{12}C,nγ) – by DSA method), except otherwise noted.

[c] From (^{3}He,$\alpha\gamma$) by DSA method.

[d] Band(A): π+ band.

[e] Band(B): K^{π}=(1/2^{-}) band.

Adopted Levels, Gammas (continued)

$\gamma(^{23}Mg)$

E_i(level)	J^π_i	E_γ	I_γ[c]	E_f	J^π_f	Mult.[d]	δ[e]	α[f]	Comments
450.70	5/2+	450.70[‡] *15*	100	0.0	3/2+	M1+E2	−0.06 *2*		B(M1)(W.u.)=0.209 *15*; B(E2)(W.u.)=24 *+20−13*
2051.6	7/2+	1601.4[@] *13*	100.0[@] *24*	450.70	5/2+	M1+E2	−0.19 *2*	1.02×10^{-4} *2*	B(M1)(W.u.)=0.070 *+16−11*; B(E2)(W.u.)=6.5 *+21−16*
		2051.5[b]	13.9 *11*	0.0	3/2+	E2(+M3)	+0.05 *5*	3.43×10^{-4} *6*	B(E2)(W.u.)=7.5 *+18−13* I_γ: Unweighted average of data from (^{12}C,nγ) and (^{3}He,$\alpha\gamma$).
2357.0	1/2+	1906[‡] *1*	100[@] *4*	450.70	5/2+	[E2]		2.74×10^{-4}	B(E2)(W.u.)=6.9 *+18−12*
		2357.9[b]	45[@] *4*	0.0	3/2+				
2714.5	9/2+	662.04[‡] *40*	42.3 *6*	2051.6	7/2+				
		2263[‡] *1*	100.0 *7*	450.70	5/2+	[E2]			B(E2)(W.u.)=26.5 *+37−30*
2771.2	1/2−	2769.7[@] *12*	100	0.0	3/2+	[E1]		1.13×10^{-3}	B(E1)(W.u.)=5.2×10^{-4} *+8−6*
2905.2	(3/2)+	2454.6[b]	59[@] *3*	450.70	5/2+	D+Q			I_γ: Other: 100 *4* (^{12}C,nγ).
		2906.4[@] *11*	100[@] *3*	0.0	3/2+	D+Q			I_γ: Other: 66 *6* (^{12}C,nγ).
3794.1	3/2−	1023[‡] *1*	3.4 *8*	2771.2	1/2−	M1			B(M1)(W.u.)=0.023 *6*
		3343.9[@] *13*	100.0 *17*	450.70	5/2+	E1		1.41×10^{-3}	B(E1)(W.u.)=7.1×10^{-4} *+13−9*
		3794.1[b]	8.1[@] *23*	0.0	3/2+	E1+M2	<0.45	0.00152 *8*	B(E1)(W.u.)=3.7×10^{-5} *+22−17*; B(M2)(W.u.)<3.0 δ: Based on the RUL(M2)=3 (upperlimit). Other: δ>0.4 in (^{3}He,$\alpha\gamma$), the lowerlimit appears to be a typo.
3860.6	3/2+,5/2+	956[‡] *1*		2905.2	(3/2)+				
		1503[‡] *1*	42 *8*	2357.0	1/2+				
		1809[‡] *1*	100 *17*	2051.6	7/2+				
3971.7	5/2−	178[‡] *1*	8.9 *6*	3794.1	3/2−				
		1067[‡] *1*	1.9 *6*	2905.2	(3/2)+				
		1200[‡] *1*	3.8 *6*	2771.2	1/2−				
		1920[‡] *1*	100 *3*	2051.6	7/2+	D[‡]			
		3972[b]	80	0.0	3/2+	D+Q			I_γ: From (^{3}He,$\alpha\gamma$). δ: −4.33 *9* in 1970Ha02 note that large value implies E2(+M1) and consequently positive parity for the depopulating state. That would be inconsistent with negative parity from L=3 (p,t).
4356.4	1/2+	1999[b]	4[@] *3*	2357.0	1/2+				
		4356[b]	100[@] *3*	0.0	3/2+				
4681.5	(7/2)+	1967[‡] *1*	17.4 *17*	2714.5	9/2+	M1+E2[‡]		0.00027 *4*	
		2630[‡] *1*	47.8 *17*	2051.6	7/2+				
		4230[‡] *1*	100.0 *26*	450.70	5/2+	M1+E2[‡]		0.00117 *8*	

$^{23}_{12}Mg_{11}$-6

Adopted Levels, Gammas (continued)

γ(^{23}Mg) (continued)

E$_i$(level)	J$^\pi_i$	E$_\gamma$	I$_\gamma$[c]	E$_f$	J$^\pi_f$	Mult.[d]	α[f]	Comments
5287.5	3/2$^+$,5/2$^+$	3236‡ *1*	100 *11*	2051.6	7/2$^+$			
		4836‡ *1*	93 *4*	450.70	5/2$^+$			
5453.7	(11/2)$^+$	2739‡ *1*	100 *3*	2714.5	9/2$^+$	D+Q‡		
		3402‡ *1*	50 *3*	2051.6	7/2$^+$	E2‡		
5690.7	(1/2 to 9/2)$^+$	1830‡ *1*		3860.6	3/2$^+$,5/2$^+$			
		5240‡ *1*	32 *2*	450.70	5/2$^+$			
		5690‡ *1*	100 *7*	0.0	3/2$^+$			
5937.9	(11/2$^+$)	3223‡ *1*	100 *3*	2714.5	9/2$^+$	D+Q‡		
		3886‡ *1*	19 *2*	2051.6	7/2$^+$	‡		
5992.8	1/2$^-$,3/2$^-$	3221‡ *1*	21 *5*	2771.2	1/2$^-$			
		3636‡ *1*	100 *11*	2357.0	1/2$^+$			
6129.3	(7/2$^-$)	2158‡ *1*	48 *7*	3971.7	5/2$^-$	(M1+E2)‡	0.00035 *5*	
		3415‡ *1*	100 *21*	2714.5	9/2$^+$	[E1]		B(E1)(W.u.)=9.3×10^{-4} *19*
		5677‡ *1*	35 *3*	450.70	5/2$^+$	(E1)‡	0.00221	B(E1)(W.u.)=7.0×10^{-5} *+19−13*
6132.3	3/2$^+$,5/2$^+$	3775‡ *1*	100	2357.0	1/2$^+$			
6194.7	(13/2$^+$)	740‡ *1*	11.8 *6*	5453.7	(11/2)$^+$	M1+E2‡		
		3480‡ *1*	100.0 *18*	2714.5	9/2$^+$	E2‡	9.86×10^{-4}	B(E2)(W.u.)=21.4 *+46−33*
6240.0	(9/2)$^+$	4188‡ *1*	100	2051.6	7/2$^+$	D+Q‡		
6372.5	(7/2$^+$)	5921‡ *1*	100	450.70	5/2$^+$	D+Q‡		
6377.0	(7/2$^+$)	4325‡ *1*	100	2051.6	7/2$^+$			
6447.5	(9/2$^-$)	1766‡ *1*		4681.5	(7/2)$^+$			
6449.8	(9/2$^-$)	996‡ *1*	10.8 *27*	5453.7	(11/2)$^+$	[E1]		B(E1)(W.u.)=0.0020 *6*
		2478‡ *1*	100.0 *27*	3971.7	5/2$^-$	E2‡	5.50×10^{-4}	B(E2)(W.u.)=32 *+9−6*
		3735‡ *1*	16.2 *27*	2714.5	9/2$^+$	[E1]		B(E1)(W.u.)=5.4×10^{-5} *+18−13*
		4398‡ *1*	71.6 *27*	2051.6	7/2$^+$	(E1)‡	0.00183	B(E1)(W.u.)=1.46×10^{-4} *+43−27*
6513.6	(7/2)$^+$	6062‡ *1*	100	450.70	5/2$^+$	D+Q‡		
6574.6	5/2$^+$	6123‡ *1*	100	450.70	5/2$^+$			
6775.4		4418‡ *1*	100	2357.0	1/2$^+$			
6803.9	3/2$^+$,5/2$^+$	2832‡ *1*	100	3971.7	5/2$^-$			
6804.6		6353‡ *1*	100	450.70	5/2$^+$			
7021.5	(9/2)$^+$	4307‡ *1*	100 *13*	2714.5	9/2$^+$			
		4969‡ *1*	67 *4*	2051.6	7/2$^+$	D+Q‡		
7111.7	(3/2 to 11/2)$^+$	6660‡ *1*	100	450.70	5/2$^+$			
7145.2	(13/2$^+$)	951‡ *1*	1.0 *3*	6194.7	(13/2$^+$)			
		1207‡ *1*	2.3 *3*	5937.9	(11/2$^+$)			

Adopted Levels, Gammas (continued)

γ(^{23}Mg) (continued)

E_i(level)	J^{π}_i	E_γ	I_γ[c]	E_f	J^{π}_f	Mult.[d]	α[f]	Comments
7145.2	(13/2$^+$)	1691[‡] *1*	2.0 *3*	5453.7	(11/2)$^+$			
		4430[‡] *1*	100 *10*	2714.5	9/2$^+$			I_γ: Assuming half of the 4430+4435 γ-ray doublet intensity.
7149.0	(5/2$^+$)	1459[‡] *1*	3.0 *3*	5690.7	(1/2 to 9/2)$^+$			
		4435[‡] *1*	100 *10*	2714.5	9/2$^+$			I_γ: Assuming half of the 4430+4435 γ-ray doublet intensity.
7228.5		4871[‡] *1*	100	2357.0	1/2$^+$			
7261.9	(11/2$^+$)	1808[‡] *1*	8.5 *21*	5453.7	(11/2)$^+$			
		4547[‡] *1*	100.0 *21*	2714.5	9/2$^+$	M1+E2[‡]	0.00128 *8*	
7382.8	(7/2$^+$)	6931[‡] *1*	100	450.70	5/2$^+$	D+Q[‡]		
7450.5	(9/2)$^+$	5399[‡] *1*	63 *6*	2051.6	7/2$^+$	D+Q[‡]		
		6998[‡] *1*	100 *6*	450.70	5/2$^+$	E2[‡]		
7497.2	(9/2)$^+$	5445[‡] *1*	100	2051.6	7/2$^+$			
7624.4	(9/2)$^+$	7172.5[‡] *9*	100	450.70	5/2$^+$	E2[‡]		B(E2)(W.u.)=2.7 *+23−10*
7648	3/2$^+$,5/2$^+$	7196.0[‡] *26*	100	450.70	5/2$^+$	D+Q[‡]		
7770.4		2316.9[‡] *5*	73 *9*	5453.7	(11/2)$^+$			
		5054.8[‡] *6*	100 *18*	2714.5	9/2$^+$			
7781.8	(11/2$^+$)	5067.1[‡] *11*	100 *9*	2714.5	9/2$^+$			
		5729.1[‡] *11*	50 *13*	2051.6	7/2$^+$	E2[‡]	1.68×10^{-3}	B(E2)(W.u.)>8.5
7784.7	3/2$^+$,5/2$^+$	5732	16 *4*	2051.6	7/2$^+$			I_γ: Unweighted average of data from (p,γ) and ^{23}Al ε decay.
		7333.2[#] *11*	100[&] *6*	450.70	5/2$^+$	M1+E2[‡]		
7803.0	5/2$^+$	5751[a]	5.5[a] *21*	2051.6	7/2$^+$			
		7351[a]	45[a] *5*	450.70	5/2$^+$			
		7801.3[a]	100[a]	0.0	3/2$^+$			
7855.5	(7/2$^+$)	5139.7[#] *12*	100[&] *8*	2714.5	9/2$^+$			
		5803.2[&] *13*	26[&] *4*	2051.6	7/2$^+$			
		7403.6[b]	7[&] *3*	450.70	5/2$^+$			
8015.6	(5/2,7/2)	5300.1[&] *8*	100.0[&] *23*	2714.5	9/2$^+$			
		5964.7[#] *20*	84.0[&] *23*	2051.6	7/2$^+$			
		7564	8.7[&] *15*	450.70	5/2$^+$			
8062		8060.5[b]	100	0.0	3/2$^+$			
8163.1	5/2$^+$	6109.5[‡] *18*	33[&] *3*	2051.6	7/2$^+$			
		7712 *2*	30.3[&] *21*	450.70	5/2$^+$			
		8162 *2*	100[&] *3*	0.0	3/2$^+$			
8288		5573[b]	100	2714.5	9/2$^+$			

Adopted Levels, Gammas (continued)

$\gamma(^{23}Mg)$ (continued)

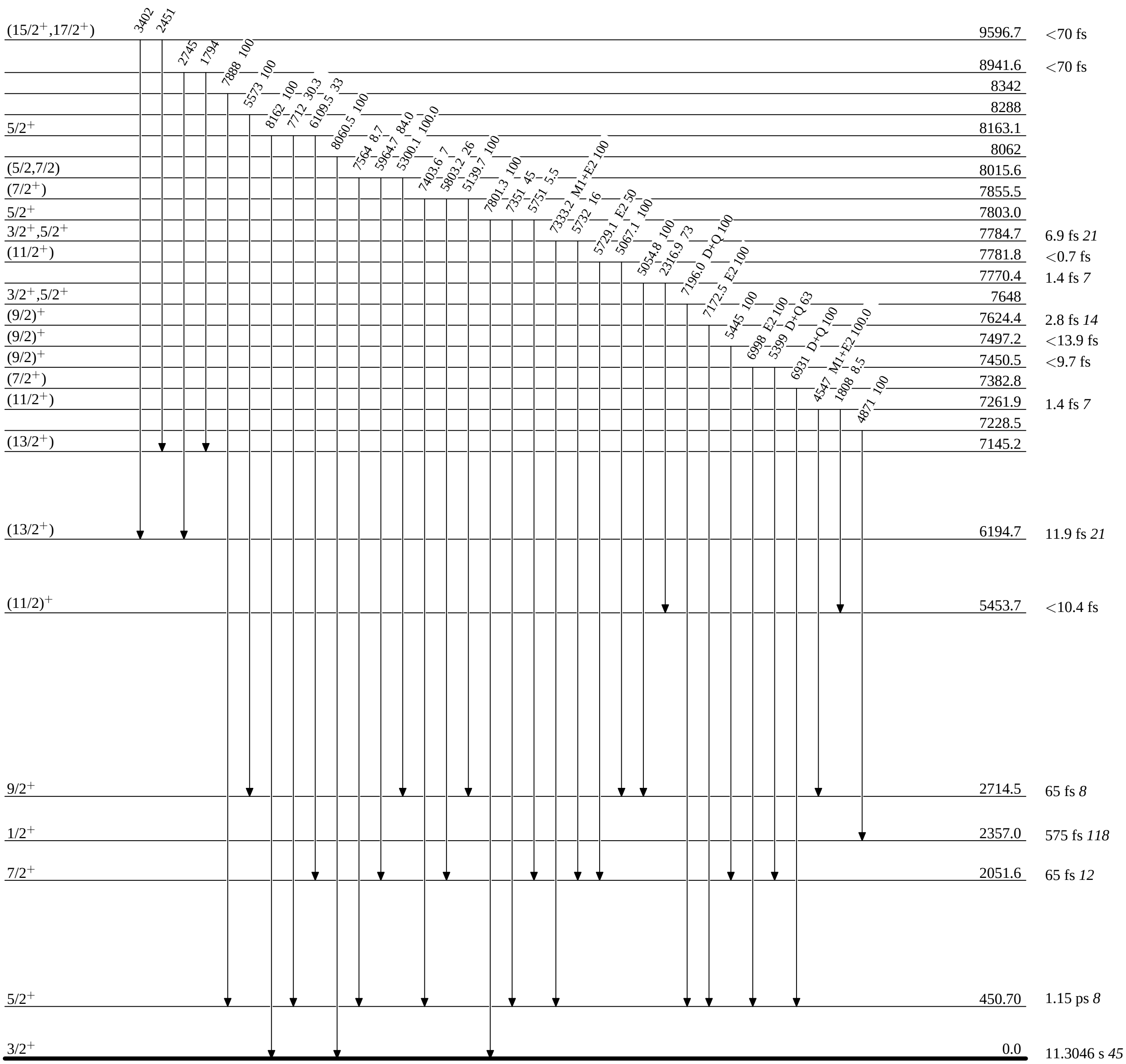
E_i(level)	J^π_i	E_γ	I_γ[c]	E_f	J^π_f	Comments
8342		7888[b]	100	450.70	$5/2^+$	
8941.6		1794[†]		7145.2	$(13/2^+)$	
		2745[†]		6194.7	$(13/2^+)$	E_γ: Other: 2752 (^{12}C,nγ).
9596.7	$(15/2^+,17/2^+)$	2451[†]		7145.2	$(13/2^+)$	
		3402[†]		6194.7	$(13/2^+)$	E_γ: Other: 3417 (^{12}C,nγ).

[†] From (^{16}O,αnγ).
[‡] From (^{12}C,nγ).
[#] Weighted average of data from (^{12}C,nγ) and (p,γ).
[@] From (^{3}He,$\alpha\gamma$).
[&] From (p,γ).
[a] From ^{23}Al ε decay.
[b] Deduced from level-energy differences, corrected for recoil, except otherwise noted.
[c] From (^{12}C,nγ), except otherwise noted.
[d] From (^{3}He,$\alpha\gamma$), except where otherwise noted and RUL.
[e] From (^{3}He,$\alpha\gamma$).
[f] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

