^{24}Mg(^{3}He,nγ) 2015Do07,2014Ko41,1969Be31

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	M. S. Basunia and A. M. Hurst	NDS 134, 1 (2016)	1-Feb-2016

Others: 1960Ro06,1963Fr10,1968Ro18,1971Mo27,1972Ha58,1982Al15.

2015Do07: ^{3}He beam, E=10 MeV, from ATLAS accelerator at ANL bombarded a ^{24}Mg target (thickness ~840 μg/cm^2); γ-rays detected with almost 4π coverage using Gammasphere array; Measured Eγ, Iγ, $\gamma\gamma$ coincidence, $\gamma(\theta)$, deduce level scheme, angular distribution coefficients, spin-parity.

2014Ko41: E(^{3}He)=10 MeV. Measured Eγ, Iγ, $\gamma\gamma$-coin, nγ-coin, $\gamma(\theta)$, $\gamma\gamma(\theta)$(DCO) using three large HPGe detectors at Tsukuba accelerator UTTAC. Deduced levels, J, π, proton resonances. Comparison with previous experimental results. Based on proton resonances studied in this work, deduced astrophysical reaction rates for ^{25}Al(p,γ)^{26}Si.

1982Al15: ^{3}He(^{24}Mg,nγ) inverse reaction used to produce ^{26}Si recoils and analyze Doppler-broadened γ-ray lineshapes to extract mean lifetimes. Target prepared by implanting 35-keV ^{3}He ions into 250 μm Au backings to a dose of 6×10^{10} ^{17} ^{3}He/cm^2. Data accumulated over five days running with ^{24}Mg^{6+} beam at E(lab)=50 MeV. Neutrons detected with two NE213 liquid scintillators and γ rays detected with threeGe(Li) detectors.

1969Be31: Deduced excitation energies, γ-ray intensities, lifetimes, J$^\pi$, and branching ratios in ^{26}Si using the Doppler-shift attenuation method. Results compared to shell-model calculations. Measurements carried out using a ^{3}He beam at E(lab)=5.5, 7.8, and 10.0 MeV from the Oxford University Van de Graff accelerator. Enriched (99.8%) ^{24}Mg self-supporting target (3 mg/cm^2). Measured n-γ angular correlations using Ge(Li) and NaI(Tl) counters, NE213 liquid scintillator and XP1040 photomultiplier.

1968Ro18: ^{24}Mg(^{3}He,nγ)^{26}Si reaction used to study n-γ coincidences at ^{3}He beam (intensity 0.1 $\mu\alpha$) energies E(lab)=6.0, 7.0, and 7.3 MeV using a 5.5 MV Van de Graaff accelerator. Enriched (99.9%) ^{24}Mg target (thickness 200 μg/cm^2) on thick tantalum backing. Coincidence n-γ angular correlations and γ-γ spectroscopy using NaI(Tl) crystals and NE213 liquid scintillators. Deduced ^{26}Si energy levels, γ-ray intensities, J$^\pi$, and δ(M1/E2) mixing ratios.

1960Ro06: Half-life measurement using a pneumatic-transfer system (transit time 0.25 s) to transport activated samples to a NaI(Tl) scintillator. An 8-MeV ^{3}He beam provided by the Purdue University 37-inch cyclotron was used to bombard a series of four rabbit-interchangeable 3/4-inch diameter by 3/8-inch height vacuum-distilled natural magnesium targets. Measured ^{26}Si half life.

1963Fr10: Van de Graff accelerator provides 5.5-MeV ^{3}He beam to bombard 5 mg/cm^2 foil of natural magnesium. A Siegbahn-Slätis intermediate- image focusing spectrometer was used. Delayed γ rays were measured using NaI scintillator mounted onto a photomultiplier tube. Measured ^{26}Si half life.

1971Mo27: A 16-MeV ^{3}He2+ ion beam from University of Colorado cyclotron is delivered to a thick natural magnesium target. The decay products are transported a distance 5 min to a low-background facility using a pneumatic-transfer shuttle (transit time 0.3 s). β-delayed γ rays measured using 25 cm^3 Ge(Li) detector. Deduced log ft values. Measured ^{26}Si half life.