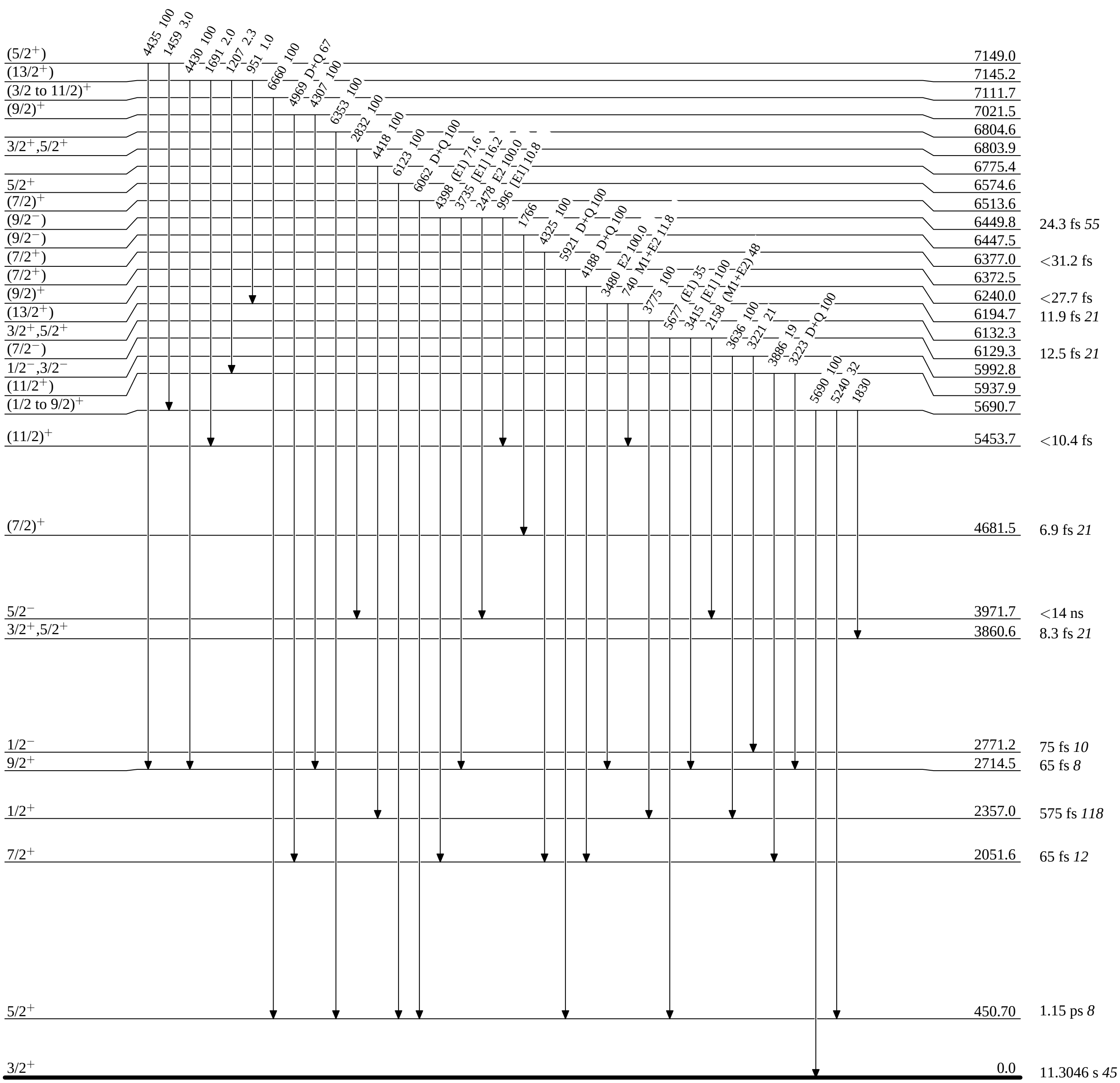


$^{23}_{12}Mg_{11}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

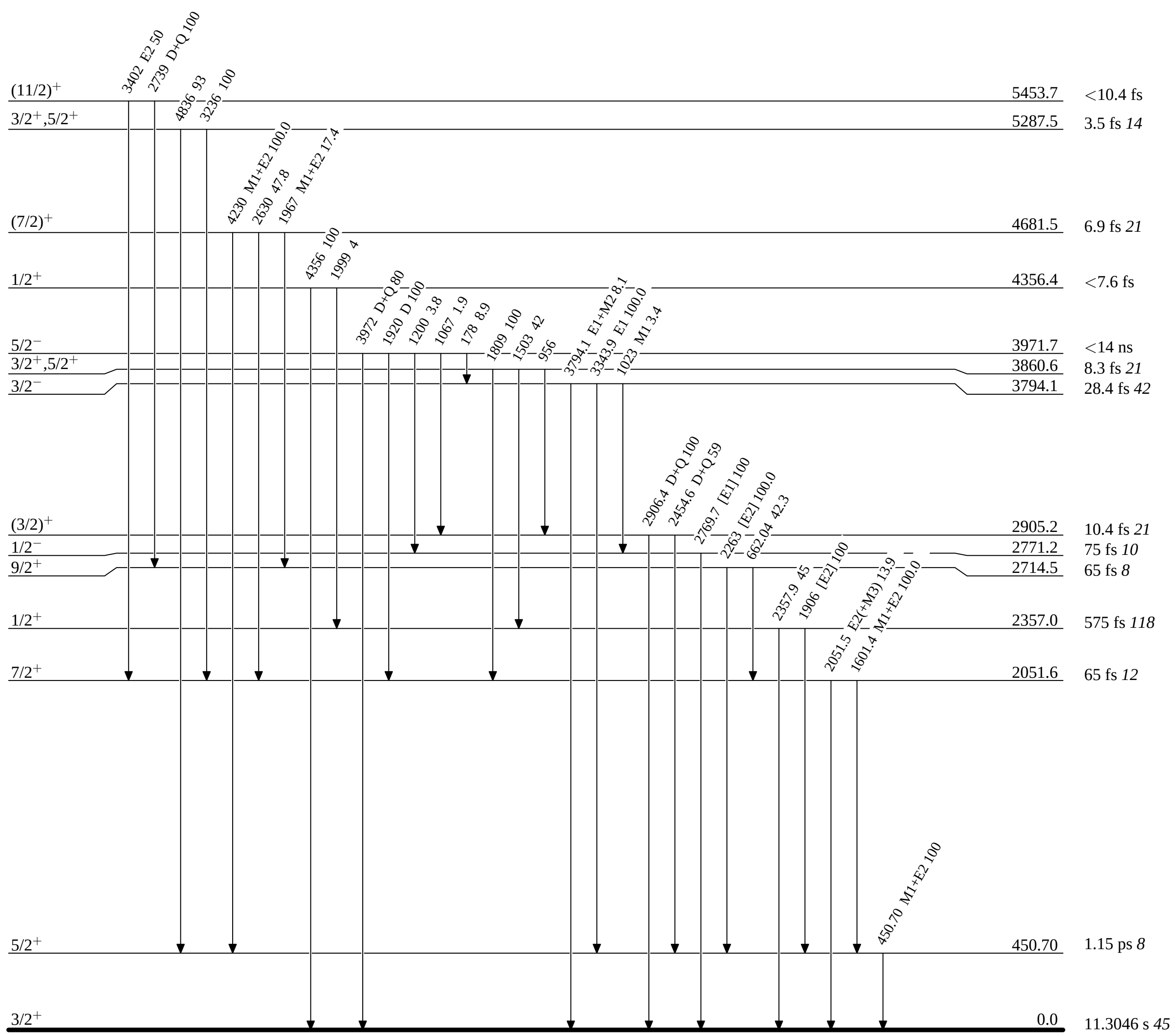


$^{23}_{12}Mg_{11}$

Adopted Levels, Gammas

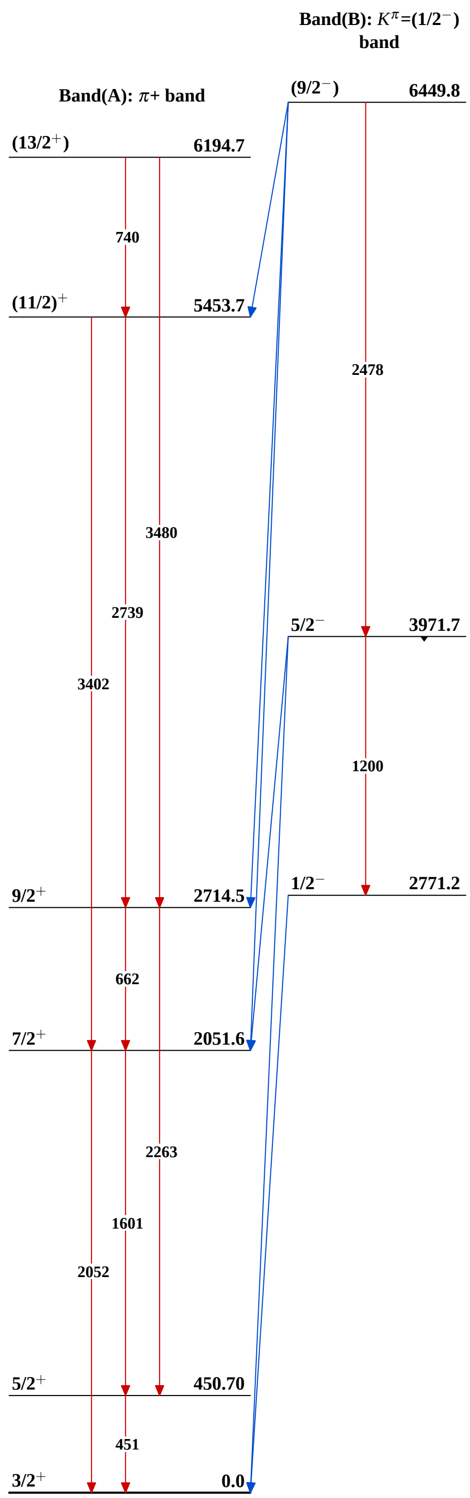
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{23}_{12}Mg_{11}$

Adopted Levels, Gammas



$^{23}_{12}Mg_{11}$

^{23}Al ε decay 2011Sa15,2011Ki26,2006Ia03

Parent: ^{23}Al: E=0.0; J^{π}=5/2$^+$; $T_{1/2}$=446 ms *6*; Q(ε)=12221.6 *4*; %ε+%β^+ decay=100

Other references: 2015Su15, 2014Ka01, 2012Tr08, 2002Wa33, 2001Wa54, 2000Pe28, 1998Jo20, 1995Ti08, 1972Go03, 1998RoZX (same group of 1995Ti08), and 2020Fr04.

2011Sa15,2012Tr08,2006Ia03: Source produced by ^{1}H(^{24}Mg,^{23}Al) at E(^{24}Mg)=48 MeV/u. Target=2.5 mg/cm^2 thick liquid nitrogen cooled H_2 at 1.6 atm pressure. Detection system: double-sided Si strip detector (DSSSD) and a thick Si pad detector for particle detection. This system was used in implantation mode as a ΔE-E telescope to control the implantation for particles of interest, and in measurement mode to record spectra of protons. The thick Si detector served as a detector of β^+ particles. A 70% HPGe detector was used for detecting γ rays. Measured Eγ, Iγ, delayed proton spectra, βp coin, $\beta\gamma$ coin.

Ref. 31 in 2006Ia03 and Ref. 25 in 2011Sa15 refer to a Ph.D. dissertation by Y. Zhai at Texas A & M (2007), which contains additional data (R. E. Tribble mentioned by e-mail to B. Singh (dated March 13, 2019) that identification of some of the gamma lines was uncertain and not included in the publication). The statements like "Transitions to and from 13 distinct excited levels in ^{24}Mg levels are observed" or "Twenty γ-ray peaks in all were identified as originating from the decay of ^{23}Al" in paragraphs 1 and 2 (section IV) could not be followed comparing the presented data in 2006Ia03 or dissertation.

2011Ki26: ^{23}Al beam produced via the ^{24}Mg(p,2n) reaction with beam energy of 40 MeV and natural self-supporting 4.3 mg/cm^2 thick Mg target. The mass separated ions were implanted in a carbon foil. The detection system consisted of four double-sided silicon strip detectors (DSSSD) and each one backed by unsegmented silicon detector. Measured E_p, I_p. Deduced excitation energies for proton unbound states, and branching ratios.

2014Ka01: Source produced via ^{24}Mg(p,2n)^{23}Al, E=40 MeV, reaction. Measured Eβ, Iβ, Eγ, Iγ; deduced Gamow-Teller strengths.

2015Su15: ^{23}Al ions were produced by fragmentation of a 75.8 MeV/nucleon primary beam of ^{28}Si on a 1980 μm thick ^{9}Be target. Measured E_p, I_p, $\beta\gamma$-coin, pγ-coin, β-proton coin, decay-time distribution. Deduced β-delayed proton decay branching ratios.

2020Fr04: ^{23}Al εp decay – measured proton emission of 204, 275, and 583 keV (c.m) resonances in ^{23}Mg using the new device Gaseous Detector with Germanium Tagging system. Reported I_p relative to I_p (839 keV (lab)) of 2011Sa15. Deduced 204 keV (c.m.) resonance strength.

The decay scheme is incomplete.

^{23}Mg Levels

E(level)†	J^{π}‡	Comments
0.0	3/2$^+$	
451 *1*	5/2$^+$	
2051 *1*	7/2$^+$	
7788 *1*	3/2$^+$,5/2$^+$	E(level): Others: 7787 *11* from E(p)(c.m.)=206 *11* (2011Sa15), 7787 *15* from E(p)(c.m.)=206 *15* (2015Su15). Γ_p/Γ=0.0065 *8* (2020Fr04), 0.0010 *8* for 2000Pe28 in 2020Fr04 and 0.038 *20* based on Γγ=63 meV *20* and Γ_p=2.5 meV *11* in 2011Sa15 (unit "meV" not listed), however, 2020Fr04 list as 0.037 *9*. $\omega\gamma$=0.24 meV *8* (2020Fr04), 1.4 meV *+5−4* (2011Sa15), and 0.4 meV *3* for 2000Pe28 in 2020Fr04. All using τ=10 fs *3* (2004Je02).
7803 *1*	5/2$^+$	E(level): IAS of ^{23}Al g.s. No proton decay was observed from this state (2011Sa15). This is in contrast to what was observed in 1995Ti08 and 2000Pe28.
7848 *9*	(7/2$^+$)	E(p)(c.m.)=267 *9* (2011Sa15). Others: E(p)(c.m.)=269 *16* (2015Su15), E(p)(lab)=246 *20* (1998RoZX).
7918 *15*		E(p)(c.m.)=337 *15* (2011Sa15).
8024 *15*	(5/2,7/2)	E(p)(c.m.)=443 *15* (2011Sa15).
8070 *10*		E(p)(lab)=468 *10* (1998RoZX).
8164.7 *12*	5/2$^+$	%p=100 E(p)(c.m.)=583.8 *12* from E(p)(Lab)=558.2 *12* (2011Ki26). Others: E(p)(c.m.)=579 *8* (2011Sa15) and 586 *15* (2015Su15), E(p)(lab)=556 *5* (1998RoZX).
8287 *10*		E(p)(lab)=675 *10* (1998RoZX).
8448 *2*	3/2$^+$,5/2$^+$	%p=100 E(p)(c.m.)=866.8 *19* from E(p)(Lab)=828.8 *19* (2011Ki26) Others: E(p)(c.m.)=866 *8* (2011Sa15) and 875 *12* (2015Su15), E(p)(lab)=838 *5* (1998RoZX).

Continued on next page (footnotes at end of table)

^{23}Al ε decay 2011Sa15,2011Ki26,2006Ia03 (continued)

^{23}Mg Levels (continued)

E(level)†	J^{π}‡	Comments
8579 *2*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=998 *2* from E(p)(Lab)=954 *2* (2011Ki26). Other: $E(p)(lab)=942 *10* (1998RoZX).
8705 *10*		E(level): Not adopted − source is a secondary publication. E(p)(lab)=1075 *10* (1998RoZX).
8782 *3*	($7/2^+$)	%p=100 E(p)(c.m.)=1201 *3* from E(p)(Lab)=1148 *3* (2011Ki26). Others: E(p)(c.m.)=1204 *8* (2011Sa15), E(p)(lab)=1156 *10* (1998RoZX).
8840 *3*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=1259 *3* from E(p)(Lab)=1204 *3* (2011Ki26). Other: E(p)(lab)=1215 *10* (1998RoZX).
8905 *3*	($5/2^+$)	%p=100 E(p)(c.m.)=1324 *3* from E(p)(Lab)=1266 *3* (2011Ki26). Others: E(p)(c.m.)=1338 *9* (2011Sa15), E(p)(lab)=1277 *10* (1998RoZX). E(level): Other: 8916 (2001Wa54).
9000 *10*	$3/2^+,5/2^+,7/2^+$	E(p)(c.m.)=1419 *10* (2011Sa15).
9023 *4*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=1442 *4* from E(p)(Lab)=1379 *4* (2011Ki26).
9102 *5*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=1521 *5* from E(p)(Lab)=1454 *5* (2011Ki26).
9144 *4*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=1563 *4* from E(p)(Lab)=1495 *4* (2011Ki26). Others: E(p)(c.m.)=1561 *9* (2011Sa15), E(p)(lab)=1505 *10* (1998RoZX).
9321 *4*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=1740 *4* from E(p)(Lab)=1664 *4* (2011Ki26). Other: E(p)(c.m.)=1729 *25* (2011Sa15).
9422 *4*	$3/2^+,5/2^+,7/2^+$#	%p=100 E(p)(c.m.)=1841 *4* from E(p)(Lab)=1760 *4* (2011Ki26) Others: E(p)(c.m.)=1843 9 (2011Sa15), E(p)(lab)=1748 *10* (1998RoZX).
9469 *5*	$3/2^+,5/2^+,7/2^+$	%p=100 E(p)(c.m.)=1888 *5* from E(p)(Lab)=1805 *5* (2011Ki26). Other: E(p)(lab)=1797 *10* (1998RoZX).
9565 *10*		E(level): Not adopted − source is a secondary publication. E(p)(lab)=1897 *10* (1998RoZX).
9605 *5*	3/2,5/2,7/2#	%p=100 E(p)(c.m.)=2024 *5* from E(p)(Lab)=1935 *5* (2011Ki26).
9682 *7*	$3/2^-$	%p=100 E(p)(c.m.)=2101 *7* from E(p)(Lab)=2009 *7* (2011Ki26).
9883 *10*		E(level): Not adopted − source is a secondary publication. E(p)(lab)=2201 *10* (1998RoZX).

† For levels up to 7803-keV from least-squares fit to γ-ray energies and above from E(c.m.)+S(p)(^{23}Mg), where E(c.m.)=[(m(p)+m(^{22}Na)/m(^{22}Na)]*Ep (Lab). S(p)=7580.97 *23*, m(p)=1.007825 *9*, and m(^{22}Na)= 21.9944437 *18* (2017Wa10). E(p)(Lab) values from 2011Ki26 are listed in comments section. From 2011Sa15 E(p)(c.m.) values are listed.
‡ From Adopted Levels, except otherwise noted.
# Assigned by evaluators from log *ft* value.

ε,β^+ radiations

%Ip from 2011Ki26, obtained by multiplying relative Ip by 0.0041 *1* (β-decay branching ratio to the 8448 keV level in 2011Sa15).

Continued on next page (footnotes at end of table)

^{23}Al ε decay 2011Sa15,2011Ki26,2006Ia03 (continued)

ε,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ @	Iε@	Log *ft*	I(ε+β^+)†@	Comments
(2540 *7*)	9682	0.0008 *2*	6.×10^{-6} *2*	6.0 *1*	0.0008# *2*	%Ip=0.0008 *2* from 0.20 *5* (2011Ki26).
(2617 *5*)	9605	0.0025 *3*	1.7×10^{-5} *2*	5.6 *1*	0.0025# *3*	%Ip=0.0025 *3* from 0.62 *7* (2011Ki26).
(2753 *5*)	9469	0.0084 *6*	4.4×10^{-5} *3*	5.23 *4*	0.0084# *6*	%Ip=0.0084 *6* from 2.04 *13* (2011Ki26).
(2800 *4*)	9422	0.05 *1*	0.0002	4.5 *1*	0.05‡ *1*	%Ip=0.05 *1* (2011Sa15); Other: %Ip=0.021 *1* from 5.21 *19* (2011Ki26).
(2901 *4*)	9321	0.02 *1*	8.×10^{-5} *4*	5.0 *2*	0.02‡ *1*	%Ip=0.02 *1* (2011Sa15); Other: %Ip=0.0059 *4* from 1.44 *10* (2011Ki26).
(3078 *4*)	9144	0.03 *1*	9.×10^{-5} *3*	5.0 *2*	0.03‡ *1*	%Ip=0.03 *1* (2011Sa15); Other: %Ip=0.017 *1* from 4.2 *2* (2011Ki26).
(3120 *5*)	9102	0.0032 *6*	9.4×10^{-6} *18*	6.01 *9*	0.0032# *6*	%Ip=0.0032 *6* from 0.78 *14* (2011Ki26).
(3199 *4*)	9023	0.0032 *3*	8.4×10^{-6} *8*	6.08 *5*	0.0032# *3*	%Ip=0.0032 *3* from 0.77 *7* (2011Ki26).
(3222 *10*)	9000	0.02 *1*	5.×10^{-5} *3*	5.3 *2*	0.02‡ *1*	%Ip=0.02 *1* (2011Sa15).
(3317 *3*)	8905	0.02 *1*	4.×10^{-5} *2*	5.4 *2*	0.02‡ *1*	%Ip=0.02 *1* (2011Sa15); %Ip=0.017 *1* from 4.11 *16* (2011Ki26).
(3382 *3*)	8840	0.0058 *4*	1.2×10^{-5} *1*	5.97 *3*	0.0058# *4*	%Ip=0.0058 *4* from 1.42 *10* (2011Ki26).
(3440 *3*)	8782	0.02 *1*	4.×10^{-5} *2*	5.5 *2*	0.02‡ *1*	%Ip=0.02 *1* (2011Sa15); Other: %Ip=0.013 *1* from 3.17 *15* (2011Ki26).
(3642.6 *21*)	8579	0.0064 *4*	9.7×10^{-6} *6*	6.13 *3*	0.0064# *4*	%Ip=0.0064 *4* from 1.55 *10* (2011Ki26).
(3773.6 *21*)	8448	0.41 *1*	0.00054 *1*	4.42 *1*	0.41‡ *1*	%Ip=0.41 *1* (2011Sa15); %Ip=0.41 *1* from 100 (2011Ki26).
(4056.9 *13*)	8164.7	0.28 *1*		4.77 *2*	0.28‡ *1*	%Ip=0.28 *1* (2011Sa15); %Ip=0.19 *1* from 46.2 *8* (2011Ki26); 0.281 *6* – deduced from 0.685 *22* (2020Fr04).
(4198 *15*)	8024	0.02 *1*		6.0 *2*	0.02‡ *1*	%Ip=0.02 *1* (2011Sa15).
(4304 *15*)	7918	0.03 *1*		5.9 *2*	0.03‡ *1*	%Ip=0.03 *1* (2011Sa15).
(4374 *9*)	7848	0.118 *3*		5.3 *1*	0.118‡ *3*	%Ip=0.18 *4* (2011Sa15), 0.19 *6* (2015Su15), 0.118 *3* – deduced from 0.288 *10* (2020Fr04).
(4418.6 *11*)	7803	13.4 *7*	0.0093 *5*	3.31 *2*	13.4 *7*	
(4433.6 *11*)	7788	4.89 *25*	0.00336 *18*	3.759 *23*	4.89 *25*	%Ip=0.14 *3* (2011Sa15), 0.15 *5* (2015Su15), 0.026 *2* – deduced from 0.063 *4* (2020Fr04).
(10170.6 *11*)	2051	5.91 *10*		5.67 *1*	5.91 *10*	
(11770.6 *11*)	451	26.2 *5*		5.36 *1*	26.2 *5*	
(12221.6 *4*)	0.0	36.3 *16*		5.30 *2*	36.3 *16*	I(ε+β^+): Quoted in 2006Ia03 – appears to be from Ref. 31 (Ph.D. dissertation by Y. Zhai at Texas A & M (2007)): deduced from γ-ray intensity balance. R. E. Tribble mentioned by e-mail to B. Singh (dated March 13, 2019) that identification of some of the gamma lines in the thesis was uncertain and not included in the publication. The datum should be considered with caution.

† From 2006Ia03, except otherwise noted. Deduced from γ-ray intensity balance quoted in 2006Ia03, appears to be from Ref. 31 in 2006Ia03 (Ph.D. dissertation by Y. Zhai at Texas A & M (2007)). Note that 2006Ia03 state "Transitions to and from 13 distinct excited levels in ^{24}Mg levels are observed" or "Twenty γ-ray peaks in all were identified as originating from the decay of 23Al" in paragraphs 1 and 2 (section IV) could not be followed comparing the presented data in 2006Ia03 or in the dissertation (Ref. 31 in 2006Ia03 and Ref. 25 in 2011Sa15). Note total I(ε+β+) < 100 – the decay scheme is incomplete.

‡ From 2011Sa15, based on %Ip.

From 2011Ki26, based on %Ip.

@ Absolute intensity per 100 decays.

^{23}Al ε decay 2011Sa15,2011Ki26,2006Ia03 (continued)

γ(^{23}Mg)

Iγ normalization: Dataset appears to be incomplete and not normalized for γ-ray transition intensities. See comments for the 451γ from 451 keV level.

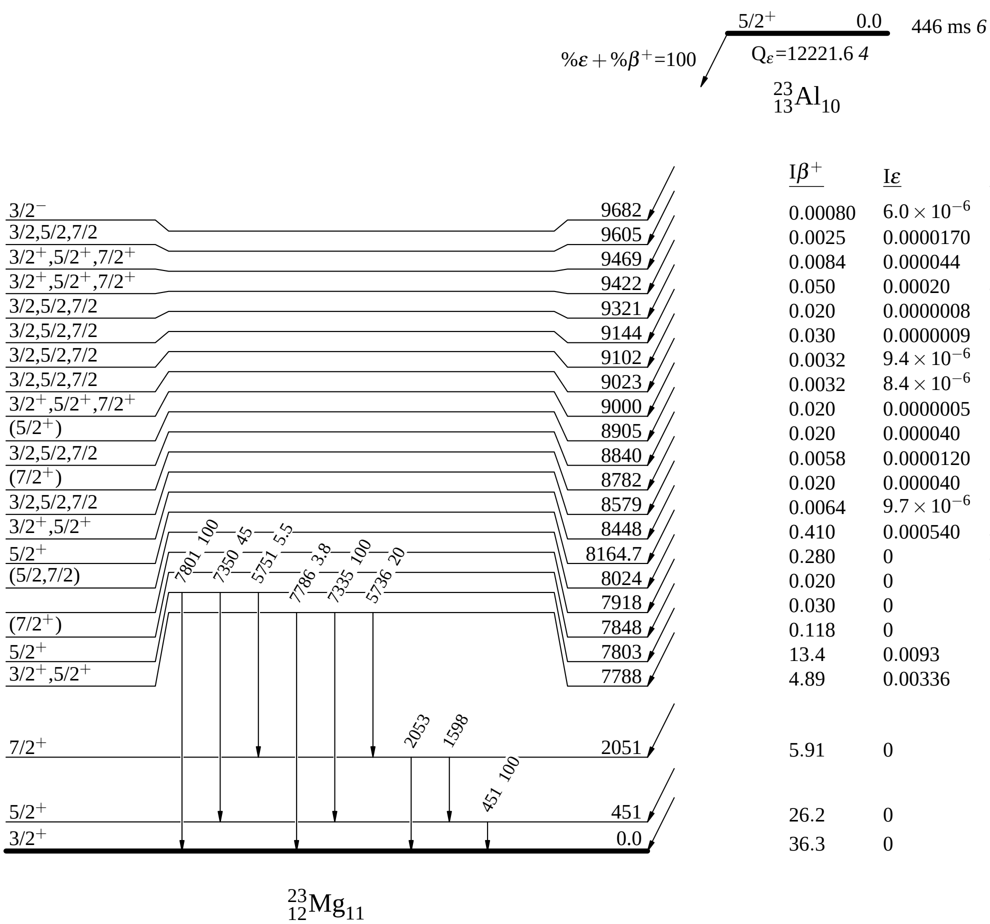
E_i(level)	J^π_i	E_γ †	I_γ @	E_f	J^π_f	Comments
451	5/2+	451 *1*	100	0.0	3/2+	E_γ: Other: 450.7 (2011Sa15). I_γ: From 2011Sa15. Absolute intensity=43.3% *10* quoted in 2011Sa15 appears to be using data from Ref. 25 (Ph.D. dissertation by Y. Zhai at Texas A & M (2007)). The procedure to deduce the value was not available. In an e-mail reply, R. E. Tribble mentioned to B. Singh (dated March 13, 2019) that identification of some of the gamma lines in the thesis was uncertain and not included in the publication. It is not clear which γ-ray intensity was considered to deduce the 43.3% *10* value. The datum should be considered with caution.
2051	7/2+	1598 *2*		451	5/2+	E_γ: Other: 1600.0 (2011Sa15).
		2053 *2*		0.0	3/2+	E_γ: Other: 2050.8 (2011Sa15).
7788	3/2+,5/2+	5736‡	20 *5*	2051	7/2+	I_γ: 1.53 with respect to Iγ(450)=100 (2011Sa15).
		7335‡	100	451	5/2+	I_γ: 1.53 with respect to Iγ(450)=100 (2011Sa15).
		7786	3.8 *25*	0.0	3/2+	E_γ: From 2006Ia03; not reported in 2011Sa15.
7803	5/2+	5751‡	5.5 *21*	2051	7/2+	
		7350 *2*	45 *5*	451	5/2+	E_γ: Other: 7351 (2011Sa15).
		7801 *2*	100	0.0	3/2+	E_γ: Other: 7801.3 (2011Sa15).

† From 2000Pe28, unless otherwise stated.
‡ From 2011Sa15.
# From Fig 2 in 2006Ia03, not placed in the level scheme by the authors. Evaluators list as unplaced.
@ From 2006Ia03, except otherwise noted.
x γ ray not placed in level scheme.

^{23}Al ε decay 2011Sa15,2011Ki26,2006Ia03

Decay Scheme

Intensities: Relative photon branching from each level



Iβ+	Iε	Log ft
0.00080	6.0×10^{-6}	6.0
0.0025	0.0000170	5.6
0.0084	0.000044	5.23
0.050	0.00020	4.5
0.020	0.0000008	5.0
0.030	0.0000009	5.0
0.0032	9.4×10^{-6}	6.01
0.0032	8.4×10^{-6}	6.08
0.020	0.0000005	5.3
0.020	0.000040	5.4
0.0058	0.0000120	5.97
0.020	0.000040	5.5
0.0064	9.7×10^{-6}	6.13
0.410	0.000540	4.42
0.280	0	4.77
0.020	0	6.0
0.030	0	5.9
0.118	0	5.3
13.4	0.0093	3.31
4.89	0.00336	3.759
5.91	0	5.67
26.2	0	5.36
36.3	0	5.30

^{24}Si εp decay 2009Ic05,2009Ic06

Parent: ^{24}Si: E=0.0; $J^\pi=0^+$; $T_{1/2}$=141.4 ms *15*; Q(εp)=8930 *20*; %εp decay=45 *4*

^{24}Si-Q(εp): from 2017Wa10.

^{24}Si-$T_{1/2}$: Weighted average of 140.5 ms *15* (2009Ic05) and 143.4 ms *22* (2015Su15,2016Su22). Half-life 140.5 ms *15* in 2009Ic05 was recommended based on their measured values of 140.1 ms *26* (664γ(t)) 140.8 ms *18* (ΣIp(t)).

^{24}Si-%εp decay: 100−(%ε+%β^+) decay to bound states. %εp=55 *4* quoted in 2009Ic06 is incorrect, based on an email communication between the first author of 2009Ic06 and XUNDL compiler, dated May 25, 2009.

Others: 1998Ba53, 1998Cz01, 2001Ba07, 2015Su15, 2016Su22.

2009IC05,2009IC06: ^{24}Si produced by fragmentation of ^{28}Si beam, E=100 MeV, bombarding a ^{9}Be target. Reaction fragments were collected and analyzed using RIPS facility at RIKEN. The γ′s were measured using a clover-type germanium detector and eight BGO counters. A plastic β veto counter was used to detect β particles. Protons were detected and separated from β′s using the ΔE-E method. Four ΔE-E detectors were used, each consisting of a gas ΔE detector and silicon E detectors. Measured Eγ, Iγ, β, βγ coin, E_p, I_p.

^{23}Mg Levels

E(level)†	J^π†
0.0	3/2+
451	5/2+
2359	1/2+

† From Adopted Levels.

γ(^{23}Mg)

Eγ†	E_i(level)	J^π_i	E_f	J^π_f
1906 *1*	2359	1/2+	451	5/2+
2357 *2*	2359	1/2+	0.0	3/2+

† From 2009Ic05.

Delayed Protons (^{23}Mg)

E(p)†	E(^{23}Mg)	I(p)‡#	E(^{24}Al)
1119 *21*	0.0	7.5 *7*	2991
1492 *13*	0.0	14 *1*	3364
1724 *13*	2359	4.8 *5*	5953
2024 *10*	2359	1.0 *1*	6243
2517 *9*	0.0	0.62 *8*	4389
2828 *7*	0.0	1.4 *2*	4700
3104 *8*	0.0	1.0 *1*	4976
3510 *10*	0.0	0.87 *10*	5382
3929 *50*	0.0	1.3 *4*	5801
4081 *7*	0.0	7.9 *8*	5953
4371 *11*	0.0	1.8 *2*	6243
4615 *11*	0.0	0.33 *5*	6487
4863 *11*	0.0	0.09 *2*	6735

† From 2009Ic05, in center-of-mass (total decay energy).

‡ From 2009Ic05, deduced in proportion to the relative intensities through renormalization with %εp=45 *4*.

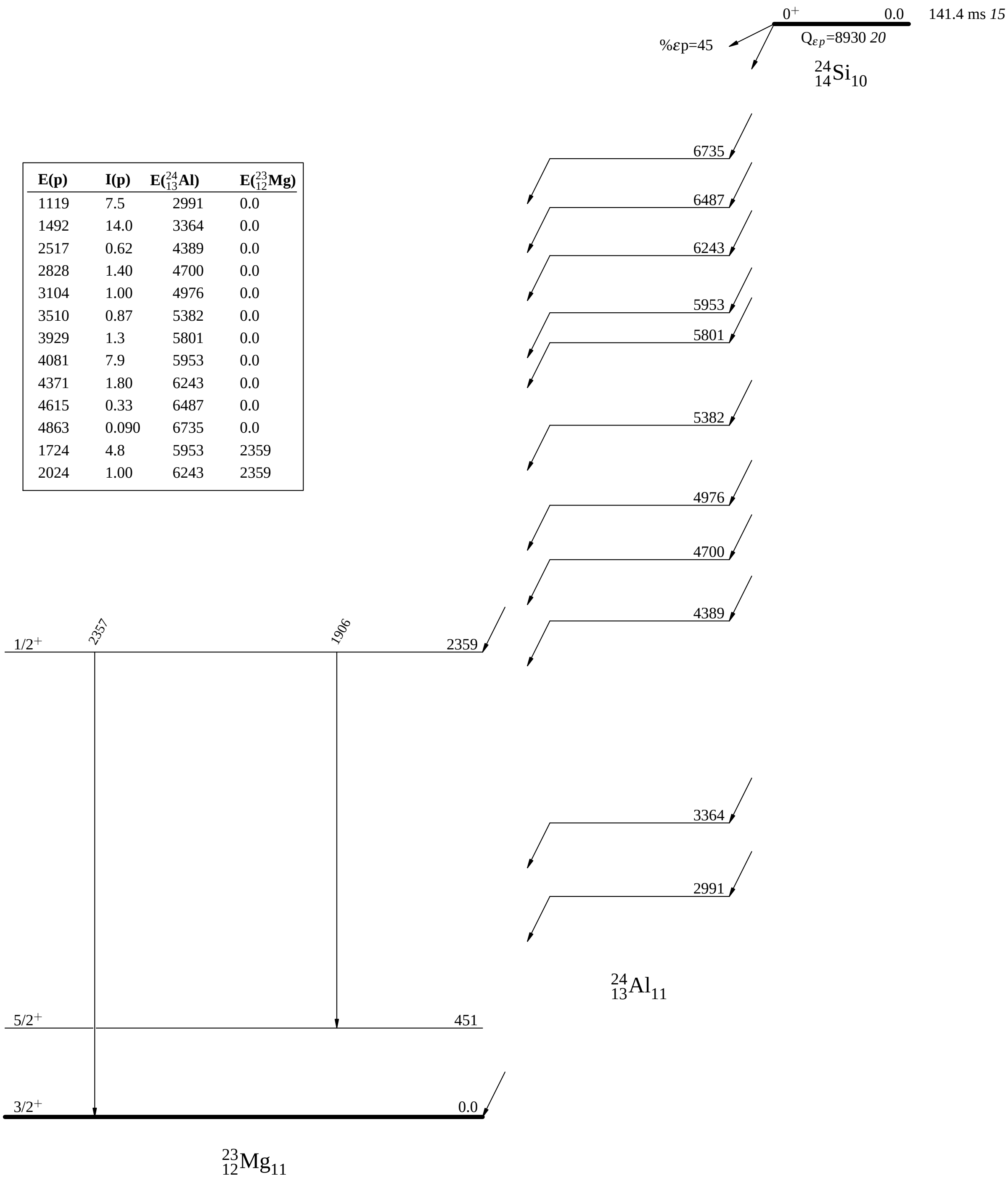
Absolute intensity per 100 decays.

^{24}Si εp decay 2009Ic05,2009Ic06

Decay Scheme

I(p) Intensities: I(p) per 100 parent decays

E(p)	I(p)	E($^{24}_{13}$Al)	E($^{23}_{12}$Mg)
1119	7.5	2991	0.0
1492	14.0	3364	0.0
2517	0.62	4389	0.0
2828	1.40	4700	0.0
3104	1.00	4976	0.0
3510	0.87	5382	0.0
3929	1.3	5801	0.0
4081	7.9	5953	0.0
4371	1.80	6243	0.0
4615	0.33	6487	0.0
4863	0.090	6735	0.0
1724	4.8	5953	2359
2024	1.00	6243	2359



$^{1}H(^{22}Na,p)$:res 2013Ji13

Based on XUNDL:
Compiled by C.D. Nesaraja (ORNL), August 12, 2014.
Resonant scattering of $^{22}Na(p,p)$ measured using thick target inverse-kinematic method. E(^{22}Na)=37.1 MeV *10* beam produced in charge exchange reaction $^{1}He(^{22}Ne,^{22}Na)n$ at E=6.0 MeV/nucleon using CRIB separator at RIBF-RIKEN facility of University of Tokyo. Scattered protons were detected using ΔE-E Si detectors. Measured proton energy spectrum. Deduced J^{π} and proton partial widths for resonance states. R-matrix analysis was applied to the experimental excitation function to deduce the ^{23}Mg resonance parameters with the assumption of only elastic scattering in the analysis. Proton spectroscopic factor for l=0 resonance calculated using the shell model code NUSHELL.

^{23}Mg Levels

E(level)†	J^{π}‡	S#	Comments
8611 *20*	$(5/2,7/2,9/2)^{-}$		Γ_p=3.2 keV *10* E(level): From Ep(c.m.)=1030 keV *20*.
8793 *13*	$7/2^{+}$	0.023 *4*	Γ_p=1.2 keV *3* S: From Γ_{sp}=67 keV. E(level): From Ep(c.m.)=1212 keV *13*.
8916 *15*	$5/2^{+}$	0.014 *5*	Γ_p=2.3 keV *7* S: From Γ_{sp}=182 keV. E(level): From Ep(c.m.)=1335 keV *15*.

† From 2013Ji13 based on Ep(c.m) + Sp(^{23}Mg). Ep(c.m.) values are listed in comments section. In AME2016 (2017Wa10) S(p)=7580.97 *23*. 2013Ji13 note the uncertainty of ΔEp(c.m.) within 20 to to 15 keV in increasing order for Ep(c.m.). Evaluators assign as of the reported uncertainty in resonance levels.
‡ Proposed by 2013Ji13, based on R-matrix analysis of measured excitation function.
# Experimental spectroscopic factor based on theoretical single-particle widths.

^{9}Be,C(^{22}Mg,^{23}Mgγ) 2011Ga18

Based on XUNDL: Compiled by J. Choquette and B. Singh (McMaster), Aug 13, 2011.

The ^{22}Mg beam obtained by fragmentation of ^{24}Mg beam, E=170 MeV/nucleon, bombarding a ^{9}Be target (thickness 1.904 g/cm^2). The A1900 fragment separator at NSCL used to separate ^{22}Mg ions. Secondary ^{22}Mg beam, E=84 MeV/nucleon, bombarded a secondary ^{9}Be (thickness 188 mg/cm^2) and C target (thickness 149.4 mg/cm^2) – placed at the reaction target position of S800 magnetic spectrograph. The target position was surrounded by SeGA array of 32-fold segmented HPGe detectors. Measured Eγ, Iγ, particle spectra (^{23}Mg)γ-coin, cross sections, longitudinal momentum distributions. Particle identification from energy loss and time-of-flight events. Coupled-channel Born approximation (CCBA) reaction analysis.

One-neutron pickup (from ^{12}C) reaction.

Measured partial cross sections are listed in comments.

Inclusive measured cross section=2.40 mb *19* and 2.58 mb *16* for ^{9}Be and C targets, respectively.

^{23}Mg Levels

E(level)†	J$^\pi$‡	Comments
0.0	3/2$^+$	$\sigma_f \le$0.86 mb *+8−11* and <0.77 mb *+9−13* for ^{9}Be and C targets, respectively. Configuration=$0^+\otimes 1d_{3/2}$ or $2^+\otimes 1d_{5/2}$.
451	5/2$^+$	σ_f=1.32 mb *12* and 1.27 mb *14* for ^{9}Be and C targets, respectively. Configuration=$0^+\otimes 1d_{5/2}$.
2052	7/2$^+$	σ_f=0.15 mb *4* and 0.18 mb *5* for ^{9}Be and C targets, respectively. Configuration=$2^+\otimes 1d_{5/2}$.
2360	1/2$^+$	σ_f=0.13 mb *4* and 0.08 mb *5* for ^{9}Be and C targets, respectively. Configuration=$0^+\otimes 2s_{1/2}$.
2715	9/2$^+$	σ_f=0.13 mb *4* and 0.10 mb *5* for ^{9}Be and C targets, respectively. Configuration=$2^+\otimes 1d_{5/2}$.
≈2900	3/2$^+$	Configuration=$0^+\otimes 1d_{3/2}$.

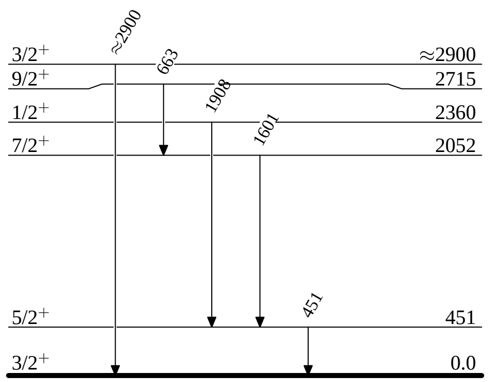
† From γ-ray energies.
‡ From 2011Ga18 based on comparison of measured neutron pickup cross section and CCBA calculations.

γ(^{23}Mg)

Eγ	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
451	451	5/2$^+$	0.0	3/2$^+$
663	2715	9/2$^+$	2052	7/2$^+$
1601	2052	7/2$^+$	451	5/2$^+$
1908	2360	1/2$^+$	451	5/2$^+$
≈2900	≈2900	3/2$^+$	0.0	3/2$^+$

^{9}Be,C(^{22}Mg,^{23}Mgγ) 2011Ga18

Level Scheme



$^{23}_{12}Mg_{11}$

$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02

Others: 2015Bu08,2006Ag08,2006Je06,2005Je06,2004Je02,1990Ti02,1977Ev02, 1974Sp03,1973Wa26.

2013Je04,2004Je02: E(^{12}C)=16,22 MeV provided by the ATLAS accelerator at Argonne National Laboratory. Target=160 μg/cm^2 ^{12}C. Measured Eγ, Iγ,$\gamma\gamma$-coin,$\gamma\gamma(\theta)$(DCO), $T_{1/2}$ using the Gammasphere array and the fractional Doppler shift technique. Deduced levels, J, π, multipolarity, bands, mirror energy differences. 2005Je06 and 2006Je06 are conference reports from the same research group.

1977Ev02: E=19.3, 37-40 MeV; Two runs with pulsed beam and one run with a dc beam. 1) with two Ge(Li) at +90° and −90° and a Si detector; 2) γ rays were detected at 0°, 30° and 60° with Ge(Li) and at −90° with Ge(Li) and six NaI(Tl); 3) NE213 liquid scintillator detector ±50° and γ at 90°. Measured particle-γ coin, time-of-flight, angular distribution of neutrons; Deduced excited levels, spin, parity, $T_{1/2}$ by DSA method, L.

2015Bu08: ^{12}C(^{12}C,n), E=7.5, 9.5 MeV; measured reaction products, deduced yields, S-factors, astrophysical reaction rate.