1972Ha58: ^{26}Si half-life measurement by irradiating a thick ^{24}Mg foil with a 12-MeV ^{3}He beam using the Chalk River MP tandem. Recoiling ^{26}Si atoms were stopped in a hydrogen gas cell behind the target cell and periodically swept by helium gas to a counting cell 4 min away. The transit time was about 50 ms. The counting cell was viewed by a Ge(Li) detector and ^{26}Si half life was deduced by analyzing the γ-decay spectra. Branching ratios determined by comparison of γ-decay intensities to 511-keV annihilation peak from positrons.

^{26}Si Levels

E(level)[†]	J$^\pi$[#]	T$_{1/2}$[a]	Comments
0.0	0$^+$		
1797.31 *9*	2$^+$	430 fs *42*	T$_{1/2}$: Other value: 970 fs *416* 1969Be31.
2786.60 *11*	2$^+$	146 fs *35*	T$_{1/2}$: Other value 139 fs *111* 1969Be31.
3336.46 *22*	0$^+$	1.52 ps *48*	T$_{1/2}$: Deduced from mean lifetime 2000 fs *+900−500*. Other value: 1.87 ps *114* (1969Be31).
3757.23 *14*	3$^+$	<485[b] fs	
3843.4?[‡] *20*	(4$^+$)[@]		J$^\pi$: From 1969Be31, based on n-γ correlations and observation of of more than one of γ-ray transitions. 1968Ro18 proposed 3$^{(+)}$ from n-γ angular correlations of 2046γ.
4094?[‡] *4*	(1,2)[&]		E(level): Level apparent only from its ground-state branch in 1969Be31 and cannot be

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^{24}Mg(^{3}He,nγ) 2015Do07,2014Ko41,1969Be31 (continued)

^{26}Si Levels (continued)

E(level)[†]	J$^{\pi}$[#]	T$_{1/2}$[a]	Comments
			considered absolutely established. Level not reported in coincidence measurements 2014Ko41 and 2015Do07 and not adopted by evaluators. A γ at 4092 keV is reported to deexcite the 5890-keV state in 2014Ko41 and 2015Do07, suggesting the 4094-keV γ in 1969Be31 was misplaced and it is likely the 4094-keV level does not exist.
			J$^{\pi}$: Assignment tentatively deduced on the basis of ground-state transition in 1969Be31.
4139.15 *22*	2$^+$	35 fs *3*	T$_{1/2}$: Other value 76 fs *72* 1969Be31.
4187.38 *18*	3$^+$		
4446.43 *17*	4$^+$	<350[b] fs	
4796.6 *4*	4$^+$		
4812.1 *4*	(2$^+$)	<69[b] fs	
4832.3 *7*	(0$^+$)		
5147.6 *4*	2$^+$		
5289.05 *17*	4$^+$		
5517.53 *22*	4$^+$		E(p)(res)=4.7 keV. E(level): Excitation energy not established firmly. Poor fit of γ rays in the decay scheme.
5676.3 *3*	1$^+$		E(p)(Lab)=160.4 keV.
5889.9 *3*	0$^+$		E(p)(Lab)=377.2 keV. J$^{\pi}$: proposed in 2015Do07, based on isotropic distribution of γ rays and absence of 0$^-$ analogue states in ^{26}Al and ^{26}Mg.

[†] From a least-squares fit to γ-ray energies. The 1764.2- and 2736.3-keV γ rays from 5517 level fit poorly. These were omitted from the fitting procedure.
[‡] Tentative level in 1969Be31.
[#] Deduced from angular correlations in 2014Ko41 except where noted.
[@] Deduced from n-γ angular correlations in 1968Ro18.
[&] Deduced from angular distributions in 1969Be31.
[a] Deduced from Doppler-broadened γ-ray lineshapes in 1982Al15, except where noted.
[b] Deduced from Doppler-broadened γ-ray lineshapes in 1969Be31.

γ(^{26}Si)

S(p)(^{26}Si)=5513.8 *5* (2012Wa38).
DCO values (2014Ko41) are for 90° and 135° geometry, gated on 1797.4γ from first 2$^+$ to g.s., and further normalized to that for 988.8γ-1797.4γ 2$^+$ -> 2$^+$ -> 0$^+$ cascade, with δ(988.8γ)=−0.21 *10* taken from literature (1968Ro18).