^{23}Mg Levels

E(level)[†]	J$^\pi$[@]	$T_{1/2}$[&]	Comments
0.0[a]	3/2$^+$		
450.3[a] *6*	5/2$^+$	1.15 ps *12*	E(level): From 1973Wa26. $T_{1/2}$: From τ=1.66 ps *17*: wt. ave. of τ=1.57 ps *12* (1990Ti02) and τ=2.00 ps *24* (1973Wa26).
2050.3[a] *6*	7/2$^+$		
2356.3 *8*	1/2$^+$		
2713.6[a] *7*	9/2$^+$	61 fs *8*	$T_{1/2}$: From τ=88 fs *12*: wt. ave. of τ=91 fs *12* (1990Ti02) and τ=80 fs *20* (1973Wa26). Δt lowest input value.
2770.8[b] *7*	1/2$^-$		
2903.5 *7*	3/2$^+$		
3793.3 *8*	3/2$^-$		
3859.6 *7*	5/2$^+$	8.3 fs *21*	$T_{1/2}$: From τ=12 fs *3* (2013Je04).
3970.7[b] *7*	5/2$^-$		
4680.6 *8*	7/2$^+$	6.9 fs *21*	$T_{1/2}$: From τ=10 fs *3* (2013Je04).
5286.7 *9*	5/2$^+$	3.5 fs *14*	$T_{1/2}$: From τ=5 fs *2* (2013Je04).
5452.6[a] *7*	11/2$^+$		
5690.4 *7*	7/2$^+$		
5936.8 *9*	11/2$^+$		
5992.3 *10*	3/2$^-$		
6128.5 *8*	7/2$^-$	12.5 fs *21*	$T_{1/2}$: From τ=18 fs *3* (2013Je04).
6131.7 *13*	(1/2,5/2)		
6193.1[a] *9*	13/2$^+$	11.9 fs *21*	$T_{1/2}$: From τ=17 fs *3* (2013Je04).
6238.7 *12*	(9/2$^+$)		
6372.1 *12*	(7/2$^+$)		
6375.7 *12*	(7/2$^+$)		
6446.7 *13*	9/2$^-$		
6448.8[b] *8*	(9/2$^-$)	24.3 fs *55*	$T_{1/2}$: From τ=35 fs *8* (2013Je04).
6513.1 *12*	(7/2$^+$)		
6574.1 *12*	(5/2$^+$)		
6774.8 *13*	(1/2,5/2)		
6802.9 *12*	5/2$^-$		
6804.2 *12*	(7/2$^+$)		
7020.4 *9*	(9/2$^+$)		
7111.3 *12*	(7/2$^+$)		
7143.9 *9*	13/2$^+$		
7149.2 *9*	(9/2$^+$)		
7200[#]			E(level): not reported in any other studies – not adopted. Might be the same level at 7228.
7227.9 *13*	(1/2,5/2)		
7260.9 *10*	11/2$^+$	1.4 fs *7*	$T_{1/2}$: From τ=2 fs *1* (2013Je04).
7382.4 *12*	7/2$^+$		

Continued on next page (footnotes at end of table)

$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02 (continued)

^{23}Mg Levels (continued)

E(level)[†]	Jπ[@]	$T_{1/2}$[&]	L	Comments
7449.7 *9*	$9/2^+$			
7496.0 *12*	$(9/2^+)$			
7624.0 *11*	$9/2^+$	2.8 fs *14*		Γ_p=1.6 meV +*22*−*10* × 10^{-13} (2004Je02). $T_{1/2}$: From τ=4 fs *2* (2004Je02).
7647 *3*	$3/2^+$			Γ_p=2.4 meV +*34*−*15* × 10^{-9} (2004Je02).
7769.4 *8*	$(9/2^-)$	1.4 fs *7*		$T_{1/2}$: From τ=2 fs *1* (2004Je02).
7780.7 *10*	$11/2^+$	<0.7 fs		Γ_p=(6 × 10^{-2}) meV (2004Je02). $T_{1/2}$: From $\tau < 1$ fs (2004Je02).
7785.2 *13*	$7/2^{(+)}$	6.9 fs *21*		$T_{1/2}$: From τ=10 fs *3* (2004Je02).
7852.3 *15*	$(7/2^+)$			E(level),Jπ: Reported in 2004Je02 as 7851.5. Missing in the full version 2013Je04. First author expressed it might be a mistake but did not confirm, while communicated by the reviewer of this manuscript B. Singh (dated: March 14, 2019).
8015.8 *9*	$(5/2^+$ to $11/2^+)$			Jπ: In 2004Je02.
8160.7 *19*	$5/2^+$			
8945[‡] *8*	$(15/2^+)$	<70 fs	4	%p=15 (1977Ev02) Jπ: From angular correlations and decay into the g.s. rotational band (1977Ev02). $T_{1/2}$,L: From 1977Ev02.
9610[‡] *8*	$(17/2^+)$	<70 fs		%p=23 (1977Ev02) Jπ: From angular correlations and comparison to analogue state in ^{23}Na (1977Ev02). $T_{1/2}$: From 1977Ev02.
10040[#]				E(level): not adopted − may be a doublet of 9970 and 10120 in Adopted Levels.
11040[#]				
11210[#]				
11540[#]				
11760[#]				
12210[#]				E(level): not adopted − not reported by others.
12830[#]				E(level): not adopted − not reported by others. May be a doublet of 12690 and 12940 in Adopted Levels.
14000[#]				E(level): not adopted − not reported by others.
14130[‡] *20*	$(21/2^+)$		2	%p=100 (1977Ev02) Jπ: Consistency with proton penetrability ratios (1977Ev02). L: From 1977Ev02.
14400				E(level): From Table 1 in 1977Ev02. Not included in the level scheme. Not adopted.
14560[‡] *20*	$(19/2^+)$			%p=100 (1977Ev02) Jπ: Consistency with proton penetrability ratios (1977Ev02).

[†] From least-squares fit to γ-ray energies, except otherwise noted.
[‡] From 1977Ev02.
[#] From Fig 1 in 1977Ev02.
[@] From 2013Je04, based on decay scheme, γ-ray multipolarity, and band assignments.
[&] From 2013Je04 (Doppler shift technique), except otherwise noted.
[a] Band(A): π+ band.
[b] Band(B): K^π=$(1/2^-)$ band.

$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02 (continued)

$\gamma(^{23}Mg)$

E_γ[†]	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	Comments
178 *1*	1.4 *1*	3970.7	5/2⁻	3793.3	3/2⁻		
450.70[#] *15*		450.3	5/2⁺	0.0	3/2⁺	M1+E2	DCO=0.76 *1*
662.04[#] *40*	28.1 *4*	2713.6	9/2⁺	2050.3	7/2⁺	M1+E2	DCO=1.12 *1*
740 *1*	2.0 *1*	6193.1	13/2⁺	5452.6	11/2⁺	M1+E2	DCO=0.71 *4*
951 *1*	0.3 *1*	7143.9	13/2⁺	6193.1	13/2⁺		
956 *1*		3859.6	5/2⁺	2903.5	3/2⁺		
996 *1*	0.8 *2*	6448.8	(9/2⁻)	5452.6	11/2⁺		
1023 *1*	0.4 *1*	3793.3	3/2⁻	2770.8	1/2⁻		
1067 *1*	0.3 *1*	3970.7	5/2⁻	2903.5	3/2⁺		
1200 *1*	0.6 *1*	3970.7	5/2⁻	2770.8	1/2⁻		
1207 *1*	0.7 *1*	7143.9	13/2⁺	5936.8	11/2⁺		
1459 *1*	0.9 *1*	7149.2	(9/2⁺)	5690.4	7/2⁺		
1503 *1*	0.5 *1*	3859.6	5/2⁺	2356.3	1/2⁺		
1600 *1*	100.0	2050.3	7/2⁺	450.3	5/2⁺	D+Q	DCO=0.59 *1*
1691 *1*	0.6 *1*	7143.9	13/2⁺	5452.6	11/2⁺		
1766 *1*		6446.7	9/2⁻	4680.6	7/2⁺		
1808 *1*	0.8 *2*	7260.9	11/2⁺	5452.6	11/2⁺		
1809 *1*	1.2 *2*	3859.6	5/2⁺	2050.3	7/2⁺		
1830 *1*		5690.4	7/2⁺	3859.6	5/2⁺		
1906 *1*	6.2 *4*	2356.3	1/2⁺	450.3	5/2⁺		
1920 *1*	15.7 *5*	3970.7	5/2⁻	2050.3	7/2⁺	D	DCO=0.97 *2*
1967 *1*	2.0 *2*	4680.6	7/2⁺	2713.6	9/2⁺	M1+E2	DCO=1.34 *15*
2050 *1*	13.3 *11*	2050.3	7/2⁺	0.0	3/2⁺		
2158 *1*	1.4 *2*	6128.5	7/2⁻	3970.7	5/2⁻	M1+E2	DCO=1.28 *9*
2263 *1*	66.5 *5*	2713.6	9/2⁺	450.3	5/2⁺	E2	DCO=1.84 *1*
2316.9[‡] *5*	0.8 *1*	7769.4	(9/2⁻)	5452.6	11/2⁺		
2453 *1*	5.0 *2*	2903.5	3/2⁺	450.3	5/2⁺	D	DCO=1.14 *4*
2478 *1*	7.4 *2*	6448.8	(9/2⁻)	3970.7	5/2⁻	E2	DCO=1.73 *5*
2630 *1*	5.5 *2*	4680.6	7/2⁺	2050.3	7/2⁺		
2739 *1*	11.6 *3*	5452.6	11/2⁺	2713.6	9/2⁺	D+Q	DCO=0.49 *2*
2752[@]		8945	(15/2⁺)	6193.1	13/2⁺		E_γ: 2745 in 1977Ev02.
2771 *1*	1.8 *1*	2770.8	1/2⁻	0.0	3/2⁺		
2832 *1*	0.7 *2*	6802.9	5/2⁻	3970.7	5/2⁻		
2903 *1*	3.3 *3*	2903.5	3/2⁺	0.0	3/2⁺		
3221 *1*	0.4 *1*	5992.3	3/2⁻	2770.8	1/2⁻		
3223 *1*	9.5 *3*	5936.8	11/2⁺	2713.6	9/2⁺	D+Q	DCO=0.71 *4*
3236 *1*	2.7 *3*	5286.7	5/2⁺	2050.3	7/2⁺		
3343 *1*	11.9 *2*	3793.3	3/2⁻	450.3	5/2⁺	D	DCO=0.99 *2*
3402 *1*	5.8 *3*	5452.6	11/2⁺	2050.3	7/2⁺	Q	DCO=1.80 *6*
3415 *1*	2.9 *6*	6128.5	7/2⁻	2713.6	9/2⁺		
3417[@]		9610	(17/2⁺)	6193.1	13/2⁺		E_γ: 3410 in 1977Ev02.
3480 *1*	17.0 *3*	6193.1	13/2⁺	2713.6	9/2⁺	E2	DCO=1.89 *3*
3636 *1*	1.9 *2*	5992.3	3/2⁻	2356.3	1/2⁺		
3735 *1*	1.2 *2*	6448.8	(9/2⁻)	2713.6	9/2⁺		
3775 *1*	3.1 *2*	6131.7	(1/2,5/2)	2356.3	1/2⁺		
3886 *1*	1.8 *2*	5936.8	11/2⁺	2050.3	7/2⁺		DCO=1.41 *12* Mult.: E2 in 2013Je04. DCO ratio 1.41 is low for a stretched quadrupole transition.
4188 *1*	4.4 *5*	6238.7	(9/2⁺)	2050.3	7/2⁺	D+Q	DCO=0.62 *2*
4230 *1*	11.5 *3*	4680.6	7/2⁺	450.3	5/2⁺	M1+E2	DCO=0.59 *1*
4307 *1*	2.4 *3*	7020.4	(9/2⁺)	2713.6	9/2⁺		DCO=1.30 *18* Mult.: ΔJ=0 transition.
4325 *1*	2.2 *3*	6375.7	(7/2⁺)	2050.3	7/2⁺		DCO=1.6 *3* Mult.: ΔJ=0 transition.

Continued on next page (footnotes at end of table)

$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02 (continued)

$\gamma(^{23}Mg)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.&	Comments
4398 *1*	5.3 *2*	6448.8	(9/2⁻)	2050.3	7/2⁺	D	DCO=0.97 *3*
4418 *1*	2.4 *2*	6774.8	(1/2,5/2)	2356.3	1/2⁺		
4430 *1*	6.1 *3*	7143.9	13/2⁺	2713.6	9/2⁺		I_γ: for 4430+4435 γ-ray doublet.
4435 *1*	6.1 *3*	7149.2	(9/2⁺)	2713.6	9/2⁺		I_γ: for 4430+4435 γ-ray doublet.
4547 *1*	9.4 *2*	7260.9	11/2⁺	2713.6	9/2⁺	M1+E2	DCO=0.75 *6*
4836 *1*	2.5 *1*	5286.7	5/2⁺	450.3	5/2⁺		DCO=1.66 *8* Mult.: ΔJ=0 transition.
4871 *1*	0.5 *1*	7227.9	(1/2,5/2)	2356.3	1/2⁺		
4969 *1*	1.6 *1*	7020.4	(9/2⁺)	2050.3	7/2⁺	D+Q	DCO=1.06 *4*
5054.8‡ *6*	1.1 *2*	7769.4	(9/2⁻)	2713.6	9/2⁺		
5067.1‡ *11*	0.8 *1*	7780.7	11/2⁺	2713.6	9/2⁺		
5138.1 *13*		7852.3	(7/2⁺)	2713.6	9/2⁺		E_γ: Reported in 2004Je02. Missing in the full version 2013Je04. First author expressed it might be a mistake, but did not confirm, while communicated by the reviewer of this manuscript B. Singh (dated: March 14, 2019).
5240 *1*	1.7 *1*	5690.4	7/2⁺	450.3	5/2⁺		DCO=0.44 *3*
5300.2‡ *9*	0.5 *1*	8015.8	(5/2⁺ to 11/2⁺)	2713.6	9/2⁺		
5399 *1*	1.0 *1*	7449.7	9/2⁺	2050.3	7/2⁺	D+Q	DCO=0.98 *5*
5445 *1*	0.2 *1*	7496.0	(9/2⁺)	2050.3	7/2⁺		
5677 *1*	1.0 *1*	6128.5	7/2⁻	450.3	5/2⁺	D	DCO=0.87 *13*
5690 *1*	5.4 *4*	5690.4	7/2⁺	0.0	3/2⁺		
5729.1‡ *11*	0.4 *1*	7780.7	11/2⁺	2050.3	7/2⁺	E2	DCO=1.42 *11*
5921 *1*	1.5 *1*	6372.1	(7/2⁺)	450.3	5/2⁺	D+Q	DCO=2.48 *21*
5966.7‡ *11*	0.2 *1*	8015.8	(5/2⁺ to 11/2⁺)	2050.3	7/2⁺		E_γ: In 2013Je04, the γ-ray placement from (9/2⁺) is most likely a typo.
6062 *1*	3.2 *2*	6513.1	(7/2⁺)	450.3	5/2⁺	D+Q	DCO=0.69 *3*
6109.5‡ *18*	0.07 *1*	8160.7	5/2⁺	2050.3	7/2⁺		
6123 *1*	0.7 *1*	6574.1	(5/2⁺)	450.3	5/2⁺		
6353 *1*	2.4 *2*	6804.2	(7/2⁺)	450.3	5/2⁺		
6660 *1*	1.5 *1*	7111.3	(7/2⁺)	450.3	5/2⁺		
6931 *1*	2.8 *1*	7382.4	7/2⁺	450.3	5/2⁺	D+Q	DCO=0.74 *3*
6998 *1*	1.6 *1*	7449.7	9/2⁺	450.3	5/2⁺	Q	DCO=1.58 *12*
7172.5‡ *9*	0.5 *1*	7624.0	9/2⁺	450.3	5/2⁺	E2	DCO=1.57 *24*
7196.0‡ *26*	0.4 *1*	7647	3/2⁺	450.3	5/2⁺	D+Q	DCO=0.87 *15*
7333.7‡ *11*	1.9 *1*	7785.2	7/2⁽⁺⁾	450.3	5/2⁺	M1+E2	DCO=0.89 *5*

† From 2013Je04, except otherwise noted. $E\gamma$ uncertainty of 1 keV is assigned based on a statement in 2013Je04 that crossover transition energies were reproduced within 0.5 to 1 keV as compared to the energy sums of two coincident γ-ray energies. All the data are from 2013Je04 unless otherwise stated.
‡ From 2004Je02.
# From 1973Wa26.
@ From level energy difference, recoil corrected, rounded to nearest keV. Placement in 1977Ev02.
& Assigned by 2013Je04 based on DCO ratio 0.9 *1* for pure stretched-dipole transitions and 1.8 *1* for pure stretched-quadrupole ones. Magnetic/electric assignments from depopulating level′s mean lifetime measurements (RUL).

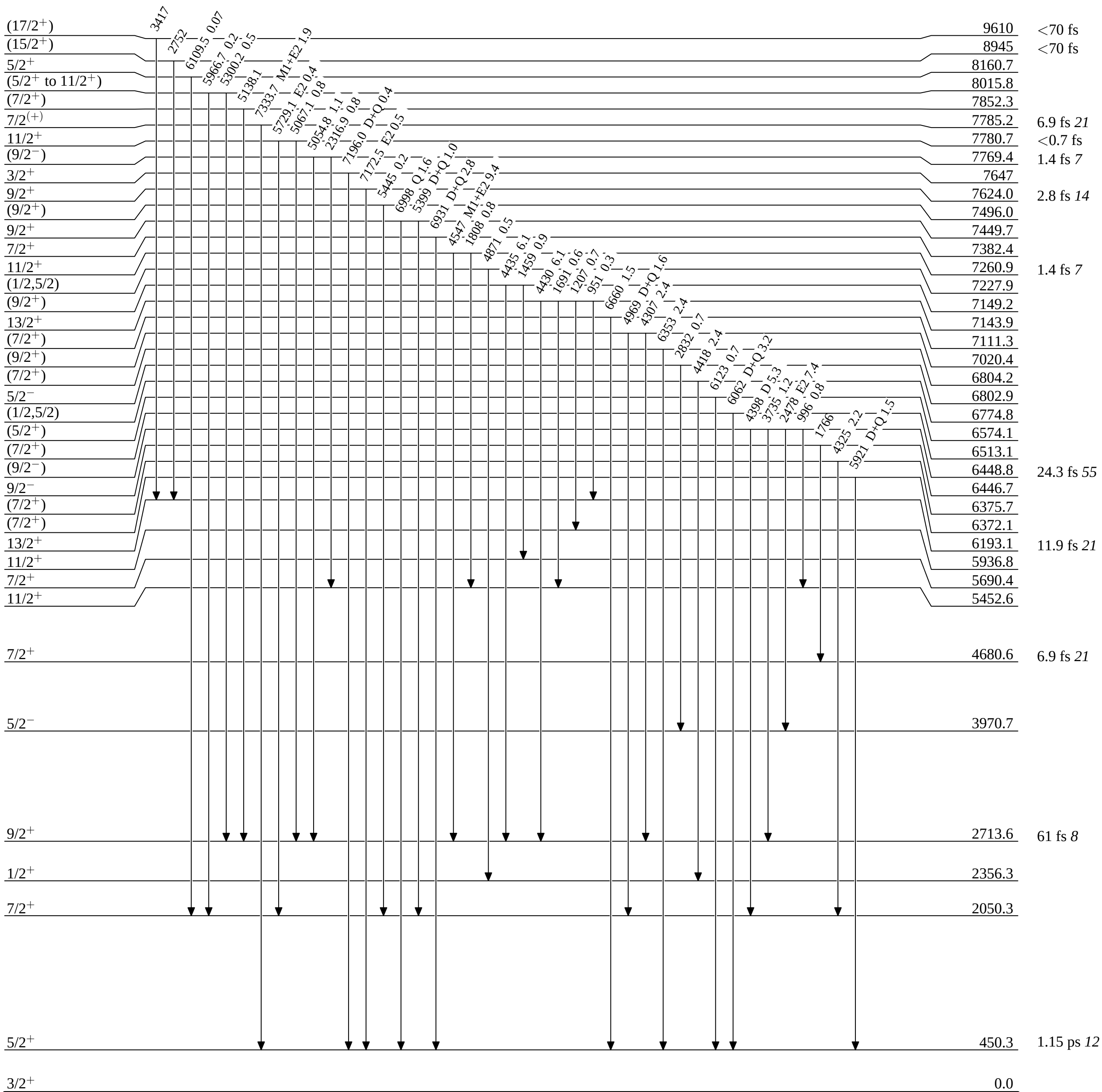
$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02

Legend

Level Scheme

Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$

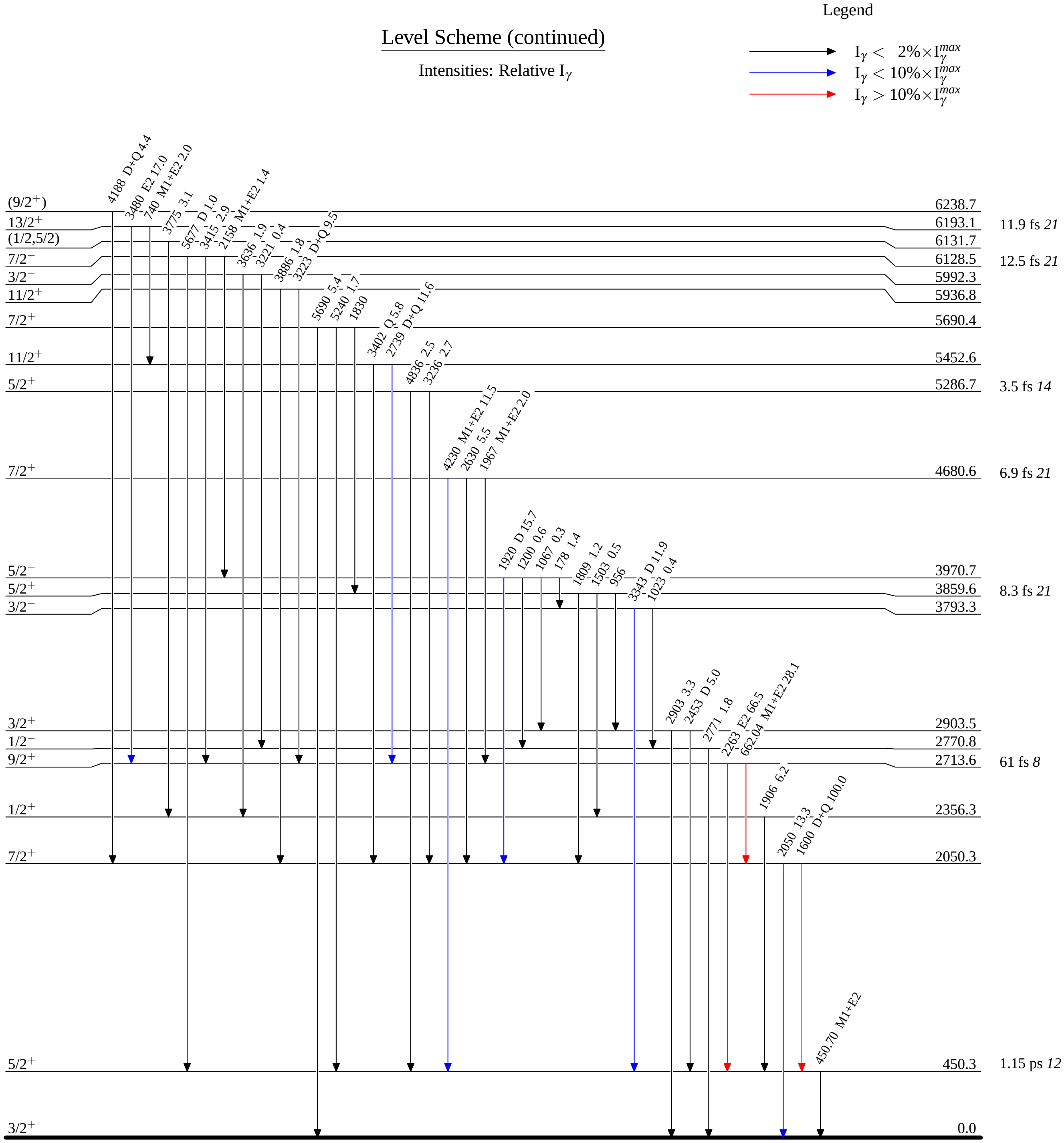


$^{23}_{12}Mg_{11}$

$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02

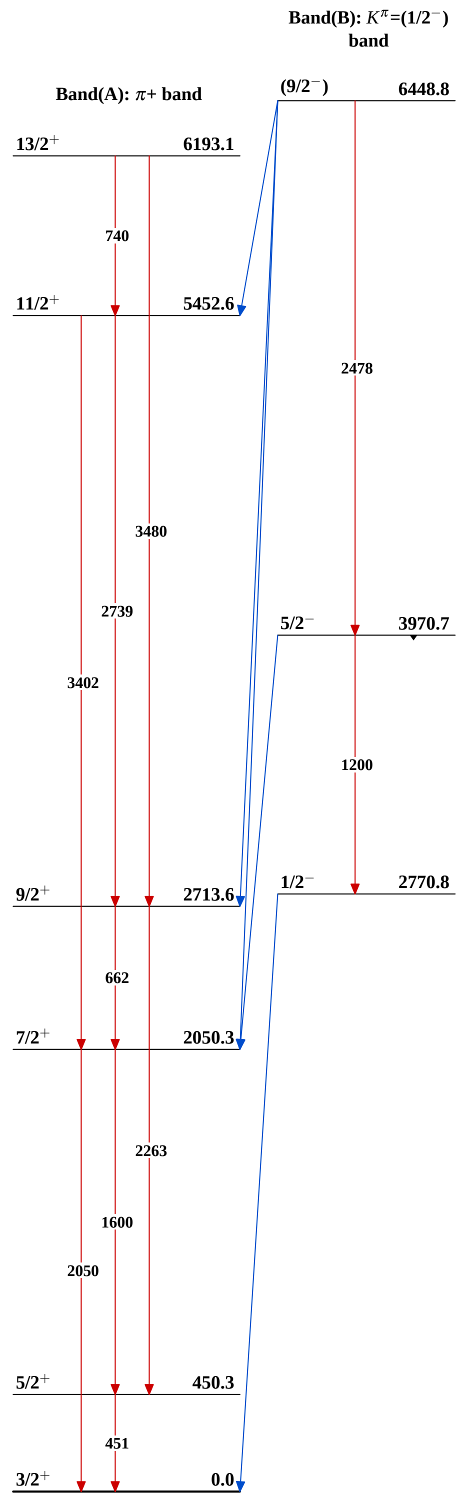
Level Scheme (continued)

Intensities: Relative I_γ



$^{23}_{12}Mg_{11}$

$^{12}C(^{12}C,n\gamma)$ 2013Je04,1977Ev02



$^{23}_{12}Mg_{11}$

$^{12}C(^{16}O,\alpha n\gamma)$ **2018Bo17**

Other: 2017Bo08.

2018Bo17,2017Bo08: E=60-70 MeV; measured charged particles by the 4π DIAMANT detector consisting of 80 CsI(Tl) scintillators, neutrons using the neutron wall array of 50 liquid scintillators, Eγ, Iγ (numerical value not given), particle-$\gamma\gamma$-coin using γ-ray array EXOGAM of 10 Compton suppressed clovers. Seven clovers were placed at 90° and other three at 135° with respect to the beam direction; deduced excited levels and MED (Mirror Energy Differences) between ^{23}Mg and ^{23}Na.

^{23}Mg Levels

E(level)†	J$^\pi$‡
0.0	3/2$^+$
450 *1*	5/2$^+$
2050 *1*	7/2$^+$
2713 *1*	9/2$^+$
5452 *1*	11/2$^+$
5937 *1*	11/2$^+$
6193 *1*	13/2$^+$
7144 *1*	13/2$^+$
8938 *1*	15/2$^+$
9595 *1*	15/2$^+$

† From least-squares fit to γ-ray energies, assuming ΔE=1 keV.
‡ Proposed by 2017Bo08, based on decay scheme and yrast/yrare band structure.

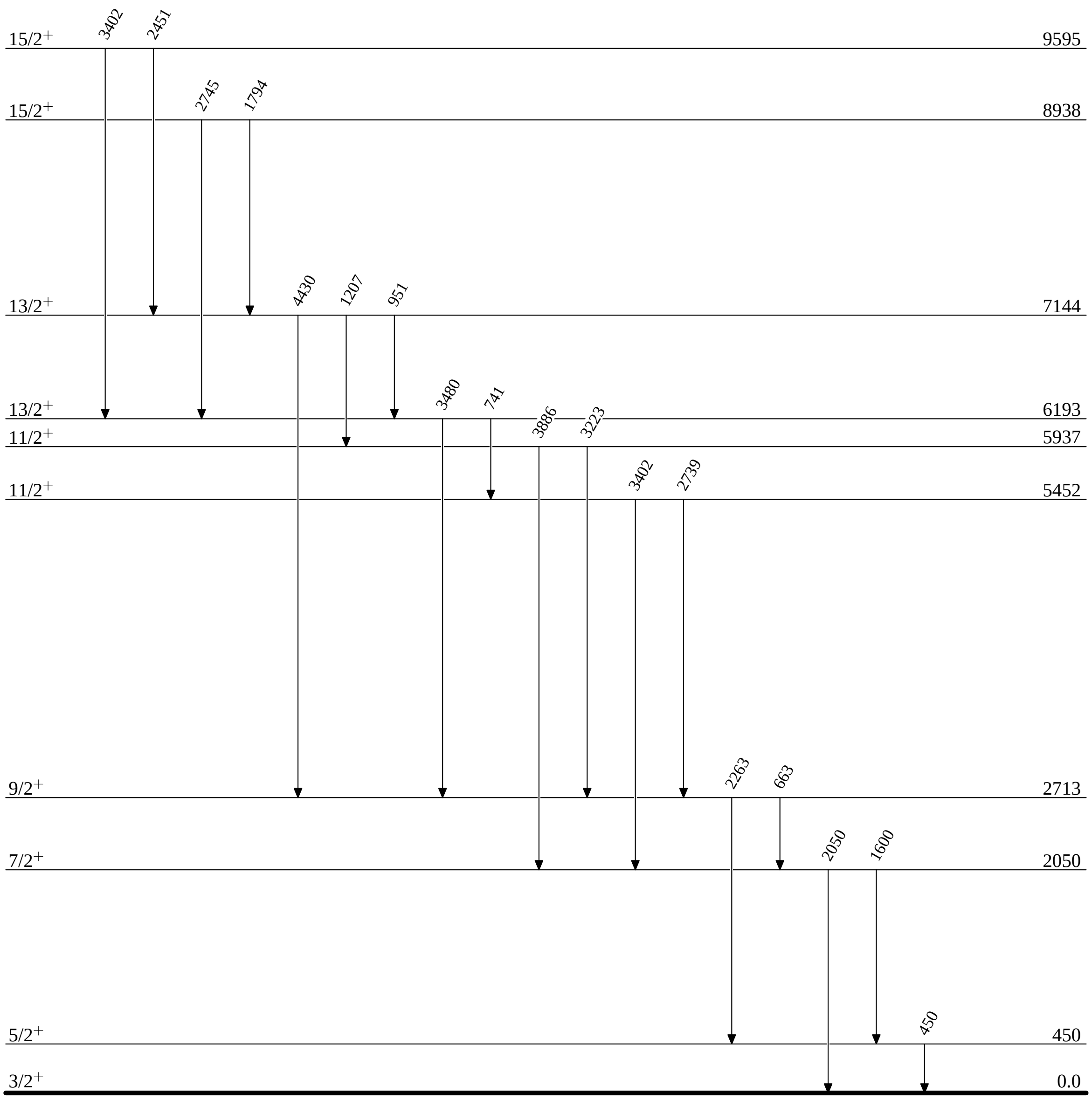
$\gamma(^{23}$Mg)

E$_\gamma$	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	E$_\gamma$	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
450	450	5/2$^+$	0.0	3/2$^+$	2451	9595	15/2$^+$	7144	13/2$^+$
663	2713	9/2$^+$	2050	7/2$^+$	2739	5452	11/2$^+$	2713	9/2$^+$
741	6193	13/2$^+$	5452	11/2$^+$	2745	8938	15/2$^+$	6193	13/2$^+$
951	7144	13/2$^+$	6193	13/2$^+$	3223	5937	11/2$^+$	2713	9/2$^+$
1207	7144	13/2$^+$	5937	11/2$^+$	3402†	5452	11/2$^+$	2050	7/2$^+$
1600	2050	7/2$^+$	450	5/2$^+$	3402†	9595	15/2$^+$	6193	13/2$^+$
1794	8938	15/2$^+$	7144	13/2$^+$	3480	6193	13/2$^+$	2713	9/2$^+$
2050	2050	7/2$^+$	0.0	3/2$^+$	3886	5937	11/2$^+$	2050	7/2$^+$
2263	2713	9/2$^+$	450	5/2$^+$	4430	7144	13/2$^+$	2713	9/2$^+$

† Multiply placed.

$^{12}C(^{16}O,\alpha n\gamma)$ 2018Bo17

Level Scheme



$^{23}_{12}Mg_{11}$

^{22}Na(p,γ) 2011Sa12

Others: 2010Sa26, 2002Wa33, 1996St08, 1990Se09, 1989Go01.
Based on XUNDL: Compiled by J. Chen and B. Singh (McMaster); Dec 9, 2010.
2011Sa12,2010Sa26: E=213, 288, 454 and 610 keV proton beams of about 40 μA produced by a tandem Van de Graaff accelerator at the Center for Experimental Nuclear Physics and Astrophysics (CENPA) of the University of Washington. Radioactive ^{22}Na target made by bombarding thick SiC targets with a 40 μA, 500 MeV proton beam from the TRIUMF cyclotron. The γ rays were detected by two high purity 100% Ge (HPGe) crystals (FWHM=4.4 and 7.4 keV at 1.275 MeV with high rates and 2.2 and 3.0 keV with low rates) surrounded by Pb shielding and scintillators for cosmic-ray rejection. Measured γ yields. Deduced resonance energies and resonance strengths.
All data are from 2011Sa12; unless otherwise stated.

^{23}Mg Levels

E(level)†	J$^\pi$#	Comments
0.0	3/2$^+$	
450.2 *13*	5/2$^+$	
2051.8 *13*	7/2$^+$	
2715.1 *15*		
7784.7 *12*	3/2$^+$,5/2$^+$	E(level): 7784.6 *16* from E(p)(lab)=213.5 *14* (2011Sa12) and S(p). Resonance strength $\omega\gamma$=5.7 meV *+16−9* (2011Sa12).
7856.1 *10*	(7/2$^+$)	E(level): 7855.9 *13* from E(p)(lab)=288.1 *11* (2011Sa12) and S(p). Resonance strength $\omega\gamma$=39 meV *8* (2011Sa12).
8015.3 *8*		E(level): 8014.8 *11* from E(p)(lab)=454.2 *8* (2011Sa12) and S(p). Resonance strength $\omega\gamma$=166 meV *22* (2011Sa12).
8062‡ *2*		E(level): From E(lab)=503 *2* (1990Se09).
8163.9 *8*	5/2$^+$	E(level): 8163.6 *11* from E(p)(lab)=609.8 *8* (2011Sa12) and S(p). Resonance strength $\omega\gamma$=591 meV *+103−74* (2011Sa12).
8288‡ *3*		E(level): From 1990Se09. E(lab)=740 *2* (1990Se09).
8342‡ *2*		E(level): From E(lab)=796 *2* (1990Se09).

† Level energies 7784.7 and above from 2011Sa12, except otherwise noted. Lower levels from γ ray feeding from above levels. E_p(lab) in 2011Sa12 is the adopted value from excitation function and value from E_γ. S(p)=7580.5 *8* in 2011Sa12 from measured masses of ^{23}Mg in 2009Sa38 and 2008Mu05. S(p)=7580.97 *23* (2017Wa10).
‡ From 1990Se09.
# From Adopted Levels.

γ(^{23}Mg)

E_i(level)	J_i^π	E_γ†	I_γ†	E_f	J_f^π	Comments
7784.7	3/2$^+$,5/2$^+$	5732#	11 *5*	2051.8	7/2$^+$	
		7332.7 *12*	89 *5*	450.2	5/2$^+$	
7856.1	(7/2$^+$)	5140.6 *10*	67 *5*	2715.1		
		5803.2 *13*	26 *4*	2051.8	7/2$^+$	
		7405#	6.7 *29*	450.2	5/2$^+$	
8015.3		5300.1 *8*	51.9 *12*	2715.1		
		5962.7 *8*	43.6 *12*	2051.8	7/2$^+$	
		7564#	4.5 *8*	450.2	5/2$^+$	
8062		8061‡		0.0	3/2$^+$	
8163.9	5/2$^+$	6111#	20.0 *18*	2051.8	7/2$^+$	I_γ: From 1996St08. In 2011Sa12, this γ ray was obscured by ^{19}F background.
		7711.2 *11*	18.6 *13*	450.2	5/2$^+$	
		8162.3 *9*	61.3 *18*	0.0	3/2$^+$	

Continued on next page (footnotes at end of table)

^{22}Na(p,γ) 2011Sa12 (continued)

γ(^{23}Mg) (continued)

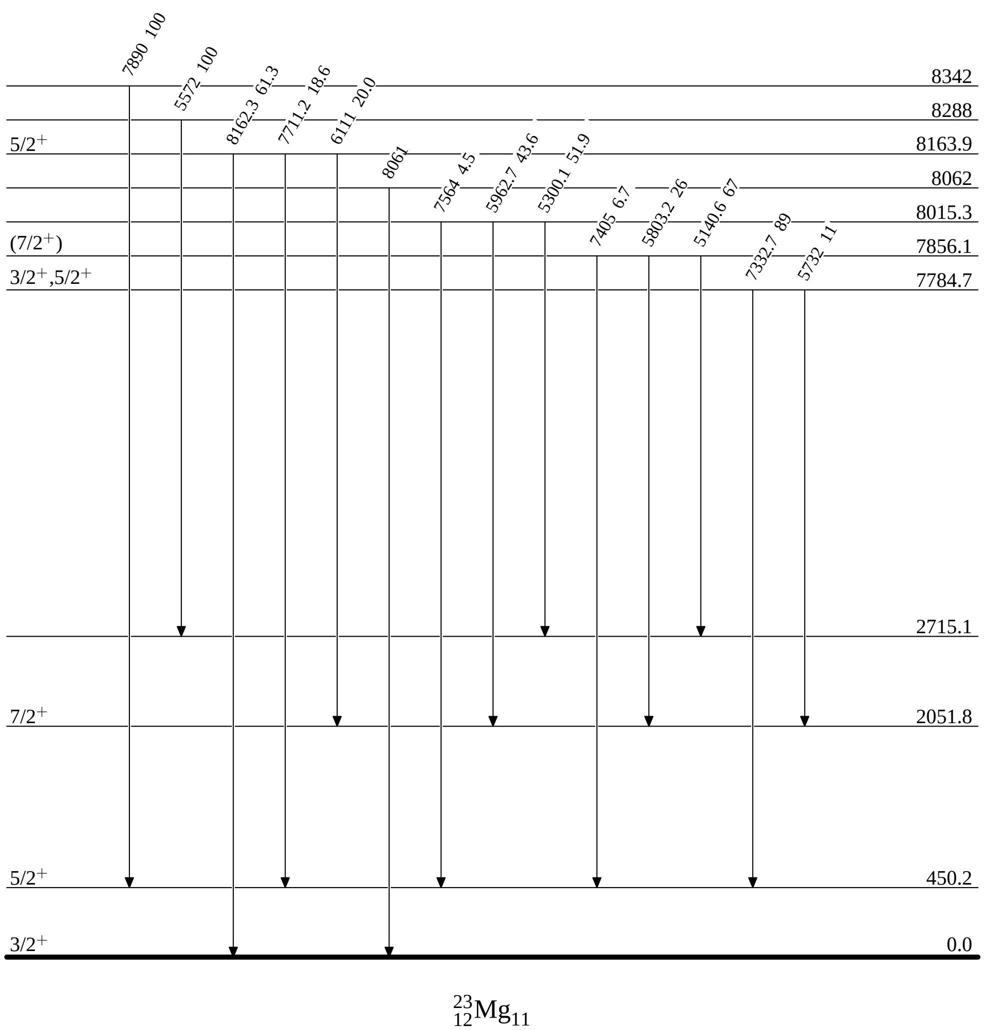
E_i(level)	E_γ †	I_γ †	E_f	J^π_f
8288	5572‡	100	2715.1	
8342	7890‡	100	450.2	5/2$^+$

† From 2011Sa12, except otherwise noted.
‡ From level energy difference, recoil energy subtracted. Placement in 1990Se09.
# From level energy difference, recoil energy subtracted. Placement in 2011Sa12.

$^{22}Na(p,\gamma)$ 2011Sa12

Level Scheme

Intensities: % photon branching from each level



^{22}Na(^{3}He,d) 1995Sc36

J^{π}(^{22}Na)=3^{+}.

Target: 0.7 mCi ^{22}Na target was prepared at ISOLDE, CERN, implanting ^{22}Na ions on a carbon foil (thickness 75 μg/cm^{2}); Projectile: ^{3}He beam, E=30 MeV; Q3D spectrograph, deuteron spectra were obtained with a position-sensitive detection array (a sequence of several proportional wire chambers with cathod readouts), energy resolution of about ΔE ~ 1.5 keV, depending on reaction kinematics, the ejectiles were finally stopped in a scintillation detector. Deuteron and other particles were separated with ΔE-E arrangement. Measured deuteron spectra, angular distribution of deuteron groups at angles θ(lab=7.5 ° to 31°), deduced spectroscopic factors. FWHM 15 keV.

^{23}Mg Levels

E(level)†	L‡	(2J+1)C^{2}S#	Comments
6236 *8*	2+0	0.47 *10*	(2J+1)C^{2}S: 0.08 for l=0.
6375 *8*	2(+0)	1.04 *7*	(2J+1)C^{2}S: 0.00 for l=0.
6507 *8*	2+0	0.24 *6*	(2J+1)C^{2}S: 0.08 *5* for l=0.
6538 *8*	2(+0)	0.20 *3*	(2J+1)C^{2}S: 0.00 for l=0.
6568 *8*	0+2	0.37 *8*	(2J+1)C^{2}S: 1.58 *18* for l=0.
6899 *8*	2+0	0.50 *7*	(2J+1)C^{2}S: 0.07 for l=0.
6984 *8*	0+2	0.06 *3*	(2J+1)C^{2}S: 0.30 *7* for l=0.
7017 *8*	2+0	0.14 *3*	(2J+1)C^{2}S: 0.02 for l=0.
7111 *8*	0+2	0.37 *9*	(2J+1)C^{2}S: 1.06 *30* for l=0.
7258 *8*	2+0,1+3		(2J+1)C^{2}S: 0.44 *21* for l=2, 0.21 (≤0.67) for l=0, 0.12 (≤0.63) for l=1, and 1.02 *23* for l=3.
7493 *8*	2(+0)	0.45 *6*	(2J+1)C^{2}S: 0.00 for l=0.
7582 *8*		≤0.03	(2J+1)C^{2}S: ≤0.07 for l=0.
7621 *8*	2+0	1.12 *12*	(2J+1)C^{2}S: 0.12 for l=0.
7641 *8*	2+0	0.34 *6*	(2J+1)C^{2}S: 0.04 for l=0.
7780 *8*	2+0,1+3		(2J+1)C^{2}S: 0.43 *13* for l=2, 0.36 *34* for l=0, 0.27 *9* for l=1, and 0.50 *16* for l=3.
7795 *8*	0+2	0.38 *14*	(2J+1)C^{2}S: 0.33 for l=0.
7853 *8*	2(+0)	0.56 *9*	(2J+1)C^{2}S: 0.00 (≤0.08) for l=0.
8016 *8*	2	0.74 *5*	
8058 *8*	0+2,1+3		(2J+1)C^{2}S: 0.91 *7* for l=2, 0.88 *30* for l=0, 1.02 *21* for l=1, and 0.32 *16* for l=3.
8076 *8*	0+2,1+3	0.79 *10*	(2J+1)C^{2}S: 0.79 *10* for l=2, 1.41 *34* for l=0, 0.55 *16* for l=1, and 1.02 *23* for l=3.

† From 1995Sc36. Absolute uncertainty stated to be about 8 keV. The relative uncertainty was 2 keV.

‡ From comparison of experimental angular distribution with DWBA calculations.

Values for l=2 listed in the column and for l=0, 1, 3 in the comments section. In some cases, 1995Sc36 list an upperlimit without a defination for l=0 values. Those values are not listed in the dataset.

$^{23}Na(^{3}He,t)$ 2002Fu17

$J^{\pi}(^{23}Na)=3/2^{+}$.

Target: Thin foil of Na_2CO_3 using polyvinyl alcohol as supporting material (thickness about 2 mg/cm^2); Projectile: ^{3}He, E=140 MeV/nucleon, from the K=400, RCNP Ring Cyclotron; Outgoing tritons were momentum analyzed and detected at the focal plane of the Grand Raiden spectrometer with a multiwire drift-chamber system allowing track reconstruction; FWHM=45 keV; Measured triton spectra mainly at 0°, and also $\Theta(\sqrt{(\theta^2+\phi^2)})$ within 0° to 2.0° in steps of 0.05° for triton intensity; Deduce excitation energy, L value, B(GT) strength. Also studied isobaric analogue structure of ^{23}Na, mirror nuclide of ^{23}Mg.