E$_{\gamma}$[†]	I$_{\gamma}$[†]	E$_i$(level)	J$_i^{\pi}$	E$_f$	J$_f^{\pi}$	Mult.[a]	δ[c]	Comments
549.9[@]		3336.46	0$^+$	2786.60	2$^+$	E2		I$_{\gamma}$: Reported as <2% branch cf. the strongest γ at 1537.9 keV in 1969Be31.
757.5[@d]		4094?	(1,2)	3336.46	0$^+$			I$_{\gamma}$: Reported as <30% branch cf. the strongest γ at 4093 keV in 1969Be31.
802.7[@]		4139.15	2$^+$	3336.46	0$^+$			I$_{\gamma}$: Reported as <10% the branch intensity in 1969Be31.
842.5[#&] *1*	26 *3*	5289.05	4$^+$	4446.43	4$^+$	D+Q[b]		A$_2$=+0.10 *3*; A$_4$=+0.01 *4* (2015Do07) E$_{\gamma}$,I$_{\gamma}$: Other: 840.4 *7* and 3.2 *1* (2014Ko41).
970.6 *1*	45 *2*	3757.23	3$^+$	2786.60	2$^+$	M1+E2		A$_2$=−0.25 *1*; A$_4$=0.00 *1* (2015Do07) E$_{\gamma}$,I$_{\gamma}$: Other: 970.3 *4* and 4.3 *3*, respectively (2014Ko41).
989.1 *1*	60 *2*	2786.60	2$^+$	1797.31	2$^+$	M1+E2	+0.21 *10*	DCO=0.88 *1* (2014Ko41)

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^{24}Mg(^{3}He,nγ) 2015Do07,2014Ko41,1969Be31 (continued)