^{23}Mg Levels

E(level)	L[#]	Comments
0.0	0	B(GT)=(0.340 *14*) (including Fermi-transition strength).
451	0	B(GT)=0.146 *6* (used for calibration).
2360 *3*	0	B(GT)=0.055 *4*.
2906 *3*	0	B(GT)=0.193 *11*.
3860 *3*	0	B(GT)=0.055 *4*.
4357 *3*	0	B(GT)=0.250 *13*.
5291 *3*	0	B(GT)=0.066 *5*.
5658[†] *4*	0	B(GT)=0.270 *17*.
5712[†] *8*	0	B(GT)=0.061 *9*.
6138 *3*		L: Populated with small L transfer, 2002Fu17 noted.
6550 *3*	0	B(GT)=0.116 *7*.
6818 *3*	0	B(GT)=0.028 *3*.
6911 *3*	0	B(GT)=0.057 *4*.
7114[‡]		L: ≠0 (from Fig. 5 caption).
7241[‡]		E(level): May be a doublet of 7228.5 and 7261.9 in Adopted Levels. Not adopted. L: ≠0 (from Fig. 5 caption).
7449[‡]		L: ≠0 (from Fig. 5 caption).
7790 *6*		L: ≠0 (from Fig. 5 caption).
7851 *6*		L: ≠0 (from Fig. 5 caption).
8076 *15*		L: ≠0 (from Fig. 5 caption).
8168 *4*	0	B(GT)=0.290 *15*.
8452 *5*	0	B(GT)=0.039 *3*.
9159 *6*	0	B(GT)=0.069 *5*.
9502 *6*	0	B(GT)=0.055 *4*.
10290 *7*	0	B(GT)=0.046 *4*.
11132 *8*	0	B(GT)=0.062 *5*.

† Close doublet state – the peak shape was well reproduced at 5691 keV.
‡ From Fig. 5 in 2002Fu17.
\# Determined from relative peak intensities of the triton spectra at angle intervals of 0°–0.5°, 0.5°–1.0°, 1.0°–1.5°, and 1.5°–2.0°.

^{24}Mg(p,d),(pol p,d) 1986Mi01,1979Mi15,2020Kw01

Other references: 1994Ku06, 1984Ha02, 1984Al21, 1982Mi10, 1980Ho18, 1980Oh06, 1979Cl03, 1975Ka10, 1968Ko11, 2001Ba17.
1986Mi01: ^{24}Mg(pol p,d) E=49.2, 94.8, 150.3 MeV. Measured $\sigma(\theta)$, $A_y(\theta)$. FWHM 200-300 keV. 1986Mi01, 1984Al21, 1982Mi10, and 1979Mi15 same research group.
1979Mi15: ^{24}Mg(p,d) E=94.8 MeV. Measured $\sigma(\theta)$, performed DWBA analysis. FHWM = 80 keV.
2020Kw01: ^{24}Mg(p,d) E=31 MeV. ΔE+E Si telescope. Measured $\sigma(\theta)$, deduced excited levels, L, spin-parity. DWBA calcualtions. 99.9% enriched target. Energy resolution to the ground state was about 0.4%.
1994Ku06: ^{24}Mg(p,d) E=34.945 MeV. Magnetic spectrograph. Deduced possible spin-parity.

^{23}Mg Levels

E(level)[†]	J^{π}[b]	L[†]	S[e]	Comments
0.0	3/2$^+$	2	0.11	S: 0.12 (for 94.8 MeV) and 0.13 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$=1100 μb/sr at $\theta_{c.m.}$=10° (1979Mi15).
450[c] *1*	5/2$^+$	2	1.5	S: 1.8 (for 94.8 MeV) and 1.7 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$=6840 μb/sr at $\theta_{c.m.}$=11° (1979Mi15).
2048[c] *2*				E(level): Other: 2050 (1986Mi01).
2360	1/2$^+$	0	0.09	E(level): 2359.0 *14* (from literature) was used for internal energy calibration (2020Kw01). S: and 0.06 (for 49.2 MeV), 0.12 and 0.08 (for 94.8 MeV), 0.23 and 0.14 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$=118 μb/sr at $\theta_{c.m.}$=18.5° (1979Mi15).
2770	1/2$^-$	1	1.4	E(level): 2771 *1* (from literature) was used for internal energy calibration (2020Kw01). L: In 2020Kw01, $\sigma(\theta)$ fitted well considering L=1 and a constant contribution for DWBA calculations, instead of only L=1. S: 1.8 (for 94.8 MeV) and 1.8 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$>4760 μb/sr at $\theta_{c.m.}$<6.5° (1979Mi15).
2919[c] *6*	(3/2$^+$)	2	0.09	E(level): Other: 2910 – poorly resolved (1986Mi01). S: 0.095 (for 94.8 MeV) and 0.07 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$=955 μb/sr at $\theta_{c.m.}$=8° (1979Mi15).
3800	3/2$^-$	1	0.62	S: 0.95 (for 94.8 MeV) and 0.90 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$>1800 μb/sr at $\theta_{c.m.}$<6.5° (1979Mi15).
3810[c] *4*				E(level): Possible doublet of 3793 and 3859 – measured $\sigma(\theta)$ fitted well with considerations of L=1 (83.7%) and L=2 (16.3%) – 2020Kw01 noted. In Adopted Levels the corresponding energies are 3794.1 and 3860.6, respectively.
3974[c] *3*				E(level): Other: 3970 (1979Mi15 – Fig. 1).
4363[c] *2*	1/2$^+$	0	0.036	E(level): Other: 4360 (1986Mi01). S: and 0.025 (for 49.2 MeV), 0.070 and 0.045 (for 94.8 MeV), 0.070 0.050 (for 150.3 MeV) (1986Mi01). $d\sigma/d\Omega_{c.m.}$=86 μb/sr at $\theta_{c.m.}$=18° (1979Mi15).
4686[c] *7*				E(level): Other: 4680 (1979Mi15 – Fig. 1). $d\sigma/d\Omega_{c.m.}$=30 μb/sr at $\theta_{c.m.}$=21.5° (1979Mi15).
5290[#]		2		E(level): 5286 *1* (from literature) was used for internal energy calibration (2020Kw01). L: From 1982Mi10. $d\sigma/d\Omega_{c.m.}$=910 μb/sr at $\theta_{c.m.}$=11.5° (1979Mi15).
5450?[‡]				$d\sigma/d\Omega_{c.m.}$=4.0 μb/sr at $\theta_{c.m.}$=47° – data presented with question a ? mark in 1979Mi15, probably to indicate uncertain data.
5688[c] *7*				E(level): Other: 5690 (1979Mi15 – Fig. 1).
5990[#]		1		E(level): 5992 *1* (from literature) was used for internal energy calibration (2020Kw01). L: From 1982Mi10. $d\sigma/d\Omega_{c.m.}$>1310 μb/sr at $\theta_{c.m.}$<6.5° (1979Mi15).
6144[c] *3*	(3/2$^+$,5/2$^+$)[c]	2[c]		E(level),J^{π}: 2020Kw01 compare this level with 6129.3 and discuss the disagreement with J^{π}=7/2$^-$. However, the level energy is also comparable with 6132.3 keV in Adopted Levels.
6246[c] *4*				
6391[c] *2*	(3/2$^+$,5/2$^+$)[c]	2[c]		E(level),J^{π}: 2020Kw01 compare this level with 6372.5 and discuss the disagreement

Continued on next page (footnotes at end of table)

^{24}Mg(p,d),(pol p,d) 1986Mi01,1979Mi15,2020Kw01 (continued)

^{23}Mg Levels (continued)

E(level)[†]	J$^{\pi}$[b]	L[†]	Comments
			with J^{π}=7/2$^+$. However, the level energy is significantly different – might be considered as a different level.
6537[c] *3*	(3/2$^+$,5/2$^+$)[c]	2[cd]	E(level): Other: 6540 (1979Mi15 – Fig. 1). L: Implied from the spin and parity as of the text in 2020Kw01.
6802[c] *2*	(3/2$^+$,5/2$^+$)[c]	2[c]	E(level): Other: 6810 (1979Mi15 – Fig. 1).
6912[c] *6*	(3/2$^+$,5/2$^+$)[c]	2[cd]	
7007[c] *5*	(3/2$^+$,5/2$^+$)[c]	2[cd]	
7144[c] *4*	(3/2$^+$,5/2$^+$)[c]	2[cd]	
7260[c] *6*	(3/2$^+$,5/2$^+$)[c]	2[c]	E(level),L: Assuming the peak arose from a singlet state (2020Kw01). Other excitation energy: 7240 *20* (1979Mi15).
7441[c] *8*			E(level): Other: 7420 *30* (1979Mi15).
7585[@] *10*			E(level): Other: 7610 *30* (1979Mi15).
7625[c] *9*		4	E(level),L: Other: 7624 *10* (1994Ku06). L from 1994Ku06.
7643[@] *10*		2	L: From 1994Ku06.
7788[c] *5*	(3/2$^+$,5/2$^+$)[c]	2[cd]	E(level),L: Others: 7782 *10* (1994Ku06), 7790 *30* (1979Mi15). L=(1) (1979Mi15).
7857[c] *10*			E(level): Other: 7856 *10* (1994Ku06).
8014[@] *10*			
8044[@] *4*			E(level): Others: 8055 *10* (1994Ku06), 8060 *40* (1979Mi15).
8072[@] *10*			
8141[&] *5*			E(level): Others: 8142 at 8° (2001Ba17).
8170[ac] *4*			E(level): Others: 8170 *5* at 16° and 8168 at 8° angle (2001Ba17).
8197[&a] *5*			E(level): Other: 8195 at 8° angle (2001Ba17).
8330[c] *6*	(3/2$^+$,5/2$^+$)[c]	2[cd]	E(level),L: Assuming the peak arose from a singlet state (2020Kw01).
8436[c] *7*			E(level): Other: 8420 *40* (1979Mi15).
8610[‡] *40*			
8770[c] *8*			E(level): Other: 8770 *50* (1979Mi15).
8924[c] *5*		1[‡]	E(level): Other: 8910 *20* (1979Mi15). $d\sigma/d\Omega_{c.m.}$>177 μb/sr at $\theta_{c.m.}$<8.6° (1979Mi15).
9020[‡] *30*		1[‡]	$d\sigma/d\Omega_{c.m.}$>122 μb/sr at $\theta_{c.m.}$<8.6° (1979Mi15).
9123[c] *7*			E(level): Other: 9140 *40* (1979Mi15).
9350[c] *13*			
9472[c] *7*		0+1 or 2[‡]	E(level): Other: 9490 *40* (1979Mi15).
9642[c] *8*			E(level): Used for internal energy calibration (2020Kw01).
9670[‡] *20*		1[‡]	$d\sigma/d\Omega_{c.m.}$>421 μb/sr at $\theta_{c.m.}$<8.6° (1979Mi15).
9750[‡] *50*			
9850[‡] *30*		(2)[‡]	
9970[‡] *40*		(1)[‡]	L: (2 step + l = 1).
10120[‡] *50*			L: (2 step) (1979Mi15).
10270[‡] *30*		(1)[‡]	L: (2 step + l = 1).
10440[‡] *50*		(1)[‡]	L: (2 step + l = 1).
10570[‡] *20*		1[‡]	$d\sigma/d\Omega_{c.m.}$>306 μb/sr at $\theta_{c.m.}$<8.6° (1979Mi15).
10750[‡] *40*		(2)[‡]	L: (2 step + l = 2).
10920 *70*		[‡]	
11030 *60*		[‡]	
11210 *60*		[‡]	
11380 *60*		[‡]	
11540 *60*		[‡]	

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^{24}Mg(p,d),(pol p,d) 1986Mi01,1979Mi15,2020Kw01 (continued)

^{23}Mg Levels (continued)

E(level)†	L†
11800 *40*	‡
11990 *50*	‡
12480 *80*	‡
12690 *80*	‡
12940 *80*	‡
13280 *80*	‡

† From 1986Mi01, except where otherwise noted.
‡ From 1979Mi15.
# From Fig. 1 in 1979Mi15.
@ From Fig. 1 in 1994Ku06. Authors noted uncertainty within 10 keV.
& From 2001Ba17 (p,d) at 16° angle, measured values at 8° angle listed in comments section. 2001Ba17 used ^{24}Mg(p,d) reaction product as calibration standard. 5-keV uncertainty for 8170 and 8197 keV levels assigned by evaluators based on statement listed for 8141 keV level as "error similar to that observed for the other two states" (2001Ba17).
[a] 8180 *30* (1979Mi15) appears to be a doublet of 8170 and 8197.
[b] From vector analyzing power in 1986Mi01, except where otherwise noted.
[c] From 2020Kw01. Spin and parity are based on L − determined from measured $\sigma(\theta)$ and DWBA calculations.
[d] Not presented/listed in Fig/Table, implied in the text and proposed spin and parity in Table 1 (2020Kw01).
[e] C^2S value for 49.2 MeV in column and for 94.8, 150.3 MeV in comments section (1986Mi01).

^{24}Mg(d,t) 1972Ne18

Other: 1978Co13 (pol d,t).

1972Ne18: ^{24}Mg(d,t) E=21.1 MeV. Self-supporting 99.96% enriched ^{24}Mg target (thickness about 370 μg/cm^2) was used. Measured $\sigma(\theta)$. Performed CCBA and DWBA analysis. FWHM 42-55 keV.

^{23}Mg Levels

E(level)†	J^π‡	C^2S	Comments
0.0	3/2$^+$	0.33	
450	5/2$^+$	2.2	J^π: From the vector analyzing power data and DWBA predictions (1978Co13).
2050	7/2$^+$		
2360	1/2$^+$	0.18	
2710	9/2$^+$		
2770	1/2$^-$	2.3	
2900	3/2$^+$	0.14	
3790	3/2$^-$	0.36	
3860	(5/2$^+$)	0.014	
3970	(5/2$^-$)		
4350	1/2$^+$	0.053	
4680	(7/2$^+$)		
5290	(5/2$^+$)		C^2S: 0.21 from shell model calculations.
5450	(11/2$^+$)		

† As listed in 1972Ne18.

‡ From comparison of measured angular distributions with coupled-channel Born approximation (CCBA) and DWBA calcualtions.

^{24}Mg(^{3}He,α) 1967Ha17,1981En04,1969Jo15

Other references: 1984ScZM,1981Gi04,1970Mc18,1969Ka28,1969Jo15, 1967Du04.

1967Ha17: ^{24}Mg(^{3}He,α), E=8, 10 MeV. σ(Eα), deduced excited level energies, 99.9% enriched target.

1981En04: ^{24}Mg(pol ^{3}He,α), E=33.3 MeV, 99.9% enriched target, measured $\sigma(\theta)$, $A_y(\theta)$, deduced contribution of two-step processes, DWBA, coupled-channels analysis.

1969Jo15: ^{24}Mg(^{3}He,α), E=15 MeV. Measured σ(Eα,θ). Deduced levels, L, S.

1984ScZM: ^{24}Mg(^{3}He,α), E=12, 15, 18 MeV. Measured $\sigma(\theta$,E) using broad range magnetic spectrograph, position sensitive proportional counter, and photographic plates. Deduced levels, spin, parity, L-transfer. The reported results were preliminary, noted by authors.

^{23}Mg Levels

E(level)[†]	J$^{\pi}$	L[&]	Comments
0.0[‡]	3/2^{+}[@]	2[‡]	S: 0.84 (1981En04), 1.6 (1969Jo15), 0.9 (1970Mc18).
450[‡]	5/2^{+}[@]	2[‡]	S: 4.74 (1981En04), 7.8 (1969Jo15), 4.4 (1970Mc18).
2050[‡]	7/2^{+}[@]	4	
2356	1/2^{+}	0	E(level): From 1969Jo15. L: From 1969Jo15, 1967Du04. S: 0.57 (1969Jo15).
2710			E(level): From 1969Jo15. L: 3 in 1967Du04 (fewer data points) and (2) in 1969Jo15 (poor fit). S: (4.4) (1969Jo15).
2768[a]	1/2^{-},3/2^{-}	1[a]	
2904[a]	3/2^{+},5/2^{+}	2[a]	
3800 *5*	1/2^{-},3/2^{-}	1[a]	
3865 *5*			
3976 *5*			
4360 *6*	1/2^{+}	0[a]	
4682 *6*			
5284 *6*	3/2^{+},5/2^{+}	2[a]	
5450 *6*			
5651 *7*			
5686 *8*			
5706 *8*			
5931 *7*			
5984 *7*	1/2^{-},3/2^{-}	1[a]	
6128 *7*			
6194 *7*			
6238 *7*			
6379 *8*			
6444 *8*			
6508 *8*			
6540 *8*			
6571 *9*			
6771 *8*			
6811 *8*			
6900 *8*			
6988 *8*			
7016 *9*			
7110 *9*			
7141 *9*			
7224 *10*			
7255 *10*			
7587[#]	3/2^{+},5/2^{+}	2[#]	
7635[#]	5/2^{-},7/2^{-}	3[#]	
7777[#]	5/2^{-},7/2^{-}	3[#]	

Continued on next page (footnotes at end of table)

$^{24}Mg(^{3}He,\alpha)$ 1967Ha17,1981En04,1969Jo15 (continued)

^{23}Mg Levels (continued)

E(level)[†]	J^{π}	L[&]	Comments
7793[#]	$3/2^+,5/2^+$	2[#]	
7852[#]	$7/2^+,9/2^+$	4[#]	
8016[#]			
8054[#]			
8076[#]			
8164[#]			J^{π}: $5/2^+$ in 1984ScZM – no argument was available.

[†] From 1967Ha17, except where otherwise noted.
[‡] From 1981En04.
[#] From 1984ScZM (Preliminary).
[@] From vector analyzing power in 1981En04.
[&] From 1969Ka28, except otherwise noted.
[a] From 1967Du04.

^{24}Mg(^{3}He,$\alpha\gamma$) 2016Ki03,1971En04,1970Ha02

Other references: 1968Bl02, 1967Da09, 1967Du04.
2016Ki03: ^{3}He(^{24}Mg,$\alpha\gamma$) E=3.125 MeV/nucleon; a γ-ray detector array consisting of four HPGe crystals is situated 7.83 cm downstream from the target. Measured Eγ, mean lifetime using Doppler Shift Attenuation Method.
1971En04: ^{24}Mg(^{3}He,α),(^{3}He,$\alpha\gamma$), E=6.4, 8.4 MeV. Measured E$\gamma(\theta)$, DSA.
1970Ha02: ^{24}Mg(^{3}He,$\alpha\gamma$) E=6.37, 8.05 MeV. σ(Eα,Eγ,$\theta(\alpha\gamma)$). Ge(Li) for Eγ and NaI(Tl) for $\alpha\gamma(\theta)$ measurements.
1968Bl02: ^{24}Mg(^{3}He,$\alpha\gamma$) E=9 MeV. σ(Eα,Eγ,$\theta(\alpha\gamma)$).
1967Da09: ^{24}Mg(^{3}He,$\alpha\gamma$), E=4.90-6.00 MeV, measured σ(Eα,Eγ,$\theta(\alpha\gamma)$). Deduced spin, mixing ratios, branching ratios.

^{23}Mg Levels

E(level)†	J$^{\pi}$#	$T_{1/2}$@	L	Comments
0.0	3/2^{+}		2	
450.8‡ *7*	5/2^{+}	1.14 ps *17*	2	$T_{1/2}$: from τ=1.65 ps *25* (1971En04).
2052.3 *3*	7/2^{+}	65 fs *12*	4	$T_{1/2}$: Weighted average of 55 fs *14* (1971En04) and 72 fs *12* (2016Ki03).
2359‡ *2*	1/2^{+}	575 fs *118*	0	
2715‡ *2*	9/2,5/2	97 fs *21*		J$^{\pi}$: From angular correlation studies of 2262γ by 1970Ha02.
2769.9 *12*	1/2^{-}	75 fs *10*	1	$T_{1/2}$: Weighted average of 107 fs *21* (1971En04) and 68 fs *10* (2016Ki03).
2906.6 *11*	(3/2)$^{+}$	10.4& fs *21*	2	$T_{1/2}$: Other: <17 fs (1971En04).
3795.0 *13*	3/2^{-}	28.4& fs *42*	1	E(level): Other: 3789 *6* (1970Ha02). $T_{1/2}$: From 2016Ki03. Other: <14 ns, upper limit estimated from the coincidence resolving time in (^{3}He,$\alpha\gamma$) measurements (1970Ha02).
3968 *6*	5/2^{-}	<14 ns		E(level): From 1970Ha02. $T_{1/2}$: Upper limit estimated from the coincidence resolving time in (^{3}He,$\alpha\gamma$) measurements (1970Ha02).
4356.4 *20*	1/2^{+}	<7.6& fs	0	E(level): Other: 4352 *6* (1970Ha02). $T_{1/2}$: From 2016Ki03. Other: <14 ns, upper limit estimated from the coincidence resolving time in (^{3}He,$\alpha\gamma$) measurements (1970Ha02).
5288 *3*		<9.7& fs		
5453.5 *24*		<10.4& fs		
6239 *4*		<27.7& fs		
6375 *7*		<31.2& fs		
6908 *3*		<6.9& fs		
7444 *3*		<9.7& fs		
7495.0 *24*		<13.9& fs		
7787.1 *20*		<8.3& fs		dσ/dΩ ≈ 3-4 μb/sr for θ(c.m.)>159° (2016Ki03).

† From γ-ray energies, except otherwise noted.
‡ From 1971En04.
# From Adopted Levels, except otherwise noted.
@ From 1971En04, unless otherwise stated.
& From 2016Ki03.

γ(^{23}Mg)

E_i(level)	J_i^{π}	Eγ†	Iγ	E_f	J_f^{π}	Mult.#	δ	Comments
450.8	5/2^{+}	450.8	100	0.0	3/2^{+}	D+Q	−0.06 *2*	A_2=−0.46 *2*; A_4=−0.02 *2* (1970Ha02) A_2=−0.48 *6*; A_4=−0.12 *11* (1968Bl02) A_2=−0.50 *4*; A_4=−0.08 *7* (1967Da09) A_2=−0.57 *7*; A_4=−0.09 *7* (1967Du04)

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^{24}Mg(^{3}He,$\alpha\gamma$) 2016Ki03,1971En04,1970Ha02 (continued)

γ(^{23}Mg) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ	E_f	J^π_f	Mult.[#]	δ	Comments
								δ: Weighted average of −0.07 *5* (1970Ha02), −0.04 *4* (1968Bl02), −0.06 *2* (1967Da09), −0.075 *24* (1967Du04).
2052.3	7/2$^+$	1601.4 *13*	84 *2*	450.8	5/2$^+$	D+Q	−0.19 *2*	A_2=−0.66 *3*; A_4=+0.01 *4* (1970Ha02) A_2=−0.77 *6*; A_4=+0.05 *11* (1967Da09) A_2=−0.71 *5*; A_4=+0.01 *7* (1967Du04) A_2=−0.41 *9*; A_4=−0.15 *14* (1968Bl02) I_γ: Weighted average of 85 *3* (1970Ha02), 81 *5* (1968Bl02), and 84 *3* (1967Da09). δ: Weighted average of −0.18 *4* (1970Ha02), −0.08 *7* (1968Bl02), −0.23 *3* (1967Da09), and −0.182 *25* (1967Du04).
		2052.2	16 *2*	0.0	3/2$^+$	Q(+O)	+0.05 *5*	A_2=+0.17 *10*; A_4=−0.33 *15* (1970Ha02) A_2=+0.49 *10*; A_4=−0.05 *16* (1967Da09) A_2=−0.56 *11*; A_4=−0.03 *10* (1968Bl02) I_γ: Weighted average of 15 *3* (1970Ha02), 19 *5* (1968Bl02), and 16 *3* (1967Da09). δ: Wt. ave. of +0.06 *5* (1967Da09) and −0.14 *25* (1970Ha02).
2359	1/2$^+$	1908	69 *3*	450.8	5/2$^+$			A_2=+0.00 *3*; A_4=−0.03 *4* (1970Ha02) A_2=+0.02 *4*; A_4=+0.00 *6* (1967Da09) A_2=+0.01 *9*; A_4=+0.00 *12* (1967Du04) A_2=−0.02 *7*; A_4=+0.01 *9* (1968Bl02) I_γ: Wt. ave. of 71 *4* (1970Ha02), 68 *3* (1967Da09), 67 *5* (1968Bl02). δ: 0.08 *1* or −3.34 *17* for spin 3/2 (1967Da09).
		2359	31 *3*	0.0	3/2$^+$			A_2=−0.01 *5*; A_4=−0.03 *8* (1970Ha02) A_2=+0.13 *7*; A_4=+0.04 *10* (1967Da09) A_2=+0.06 *12*; A_4=+0.09 *20* (1967Du04) A_2=+0.04 *9*; A_4=−0.05 *10* (1968Bl02) I_γ: Wt. ave. of 29 *4* (1970Ha02), 32 *3* (1967Da09), and 33 *5* (1968Bl02). δ: 0.19 *3* or +15.5 *73* for spin 3/2 (1967Da09).
2715	9/2,5/2	663	33 *2*	2052.3	7/2$^+$			I_γ: Weighted average of 34 *5* (1970Ha02), 33 *5* (1968Bl02), and 32 *3* (1967Da09).
		2264	67 *2*	450.8	5/2$^+$			A_2=+0.06 *14*; A_4=−0.68 *21* (1970Ha02) I_γ: Weighted average of 66 *5* (1970Ha02), 67 *5* (1968Bl02), and 68 *3* (1967Da09).
2769.9	1/2$^-$	2769.7 *12*	100	0.0	3/2$^+$			A_2=0.00 *1*; A_4=0.00 *2* (1970Ha02) A_2=−0.10 *3*; A_4=−0.17 *4* (1967Du04) A_2=+0.04 *5*; A_4=−0.05 *6* (1968Bl02)
2906.6	(3/2)$^+$	2455.7	33 *2*	450.8	5/2$^+$	D+Q		A_2=−0.05 *5*; A_4=−0.24 *7* (1970Ha02) A_2=+0.12 *17*; A_4=−0.13 *26* (1967Da09) A_2=−0.11 *5*; A_4=+0.02 *7* (1967Du04) I_γ: Weighted average of 40 *4* (1970Ha02), 30 *5* (1968Bl02), and 32 *2* (1967Da09).
		2906.4 *11*	67 *2*	0.0	3/2$^+$	D+Q		A_2=+0.11 *3*; A_4=+0.15 *4* (1970Ha02) A_2=+0.17 *3*; A_4=+0.10 *4* (1967Da09) A_2=+0.07 *4*; A_4=+0.02 *5* (1967Du04) I_γ: Weighted average of 60 *4* (1970Ha02), 70 *5* (1968Bl02), and 68 *2* (1967Da09).
3795.0	3/2$^-$	1025.1	7 *3*	2769.9	1/2$^-$	D+Q		A_2=−0.33 *18*; A_4=−0.04 *31* (1970Ha02) A_2=+0.19 *17*; A_4=+0.22 *25* (1968Bl02) I_γ: Weighted average of 6 *5* (1970Ha02) and 8 *3* (1968Bl02). δ: +0.08 *20* or −2.15 *21* (1970Ha02).
		3343.9 *13*	86 *5*	450.8	5/2$^+$	D(+Q)	+0.02 *4*	A_2=−0.09 *3*; A_4=+0.00 *5* (1970Ha02)

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^{24}Mg(^{3}He,$\alpha\gamma$) 2016Ki03,1971En04,1970Ha02 (continued)

γ(^{23}Mg) (continued)

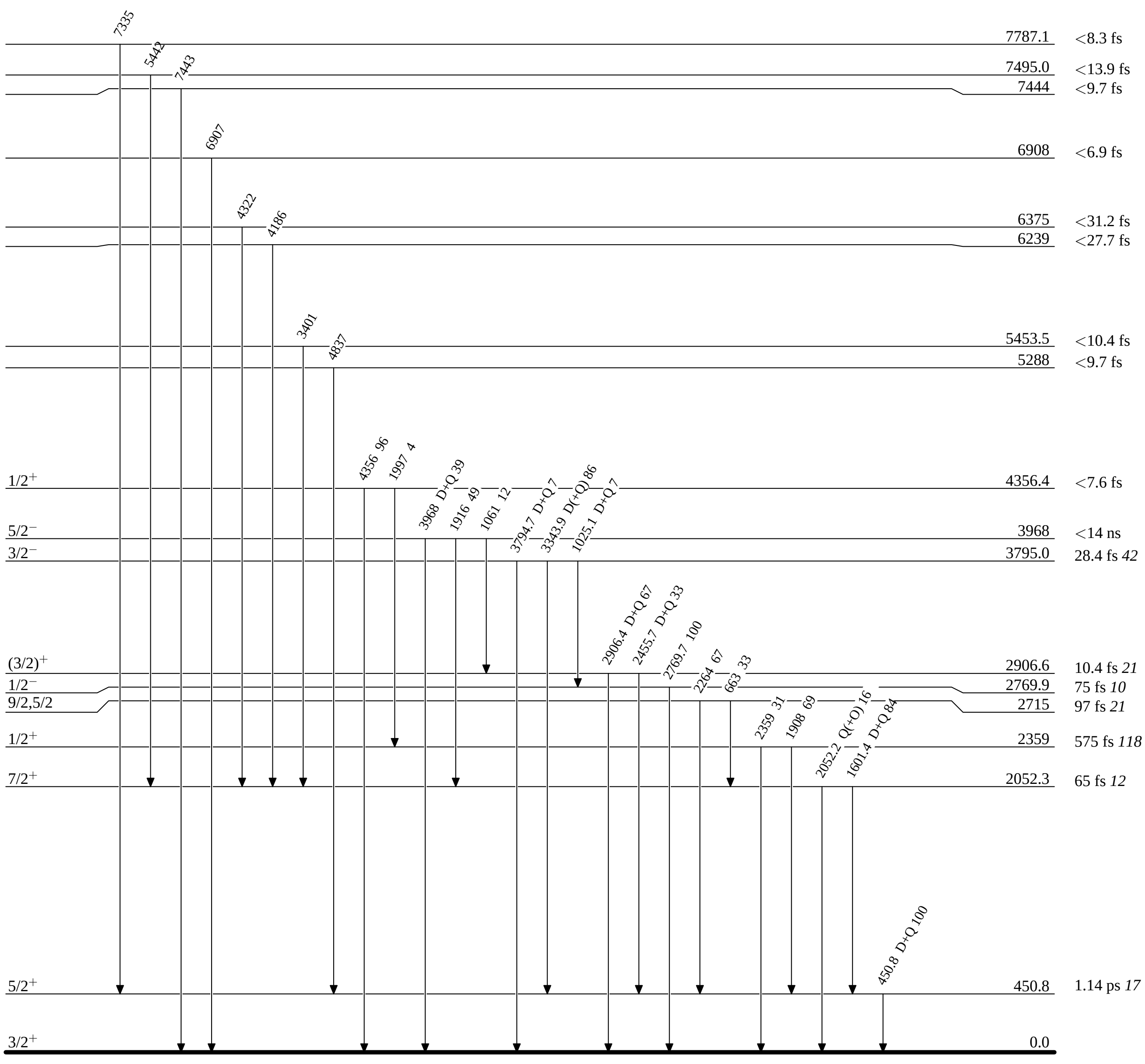
E_i(level)	J^π_i	E_γ[†]	I_γ	E_f	J^π_f	Mult.[#]	Comments
							A_2=−0.12 *4*; A_4=−0.02 *6* (1967Du04) A_2=−0.19 *4*; A_4=−0.10 *9* (1968Bl02) I_γ: Weighted average of 86 *5* (1970Ha02) and 85 *5* (1968Bl02). δ: Weighted average of +0.00 *14* (1970Ha02), +0.07 *7* (1968Bl02), and +0.011 *37* (1967Du04).
3795.0	3/2$^-$	3794.7	7 *2*	0.0	3/2$^+$	D+Q	A_2=−0.47 *8*; A_4=+0.06 *12* (1970Ha02) I_γ: Weighted average of 8 *5* (1970Ha02) and 7 *2* (1968Bl02). δ: $-7.1 \le \delta \le -0.4$ (1970Ha02).
3968	5/2$^-$	1061	12[‡]	2906.6	(3/2)$^+$		
		1916	49[‡]	2052.3	7/2$^+$		
		3968	39[‡]	0.0	3/2$^+$	D+Q	A_2=−0.20 *4*; A_4=+0.40 *6* (1970Ha02) δ: −4.33 *9* in 1970Ha02 implies E2+M1 and consequently positive parity for the depopulating level. It is inconsistent with the adopted negative parity in Adopted Levels.
4356.4	1/2$^+$	1997	4[‡] *3*	2359	1/2$^+$		
		4356 *2*	96[‡] *3*	0.0	3/2$^+$		A_2=−0.02 *3*; A_4=−0.01 *4* (1970Ha02) A_2=−0.04 *17*; A_4=−0.03 *18* (1968Bl02)
5288		4837 *3*		450.8	5/2$^+$		
5453.5		3401 *2*		2052.3	7/2$^+$		
6239		4186 *3*		2052.3	7/2$^+$		
6375		4322 *6*		2052.3	7/2$^+$		
6908		6907 *3*		0.0	3/2$^+$		
7444		7443 *3*		0.0	3/2$^+$		
7495.0		5442 *2*		2052.3	7/2$^+$		
7787.1		7335 *2*		450.8	5/2$^+$		

† From 2016Ki03. γ rays without uncertainty – from level energy differences, recoil energy subtracted, calculated by evaluators after obtaining the level energies from the measured Eγ.
‡ From 1970Ha02.
# From γ-ray angular distribution measurements (coefficients).

^{24}Mg(^{3}He,$\alpha\gamma$) 2016Ki03,1971En04,1970Ha02

Level Scheme

Intensities: % photon branching from each level



$^{23}_{12}Mg_{11}$

^{25}Mg(p,t) 1981Na01

J$^{\pi}$(^{25}Mg)=5/2^{+}.
Other: 1969Ha38.
1981Na01: ^{25}Mg(p,t), E=40 MeV. Measured $\sigma(\theta)$. DWBA analysis, shell model spectroscopic amplitudes. Enriched target. FWHM = 10-15 MeV.

^{23}Mg Levels

E(level)	L	dσ/dΩ (μb/sr)[‡]	Comments
0.0 *3*	2	76.0	
450 *3*	0+2	235.0	
2047 *3*	2	50.9	
2355 *5*	2	3.4	
2712 *5*	4	34.2	
2768 *5*	3	50.9	
2905 *5*	2	6.2	
3801 *5*	3	61.0	
3863 *5*	2	12.9	
3973 *5*	3	50.9	
4350 *6*	2	5.1	
4688 *6*	2	3.0	
5290 *6*	2+4	10.3	
5463 *6*	>3	5.9	L: ≥4 in 1981Na01.
5662 *8*	0	55.0	
5695 *8*	2	5.0	
5715 *8*	2	4.9	
5933 *6*		6.1	
5984 *6*		11.3	
6123 *6*	3	22.0	
6189 *6*	>3	5.9	L: ≥4 in 1981Na01.
6234 *6*	2	4.5	
6370 *10*	4	2.4	
6440 *6*		6.3	
6507 *6*	2	12.0	
6536 *6*	2	2.0	
6566 *8*	0	5.6	
6771 *6*			
6799 *6*		8.1	
6809 *6*		4.4	
6899 *5*	0	11.2	
6982 *5*	0	39.0	
7017 *5*	2	5.0	
7111 *7*	4	2.2	
7148 *6*	2(+0)	21.8	
7231 *7*	4	1.5	
7259 *7*	>3	2.2	L: ≥4 in 1981Na01.
7381 *8*			
7444 *8*		3.8	
7493 *8*	2	4.4	
7582 *6*	0	4.2	
7621 *8*	2	3.4	
7780[†] *6*	4	7.4	
7795[†] *6*	0	140.0	
7852 *6*		3.2	
8016 *6*		4.7	
8058 *7*			
8076 *8*			

Continued on next page (footnotes at end of table)

^{25}Mg(p,t) 1981Na01 (continued)

^{23}Mg Levels (continued)

E(level)	L	dσ/dΩ (μb/sr)‡	Comments
8155 *6*	0	46.0	
8193 *8*			
8285 *8*			
8334 *8*			
8393 *6*			
8420 *6*			
8453 *5*	4	7.4	
8557 *6*			
8617 *6*	>3	2.0	L: (≥4) in 1981Na01.
8758 *6*		2.8	
8793 *8*			
8870 *8*		2.1	
8916 *6*	4	5.9	
8941 *7*			
8990 *6*	2	18.1	
9018 *8*		2.2	
9060 *8*			
9103 *6*		6.3	
9138 *6*	4	4.6	
9253 *8*			
9328 *8*		4.0	
9374 *8*			
9403 *8*			
9420 *8*			
9465 *6*	2	17.0	
9596 *8*		3.8	
9642 *8*		5.6	
9662 *8*			
9717 *8*		4.8	

† 7788 keV *25* in 1969Ha38 appears to be a doublet.
‡ Value at the maximum in the angular distribution (1981Na01).

Adopted Levels, Gammas

Q(β^-)=−16950 *syst*; S(n)=19525 *syst*; S(p)=141.0 *5*; Q(α)=−8606 *11* 2017Wa10
ΔQ(β^-)=500 (syst), ΔS(n)=400 (syst) (2017Wa10); Q(εp)=4640.6 *4* (2017Wa10).
S(2n)=36390 *600* (syst), S(2p)=5645.2 *4* (2017Wa10).
Other reactions:
1969Ce01: ^{28}Si(p,^{6}He), E=54.7 MeV − First observation of ^{23}Al.
2002Ca04: ^{12}C(^{23}Al,X), E=35.9 MeV/nucleon − Proton halo. Also 2002Zh49.
2016Fa10: C(^{28}Si,X), E=135 MeV/nucleon − Mechanism of two-proton emission from ^{23}Al mainly sequential.

^{23}Al Levels

Cross Reference (XREF) Flags

A	^{23}Si ε decay	E	^{12}C(^{23}Al,^{23}Al′)
B	^{9}Be(^{22}Mg,^{23}Alγ)	F	^{22}Mg(p,p):res
C	^{9}Be(^{24}Si,^{23}Al)	G	^{24}Mg(^{7}Li,^{8}He)
D	^{9}Be(^{25}Al,^{23}Alγ)	H	Pb,^{12}C(^{23}Al,p^{22}Mg)

E(level)	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	5/2$^+$	446 ms *6*	ABCD FGH	%ε+%β^+=100; %εp=1.04 *3* μ=+3.89 *22*; Q=0.16 *5* %εp: Considering all I$_p$ in 2011Sa15 and by replacing 0.14 *3* and 0.18 *4* for I$_p$[Ep(Lab) 197 and 255, respectively] of 2011Sa15 by 0.026 *2* and 0.118 *3*, respectively, in 2020Fr04 − deduced from the values of 0.063 *4* and 0.288 *10* for I$_p$[Ep(c.m.) 204 and 275, respectively] in 2020Fr04, reported relative to I$_p$[Ep(Lab) 839 2011Sa15]=0.41 *1*. %εp=1.22 *5* from 2011Sa15. Others: 1.1 (1995Ti08), relative Ip in 2000Pe28. T$_{1/2}$: From 2006Ia03 (value 446 ms *6* in 2012Tr08 from the same group appears to be from the same experiment). Other values: 470 ms *30* (1972Go03), 350 ms *100* (2000Pe28), 476 ms *45* (2001Wa54,2002Wa33). J$^\pi$: Allowed decay to 3/2$^+$, 5/2$^+$, and 7/2$^+$ states in ^{23}Mg. From g factor measurement and calculations (2006Oz04). Also from experimental exclusive momentum distributions in (^{23}Al,p^{22}Mg) − (2011Ba27). Configuration=1d$_{5/2}$. Member of isospin quartet. μ: From 2006Oz04, 2019StZV − NMR (uncertainty *2*, smaller by an order, in 2019StZV is a typo − confirmed by N. Stone, email − dated Oct 8, 2020). Q: Preliminary value − Nuclear magnetic resonance (2009NaZV, 2014StZZ).
550 *20*	(1/2$^+$)		GH	%p=100; %IT=8.6×10^{-7} *17* %IT: From Γγ/(Γγ+Γp). Γγ=6.35×10$_7$, average value of 5.49E-7 eV (^{7}Li,^{8}He) and Γγ=7.2E−7 14 eV (^{23}Al,p^{22}Mg). Γp=74 eV (^{7}Li,^{8}He). Uncertainty from the input value. J$^\pi$: Member of isospin quartet.
1475 *39*	(3/2)$^{+}$†		A	%p≈100
1619 *6*	(7/2$^+$)		B D	%p<100 E(level): from Eγ. J$^\pi$: Tentatively assigned by 2008Ga17 (^{22}Mg,^{23}Alγ), compared to mirror state of ^{23}Ne at 1701.6 keV. Configuration=[^{22}Mg(2$^+$)⊗d$_{5/2}$]$_{7/2^+}$.
1773 *35*			G	%p≈100
2575 *34*			G	%p≈100
3000 *20*	(3/2$^+$)‡		F	
3140 *30*	(7/2$^+$,5/2$^+$)‡		F	
3197 *21*	(3/2)$^{+}$†		A G	%p≈100 E(level): Weighted average of 3166 *45* (^{23}Si ε decay) and 3204 *21* (^{7}Li,^{8}He). Uncertainty lowest input value.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{23}Al Levels (continued)

E(level)	J^π	XREF	Comments
3260 *30*	$(7/2^+,5/2^+)$‡	F	
3709 *24*	$(5/2)^+$†	A G	%p≈100 E(level): Weighted average of 3745 *45* (^{23}Si ε decay) and 3699 *24* (^{7}Li,^{8}He) Uncertainty lowest input value.
3950 *30*	$(7/2^+)$‡	F	
4156 *47*	$(7/2)^+$†	A	%p≈100
5134 *59*		A	%p≈100
11832 *48*	$(5/2)^+$†	A	%2p≈100 J^π: IAS to ^{23}Si parent.
12.7×10^3 *23*		E	E(level): From excitation energy window=10.5 to 15 MeV (2015Ma19 – (^{23}Al,^{23}Al′).

† From systematics of ^{23}Ne mirror states populated in ^{23}F decay.

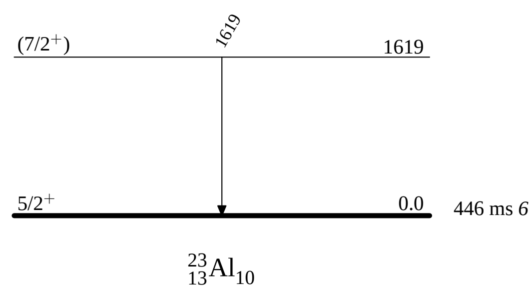
‡ Proposed by 2007He30 (p,p):Res, based on R-matrix analysis (SAMMY-M6-BETA code) of measured differential cross sections.

γ(^{23}Al)

E_i(level)	J^π_i	E_γ	E_f	J^π_f	Comments
1619	$(7/2^+)$	1619 *6*	0.0	$5/2^+$	E_γ: Average of 1616 *6* (^{22}Mg,^{23}Alγ) and 1622 *6* (^{25}Al,^{23}Alγ).