$\gamma(^{26}Si)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.[a]	δ[c]	Comments
								A_2=+0.17 *4*; A_4=−0.04 *3* (2015Do07) E_γ,I_γ: Other: 988.8 *5* and 52.0 *5*, respectively (2014Ko41).
1056.8@d		3843.4?	(4$^+$)	2786.60	2$^+$			I_γ: Reported as <15% branch cf. the strongest γ at 2046 keV in 1969Be31.
1071.4 *2*	24 *4*	5517.53	4$^+$	4446.43	4$^+$			E_γ,I_γ: Other: 1071.9 *4* and 1.6 *1*, respectively (2014Ko41).
1307.4@d		4094?	(1,2)	2786.60	2$^+$			I_γ: Reported as <40% branch cf. the strongest γ at 4093 keV in 1969Be31.
1329.4 *3*	35 *4*	5517.53	4$^+$	4187.38	3$^+$	D[b]		A_2=−0.09 *5*; A_4=+0.01 *4* (2015Do07) E_γ,I_γ: Other: 1330.0 *4* and 1.4 *2*, respectively (2014Ko41).
1351.9 *12*	9 *4*	4139.15	2$^+$	2786.60	2$^+$			E_γ,I_γ: Other: 1351.3 *4* and 1.2 *2*, respectively (2014Ko41).
1400.4 *2*	38 *3*	4187.38	3$^+$	2786.60	2$^+$	D[b]		A_2=−0.14 *4*; A_4=+0.03 *4* (2015Do07) E_γ,I_γ: Other: 1400.5 *4* and 5.5 *3*, respectively (2014Ko41).
1475.6@		4812.1	(2$^+$)	3336.46	0$^+$			I_γ: Reported as <20% the branch intensity in 1969Be31.
1531.1#& *6*	49 *3*	5289.05	4$^+$	3757.23	3$^+$	D[b]		A_2=−0.09 *2*; A_4=−0.02 *3* (2015Do07) E_γ,I_γ: Other: 1528.2 *4* and 1.2 *4* (2014Ko41).
1539.1 *2*	100	3336.46	0$^+$	1797.31	2$^+$	E2		DCO=0.48 (2014Ko41) A_2=+0.05 *4*; A_4=+0.02 *3* (2015Do07) E_γ: Other: 1537.9 *4* and 40.2 *5*, respectively (2014Ko41).
1658.3‡ *14*	9 *4*	4446.43	4$^+$	2786.60	2$^+$			
1751.9‡ *10*	28 *5*	5889.9	0$^+$	4139.15	2$^+$			
1764.2 *4*	37 *4*	5517.53	4$^+$	3757.23	3$^+$	D[b]		A_2=−0.08 *4*; A_4=−0.02 *3* (2015Do07) E_γ: level-energy difference=1761.1 *3*. E_γ,I_γ: Others: 1762.0 *4* and 1.7 *1*, respectively (2014Ko41); 1765 *3* (1969Be31).
1797.2 *1*	100	1797.31	2$^+$	0.0	0$^+$	E2		A_2=+0.33 *1*; A_4=−0.10 *2* (2015Do07) E_γ,I_γ: Other: 1797.4 *4* and 100.0 *10*, respectively (2014Ko41).
1959.8 *2*	55 *2*	3757.23	3$^+$	1797.31	2$^+$	M1+E2		DCO=1.12 *7* (2014Ko41) A_2=−0.16 *2*; A_4=+0.01 *2* (2015Do07) E_γ,I_γ: Other: 1959.9 *4* and 9.2 *3*, respectively (2014Ko41).
2025.4#& *3*	100	4812.1	(2$^+$)	2786.60	2$^+$	D+Q[b]		A_2=+0.09 *2*; A_4=+0.02 *3* (2015Do07) Γ_γ>4.6×10^{-6} keV (1969Be31). E_γ: Other: 2022.0 *4* and 8.9 *4* (2014Ko41).
2045.6#& *7*	100	4832.3	(0$^+$)	2786.60	2$^+$			E_γ,I_γ: Other: 2043.7 *3* and 3.7 *3* (2014Ko41).
2046#&d *2*		3843.4?	(4$^+$)	1797.31	2$^+$	(M1+E2)	−4.7 *20*	I_γ: Reported as the 100% branch in 1969Be31. Mult.: Reported as E2 in 1969Be31, evaluators assign (M1+E2) based on reported mixing ratio in 1968Ro18. δ: −4.7 *20* in 1968Ro18 proposing the transition from 3$^{(+)}$ to 2$^+$. 1969Be31 propose this transition as E2 from (4$^+$) to 2$^+$. See comments for spin and parity.
2296.6@d		4094?	(1,2)	1797.31	2$^+$			I_γ: Reported as <20% branch cf. the strongest γ at 4093 keV in 1969Be31.
2341.8 *2*	81 *4*	4139.15	2$^+$	1797.31	2$^+$	D+Q[b]		DCO=0.63 *2* (2014Ko41)

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^{24}Mg(^{3}He,nγ) 2015Do07,2014Ko41,1969Be31 (continued)

$\gamma(^{26}Si)$ (continued)

E_γ[†]	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[a]	Comments
							A_2=+0.14 *2*; A_4=+0.02 *3* (2015Do07) E_γ,I_γ: Other: 2341.6 *4* and 24.7 *5*, respectively (2014Ko41). Γ_γ>2.4×10^{-6} keV (1969Be31).
2359.3[#&] *15*	84 *3*	5147.6	2$^+$	2786.60	2$^+$	D+Q[b]	A_2=+0.11 *4*; A_4=−0.02 *5* (2015Do07) E_γ: Average of 2360.8 *4* (2015Do07) and 2357.7 *2* (2014Ko41). I_γ: Other: 2357.7 *2* and 4.6 *2* (2014Ko41).
2390.0 *3*	62 *3*	4187.38	3$^+$	1797.31	2$^+$	D[b]	DCO=0.79 *7* (2014Ko41) A_2=−0.19 *6*; A_4=+0.01 *5* (2015Do07) E_γ,I_γ: Other: 2390.0 *4* and 4.4 *2*, respectively (2014Ko41).
2501.9[‡] *10*	4 *4*	5289.05	4$^+$	2786.60	2$^+$		
2648.9 *2*	91 *2*	4446.43	4$^+$	1797.31	2$^+$	Q[b]	DCO=1.24 *7* (2014Ko41) A_2=+0.21 *4*; A_4=−0.09 *4* (2015Do07) E_γ,I_γ: Other: 2647.8 *4* and 10.6 *4* (2014Ko41). Γ_γ>1.3×10^{-6} keV (1969Be31).
2736.3[‡] *10*	4 *5*	5517.53	4$^+$	2786.60	2$^+$		E_γ: poor fit in the level scheme. Level-energy difference=2730.8 *2*.
2786.6 *2*	40 *3*	2786.60	2$^+$	0.0	0$^+$	E2	A_2=+0.24 *2*; A_4=−0.08 *3* (2015Do07) E_γ,I_γ: Other: 2787.4 *4* and 0.7 *1*, respectively (2014Ko41).
2888.9[‡] *9*	14 *6*	5676.3	1$^+$	2786.60	2$^+$		
2999.1 *3*	100	4796.6	4$^+$	1797.31	2$^+$	Q	DCO=0.98 *6* (2014Ko41) A_2=+0.16 *5*; A_4=−0.05 *4* (2015Do07) E_γ: Other: 2998.2 *4* and 6.4 *3*, respectively (2014Ko41).
3014.6[@]		4812.1	(2$^+$)	1797.31	2$^+$		I_γ: Reported as a 30% *10* branch in 1969Be31. Γ_γ>2×10^{-6} keV (1969Be31).
3103.1 *4*	35 *5*	5889.9	0$^+$	2786.60	2$^+$	Q	A_2=+0.06 *4*; A_4=−0.04 *4* (2015Do07) E_γ: Average of 3103.0 *4* (2015Do07) and 3103.7 *6* (2014Ko41). I_γ: Other: 1.6 *2* (2014Ko41).
3350.3[‡] *8*	16 *4*	5147.6	2$^+$	1797.31	2$^+$		
3492.0[‡‡] *2*	21 *4*	5289.05	4$^+$	1797.31	2$^+$	Q[b]	A_2=+0.12 *3*; A_4=−0.08 *2* (2015Do07)
3878.8 *3*	86 *4*	5676.3	1$^+$	1797.31	2$^+$	D[b]	DCO=0.94 *11* (2014Ko41) A_2=−0.07 *3*; A_4=−0.01 *2* (2015Do07) E_γ,I_γ: Other: 3876.2 *10* 8.8 *3* and 2.6 *2*, respectively (2014Ko41).
4092.1 *4*	37 *5*	5889.9	0$^+$	1797.31	2$^+$	Q	DCO=0.55 *11* (2014Ko41) A_2=+0.03 *2*; A_4=−0.02 *2* (2015Do07) E_γ,I_γ: Other: 4092.2 *10* and 2.1 *2*, respectively (2014Ko41).
4094[#&d] *4*		4094?	(1,2)	0.0	0$^+$		E_γ: Evaluators believe this Eγ is the same as the 4092-keV γ that depopulates the 5889.9-keV level. I_γ: Reported as the 100% branch in 1969Be31.
4135[#&] *6*		4139.15	2$^+$	0.0	0$^+$		Γ_γ>6×10^{-7} keV (1969Be31). I_γ: Reported as a 20% *10* branch in 1969Be31.
4811.6[@]		4812.1	(2$^+$)	0.0	0$^+$		I_γ: Reported as <10% the branch intensity in 1969Be31.

[†] From 2015Do07, except where noted. Eγ from 2014Ko41 listed in comments section.
[‡] Reported only in 2015Do07.
[#] Reported energy in 2014Ko41 significantly lower compared to value in 2015Do07.
[@] Calculated from level energy difference, recoil energy subtracted. γ transition from 1969Be31 (energy not listed).
[&] From 1969Be31.