Adopted Levels, Gammas

Level Scheme



^{23}Si ε decay 1997Bl04,2018Wa05

Parent: ^{23}Si: E=0.0; J^{π}=(5/2)$^{+}$; $T_{1/2}$=42.3 ms *4*; Q(ε)=16950 *syst*; %ε+%β^{+} decay=100

Other references: 1997Cz02 − same research group and same experiment of 1997Bl04.

1997Bl04,1997Cz02: Produced by ^{58}Ni(^{36}Ar,x) E(^{36}Ar)=95 MeV/nucleon. LISE2 at GANIL. TOF mass identification, Si EΔE telescope. Measured β delayed Ep, %Ip, deduce %ε2p, level energy, etc.

2018Wa05: ^{23}Si produced from ^{28}Si beam, E=75.8 MeV/nucleon, fragmentation on ^{9}Be target (thickness 1980 μm). ^{23}Si was separated by Radioactive Ion Beam Line in Lanzhou, China. Particles identified by energy loss (ΔE) by two Si detectors and time of flight (TOF) by two plastic scintillators. Implanted on Si array of two double-sided Si detectors (DSSD). Also a 314−μm thick quadrant Si detector for escaping protons, another 1546 μm thick Si detector for β particle detection. Two additional Si and four clover HPGe detectors. Measured β delayed Ep, %Ip, $T_{1/2}$.

^{23}Al Levels

Proton decay branch for levels above Sp(^{23}Al)=141.0 *5* (2017Wa10) assuming no competition with γ decay.

E(level)†	J^{π}‡	$T_{1/2}$	Comments
0.0	5/2^{+}	446 ms *6*	$T_{1/2}$: From Adopted Levels.
1475 *39*	(3/2)$^{+}$		%p≈100 E(level): From E_{decay}=1333 *39*, weighted average of 1320 *40* (1997Bl04) and 1346 *39* (2018Wa05). Uncertainty − lowest input value. Level energy 1450 in 1997Bl04 and 1445 in 2018Wa05.
3166 *45*	(3/2)$^{+}$		%p≈100 E(level): From E_{decay}=3024 *45*, weighted average of 3040 *60* (1997Bl04) and 3015 *45* (2018Wa05). Uncertainty lowest input value. Level energy 3170 in 1997Bl04 and 3140 in 2018Wa05.
3745 *45*	(5/2)$^{+}$		%p≈100 E(level): From E_{decay}=3603 *45*: from 2356 *45* [weighted average of 2400 *40* (1997Bl04) and 2309 *41* (2018Wa05)] + E(^{22}Mg)=1247. Also E_{decay} 3650 *60*, level energy 3770 in 1997Bl04 and E_{decay} 3524 *65* and level energy 3665 in 2018Wa05.
4156 *47*	(7/2)$^{+}$		%p≈100 E(level): From E_{decay}=4014 *47*: from 2764 *47* [weighted average of 2830 *60* (1997Bl04) and 2730 *43* (2018Wa05)] + E(^{22}Mg)=1247. Others: Level energy 4200 in 1997Bl04 and 4120 in 2018Wa05.
5134 *59*			%p≈100 E(level): From E_{decay}=4992 *59*: weighted ave. of 5058 *51* [from 3811 *51* (2018Wa05) + E(^{22}Mg)=1247] and 4939 *46* [from 1631 *46* (2018Wa05) + E(^{22}Mg)=3308].
11832 *48*	(5/2)$^{+}$		%2p≈100 E(level): Unweighted ave. of E_{decay}=11837 *100* (Ep=5860 *100* (1997Bl04) + S(2p)(^{23}Al) + E(^{21}Na)=332), 11834 *66* (Ep=5857 *66* (2018Wa05) + S(2p)(^{23}Al) + E(^{21}Na)=332), and 11825 *100* (Ep=6180 *100* (1997Bl04)) + S(2p)(^{23}Al). Others: 11645 *64* (from Ep=6000 (2018Wa05)+S(2p)=5645). IAS level energy 11780 in 1997Bl04 and 11834 in 2018Wa05.

† Deduced by evaluators from E_{decay} and Sp(^{23}Al)=141.0 keV *5* or S(2p)=5645.24 *36* (2016AME − 2017Wa10). 1997Bl04 present level energies in Fig 5 using Sp(^{23}Al)=125 keV. Those values are listed in comments along with the Ep energies. Note that E_{decay} represents the total decay energy that includes Ep and recoil energy.

‡ From systematics of ^{23}Ne mirror states populated in ^{23}F decay. Parity determined by allowed decay to all excited states from (5/2)$^{+}$.

^{23}Si ε decay 1997Bl04,2018Wa05 (continued)

ε,β^+ radiations

E(decay)	E(level)	I($\varepsilon+\beta^+$)[†‡]	Comments
(5118 *syst*)	11832	3.5 *5*	I($\varepsilon+\beta^+$): Weighted average of %I_{2p}=3.6 *3* [from 2.7 *2* and 1.9 *2* (1997Bl04)] and 1.5 *11* [from 0.9 *9* and 0.6 *6* (2018Wa05)].
(11816 *syst*)	5134	10.8 *6*	I($\varepsilon+\beta^+$): From %Ip=6.2 *1* and 4.6 *6* (2018Wa05).
(12794 *syst*)	4156	11.8 *22*	I($\varepsilon+\beta^+$): Unweighted average of %Ip=14 *1* (1997Bl04) and 9.6 *1* (2018Wa05).
(13205 *syst*)	3745	38 *4*	I($\varepsilon+\beta^+$): Weighted average of %Ip=39.2 *20* (from 32 *2* and 7.2 *2* – 1997Bl04) and 29 *5* (from 21 *2* and 8 *5*) (2018Wa05).
(13784 *syst*)	3166	8.5 *5*	I($\varepsilon+\beta^+$): Weighted average of %Ip=7.8 *6* (1997Bl04) and 8.9 *5* (2018Wa05).
(15475 *syst*)	1475	7.6 *25*	I($\varepsilon+\beta^+$): Unweighted average of %Ip=10 *1* (1997Bl04) and 5.1 *5* (2018Wa05).

† From β-delayed proton intensities in 1997Bl04 and 2018Wa05. Decay scheme incomplete.
‡ Absolute intensity per 100 decays.

^{9}Be(^{22}Mg,^{23}Alγ) 2008Ga17

Based on XUNDL: Compiled by F.G. Kondev, ANL, August 22, 2008.
One proton pickup reaction. Studies were also carried out using inelastic scattering ^{9}Be(^{23}Al,^{23}Al′γ) reaction.
Secondary cocktail beam composed of 32% ^{22}Mg and 3% ^{23}Al and produced in reaction ^{9}Be(^{36}Ar,X) at E=150 MeV/nucleon.
A1900 fragment separator. Experiment performed at NSCL, MSU facility. Detected γ rays using Segmented Germanium Array and S800 spectrograph. Measured time-of-flight, ΔE using two plastic scintillators.
A total cross section of 0.54 mb *5* was measured for the one-proton pickup channel.

^{23}Al Levels

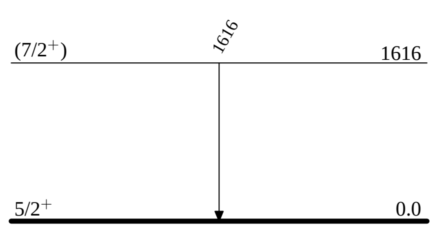
E(level)	J^π	Comments
0.0	5/2$^+$	
1616 *8*	(7/2$^+$)	E(level): from Eγ. J^π: Tentatively assigned by 2008Ga17 compared to mirror state of ^{23}Ne at 1701.6 keV. $\sigma\geq$0.07 mb *2* for one-proton pickup reaction to 7/2$^+$ state. Configuration=[^{22}Mg(2$^+$)$\otimes d_{5/2}]_{7/2^+}$. A branching ratio of $\Gamma\gamma/\Gamma p \sim 20$ is estimated from shell model and proton decay calculations (2008Ga17).

γ(^{23}Al)

E_γ	E_i(level)	J_i^π	E_f	J_f^π	Comments
1616 *8*	1616	(7/2$^+$)	0.0	5/2$^+$	E_γ: Weighted average of 1614 keV *9* and 1618 keV *8*, measured in ^{9}Be(^{22}Mg,^{23}Alγ) and ^{9}Be(^{23}Al,^{23}Alγ), respectively.

^{9}Be(^{22}Mg,^{23}Alγ) 2008Ga17

Level Scheme



$^{23}_{13}Al_{10}$

^{9}Be(^{24}Si,^{23}Al) 2008Ga10

Based on XUNDL: Compiled by S. Geraedts and B. Singh (McMaster): Apr 17, 2008.
One proton knockout reaction.
E(^{24}Si)=85.3 MeV/nucleon beam produced in reaction ^{9}Be(^{36}Ar,X) at E=150 MeV/nucleon. A1900 fragment separator. Experiment performed at NSCL, MSU facility. Measured time-of-flight, ΔE using two plastic scintillators.

^{23}Al Levels

E(level)	J^π	L	Comments
0.0	5/2$^+$	2	L: Determined from comparison of the measured ^{23}Al residue longitudinal momentum distribution to the shape calculated for the removal of a proton from the 1$d_{5/2}$ orbit. σ=67.3 mb *35*. Configuration=$d_{5/2}$.

^{9}Be(^{25}Al,^{23}Alγ) 2020Lo05

Two neutron knockout reaction.

Secondary cocktail beam composed of 54.5% ^{24}Mg, 29.5% ^{25}Al, and 13.5% ^{26}Si was produced in reaction ^{9}Be(^{36}Ar,X) at E=150 MeV/nucleon. A1900 fragment separator. Two-neutron knockout reaction of ^{25}Al was induced on another ^{9}Be target in front of the S800 spectrograph, E=102 MeV/nucleon (mid target). Detected γ rays using 192-element Cs-I scintillator array CAESAR. Measured parallel momentum distribution of states populated in ^{23}Al by gating on γ-ray transition.

Inclusive cross section of 0.69 mb *9* was measured for the two-neutron knockout reaction for g.s. and 7/2^{+} state at 1622.

^{23}Al Levels

E(level)	J$^{\pi}$†	Comments
0.0	5/2^{+}	Partial cross section σ = 0.60 mb *8*. Comparison of measured momentum distribution with preditions by sd-shell model shows neutron coupling with a predicted dominance of I (defined as the total angular momentum of two removed neutrons) =0.
1622 *6*	(7/2^{+})	E(level): from Eγ. Partial cross section σ = 0.09 mb *3*. Comparison of measured momentum distribution with preditions by sd-shell model shows neutron coupling with a predicted dominance of angular momentum I=4 larger than l=2 component by about a factor of 2. See the defination of I above in the g.s. comments.

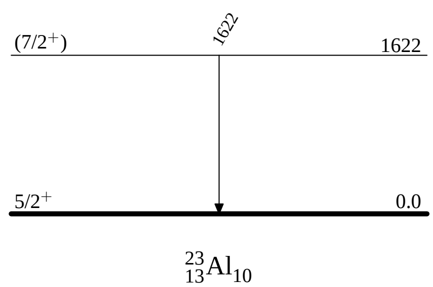
† From Adopted Levels.

γ(^{23}Al)

Eγ	E$_i$(level)	J$^{\pi}_i$	E$_f$	J$^{\pi}_f$
1622 *6*	1622	(7/2^{+})	0.0	5/2^{+}

^{9}Be(^{25}Al,^{23}Alγ) 2020Lo05

Level Scheme



$^{12}C(^{23}Al,^{23}Al')$ **2015Ma19**

Based on XUNDL. Compiled by B. Singh (McMaster); Mar 12, 2015.

Measurement of two-proton emission and proton-proton correlations from an excited state (most likely 11780, $(5/2)^+$) in ^{23}Al.
S(2p)(^{23}Al)=5645.2 *4* (2017Wa10: AME-2016).
E=57.4 MeV/nucleon ^{23}Al beam produced from fragmentation of ^{28}Si beam at 135 MeV/nucleon on ^{9}Be production target. Particle identification of ^{23}Al was done by means of Bρ-ΔE-TOF method using RIPS beamline at RIBF-RIKEN facility. The reaction target was ^{12}C around which was a γ detector array of 160 NaI(Tl) detectors (DALI2), 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 ^{21}Na+p+p channel, momentum distributions of two protons in the excitation energy window of 10.5-15 MeV, and opening angle distribution of two protons. The calculations compared the three-body (^{21}Na+p+p) emission with 2-body ($^{21}Ne+^{2}He$) emission.

^{23}Al Levels

E(level)	Comments
12.7×10^{3} *23*	E(level): From excitation energy window=10.5 to 15 MeV. A dominant mode of two-proton emission from this level is that of sequential emission based on broad momentum distribution without any peaks and structureless angle distributions.

^{22}Mg(p,p):res 2007He30

Based on XUNDL: Compiled by S. Geraedts and B. Singh (McMaster): Nov 16, 2007.

Target=$(CH_2)_n$, Beam=$^{22}Mg^{12+}$, E=5.93 MeV/nucleon, produced by bombarding a ^{3}He gas target with $^{20}Ne^{8+}$ primary beam, E=8.11 MeV/nucleon, at CNS radioactive-ion beam facility at RIKEN. Mean energy of ^{22}Mg beam was 4.38 MeV/nucleon. Target=$(CH_2)_n$ polyethylene. Measured ΔE and time-of-flight of charged particles using ΔE-E Si telescopes (at ~4°, 17°, and 23°), double-sided Si strips and focal plane detectors. Carbon target was also used to evaluate contributions from carbon in the $(CH_2)_n$ target. Overall FWHM=20 keV at 500 keV to 45 keV at 3500 keV excitation energy. R-matrix analysis.

Suffixes p and p′ imply the ^{22}Mg(g.s.)+p (elastic) and $^{22}Mg(2^+_1)$+p (inelastic) channels.

^{23}Al Levels

E(level)	J^π†	L†	Comments
0.0	$5/2^+$		J^π: From Adopted Levels.
3000 *20*	$(3/2^+)$	2	Elastic scattering peak. C^2S(to first excited state)=0.005 for $1d_{5/2}$, 0.059 for $d_{3/2}$, 0.018 for $2s_{1/2}$. C^2S(to g.s.)=0.28 for $1d_{3/2}$. Main configuration=$0^+\otimes 1d_{3/2}$, 0^+ for ^{22}Mg core g.s. Partial widths: Γ_p=32 keV *5* for $3/2^+$, Γ_p=17 keV *3* for $5/2^+$.
3140 *30*	$(7/2^+,5/2^+)$	4,2	C^2S(to first excited state)=0.024 for $1d_{5/2}$, 0.324 for $d_{3/2}$. J^π: R-matrix analysis fits 7/2,5/2, but negative-parity states of this spin are neither observed in the mirror nucleus ^{23}Ne nor predicted by shell-model. This level may correspond to calculated level at 3605, $7/2^+$. Main configuration=$2^+\otimes 1d_{3/2}$. Partial widths: Γ_p=2-5 keV, $\Gamma_{p'}$=30 keV *20*.
3260 *30*	$(7/2^+,5/2^+)$	2,0	Partial widths: Γ_p=2-5 keV, $\Gamma_{p'}$=30 keV *20*. C^2S(to first excited state)=0.010 for $1d_{5/2}$, 0.033 for $d_{3/2}$, 0.023 for $2s_{1/2}$. C^2S(to g.s.)=0.01 for $1d_{5/2}$.
3950 *30*	$(7/2^+)$	2	C^2S(to first excited state)=0.002 for $1d_{5/2}$, 0.180 for $d_{3/2}$. J^π: R-matrix analysis fits $7/2^+,5/2^-$, but from systematics of neighboring nuclides $5/2^-$ is unlikely. Main configuration=$2^+\otimes 1d_{3/2}$. Partial widths: Γ_p=20 keV *10*, $\Gamma_{p'}$=30 keV *20*.

† Proposed by 2007He30, based on R-matrix analysis (SAMMY-M6-BETA code) of measured differential cross sections, except otherwise noted.

^{24}Mg(^{7}Li,^{8}He) 2001Ca37

E(^{7}Li)=50.1 MeV/nucleon. Magnetic spectrometer, plastic scintillator TOF.
Other reference: 1988Wi18.

All data from 2001Ca37, except otherwise noted.

^{23}Al Levels

E(level)	J^{π} †	C^2S	Comments
0.0	5/2^{+}		
550 *20*	(1/2^{+})	0.66	Γp=74 eV and Γγ=5.49×10^{-7} eV (calcualted values in 2001Ca37); Γp=32 eV *+53−23* and Γγ=2.5×10^{-7} eV *+12−9* (calculated values in 1988Wi18). C^2S: From 1988Wi18.
1773 *35*			
2575 *34*			
3204 *21*			
3699 *24*			

† From Adopted Levels.

Pb,^{12}C(^{23}Al,p^{22}Mg) 2005Go33,2011Ba27

Other references: 2005Go34, 2004Go34 – same research group and experiment of 2005Go33.

2005Go33: Pb(^{23}Al,p^{22}Mg): 50 MeV/nucleon secondary ^{23}Al beam produced by 135 MeV/nucleon ^{28}Si beam on a ^{9}Be target. Si E-ΔE, plastic scintillator hodoscope, NaI(Tl) array.

2011Ba27: ^{12}C(^{23}Al,p^{22}Mg): E=57 MeV/nucleon ^{23}Ar beam produced from fragmentation of an intense (≈2μA) $^{32}S^{16+}$ beam at 95 MeV/nucleon on a thick carbon target at the GANIL coupled cyclotron facility. The secondary ion beams were collected using the SISSI device. Secondary target of a 175 mg/cm^2 thick carbon. 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. Momentum distributions using the SPEG (FWHM≈5×10^{-3}). Deduced ground state structure of ^{23}Al.

^{23}Al Levels

E(level)	J$^\pi$	L	Comments
0.0	5/2$^+$		J$^\pi$: Proposed in 2011Ba27, based on experimental exclusive momentum distributions. Configuration=1d$_{5/2}$.
550 *20*		2	E(level): From Adopted Levels. In 2005Go33: 400 keV (in relative energy scale – Fig 2.). L: From 2005Go33, from comparison of measured angular distribution of differential cross section, dσ/$\delta\Omega$ [mb/sr], and DWBA calculations. Γγ=7.2×10^{-7} eV *14*: Deduced in 2005Go33 assuming spins and parities of the g.s. and 1st exited states are 5/2$^+$ and 1/2$^+$, respectively.

Adopted Levels

S(n)=17712 *syst*; S(p)=1785 *syst*; Q(α)=−10556 *syst* 2017Wa10
ΔS(n)=711 (syst), ΔS(p)=503 (syst), ΔQα=505 (syst) (2017Wa10). Q(εp)=16810 *500 syst* (2017Wa10); Q(ε2p)=1.13×10^4 – deduced by evaluators using mass data in 2017Wa10.
S(2p)=1790 *500 syst* (2017Wa10).
Particle stability established in nickel + ^{40}Ca reactions (1986La17).

^{23}Si Levels

Cross Reference (XREF) Flags

A ^{9}Be(^{24}Si,^{23}Si)

E(level)	J^π	$T_{1/2}$	XREF	Comments
0.0	$(5/2)^+$	42.3 ms *4*	A	%ε+%β^+=100; %εp≈88; %ε2p=3.6 *4* %εp,%ε2p: From 1997Bl04. %εp from ≈92% (εp+ε2p) − 3.6. Other values: %εp=73 *6* and %ε2p=1.5 *11* (2018Wa05) − obtained by evaluators from data in Table 1. Peaks 10 and 11 were identified by 2018Wa05 as β2p branch. Note that the sum 75 *6*, from listed %εp and %ε2p in Table 1 (2018Wa05) is in good agreement with the sum 75 *3*, in Fig. 5 and Table 1 (1997Bl04). However, 1997Bl04 recommend ~92% (εp+ε2p) considering peaks in Fig. 1 and peaks not listed in their Table 1. 1997Bl04 mention their recommended value of ~92% is in agreement with the predicted value of 94% (Ref. 27 (private communication)). 2018Wa05 did not comment on total %(εp+ε2p) branch. The evaluators recommend the value of 1997Bl04. J^π: L=2 in (^{24}Si,^{23}Si). $5/2^+$ from shell model (1990Br26). $T_{1/2}$: From 1997Cz02,1997Bl04. Other value: 40.17 ms *186* (2018Wa05). 1997Bl04 also present measured values from decay-time characteristics for different event groups as 46.8 ms *20*, 40.9 ms *10*, and 37.4 ms *99*. The adopted half-life of 42.3 ms *4* by 1997Bl04 was measured considering all events. Note that the value 40.7 ms *4* (1997Bl04) in the abstract and on page 250 is a misprint, confirmed by first author B. Blank (private communication with B. Singh, dated Nov. 29, 2018).

^{9}Be(^{24}Si,^{23}Si) 2008Ga10

Based on XUNDL: Compiled by S. Geraedts and B. Singh (McMaster): Apr 17, 2008.

One neutron knockout reaction.

E(^{24}Si)=85.3 MeV/nucleon beam produced in reaction ^{9}Be(^{36}Ar,X) at E=150 MeV/nucleon. A1900 fragment separator. Experiment performed at NSCL, MSU facility. Segmented Germanium Array and S800 spectrograph. Measured time-of-flight, ΔE using two plastic scintillators.

No γ rays were observed.

^{23}Si Levels

E(level)	J^π	L	Comments
0.0	$5/2^+$	2	J^π: L=2 yields $3/2^+$,$5/2^+$. $5/2^+$ from shell model (1990Br26). Configuration=$d_{5/2}$. σ=9.8 mb *10*.

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