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^{24}Mg(^{3}He,nγ) 2015Do07,2014Ko41,1969Be31 (continued)

$\gamma(^{26}Si)$ (continued)

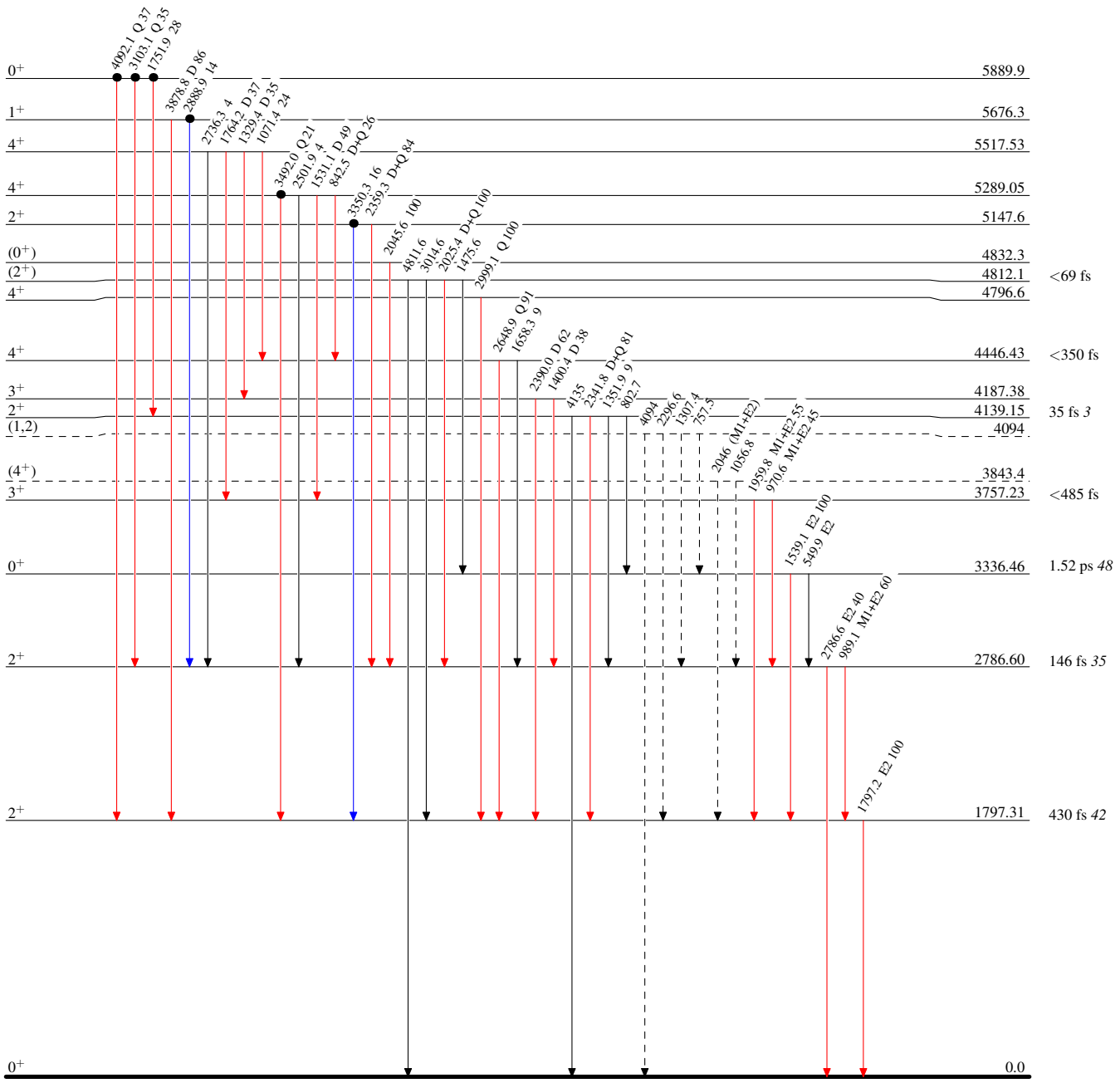
[a] From angular distribution measurements in 1969Be31, except otherwise noted.
[b] From $\gamma(\theta)$ data in 2015Do07, assigned by evaluators.
[c] Deduced from n-γ angular correlations in 1968Ro18.
[d] Placement of transition in the level scheme is uncertain.

^{24}Mg(^{3}He,nγ) 2015Do07,2014Ko41,1969Be31

Level Scheme

Intensities: Relative I_γ

Legend
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)
- Coincidence



$^{26}_{14}Si_{12}$