^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 188,1 (2023)	17-Jan-2023

2012Ho16: E(^{23}Na)=80 MeV from superconducting accelerator at FSU. Target=^{54}Fe, 14 mg/cm^2 thick. Measured Eγ, Iγ, $\gamma\gamma$ coin, $\gamma\gamma(\theta)$(DCO), and lifetimes by DSAM using FSU-γ detector array of ten Compton-suppressed Ge detectors: three clover detectors, two single Ge crystals placed at 90°, two at 35° and three at 145° to the beam direction. Comparison with cranked-shell model calculations.

^{71}Se Levels

E(level)[†]	J$^\pi$	T$_{1/2}$[‡]	Comments
0.0	5/2$^-$		
48.57 *21*	1/2$^-$	5.6 μs *7*	%IT=100 T$_{1/2}$: from the Adopted Levels.
171.60 *24*	3/2$^-$		
260.5[#] *1*	9/2$^+$	19.0 μs *5*	%IT=100 T$_{1/2}$: from the Adopted Levels.
282.46 *20*	3/2$^-$		
756.9 *4*	5/2$^-$		
797.1[&] *4*	5/2$^-$		
1040.66[a] *21*	7/2$^-$		
1154.6[@] *3*	11/2$^+$		
1233.0 *3*	9/2$^-$		
1297.8[#] *3*	13/2$^+$	>1.4 ps	T$_{1/2}$: measured mean lifetime τ>2 ps from DSAM for 1037.3γ (2012Ho16). Q(transition)<1.25.
1378.7[&] *3*	9/2$^-$		
1680.7[a] *4*	11/2$^-$		
2066.2[&] *3*	13/2$^-$		
2417.9[@] *4*	(15/2$^+$)	0.27 ps *+8−7*	T$_{1/2}$: measured mean lifetime τ=0.39 ps *+11−10* from DSAM for 1263.3γ (2012Ho16). Q(transition)=1.63 *+26−19*.
2448.3[#] *3*	17/2$^+$	0.534 ps *+42−35*	T$_{1/2}$: measured mean lifetime τ=0.77 ps *+6−5* from DSAM for 1150.5γ (2012Ho16). Q(transition)=1.40 *5*.
2481.6[a] *4*	15/2$^-$	>1.4 ps	T$_{1/2}$: measured mean lifetime τ>2 ps from DSAM for 800.9γ (2012Ho16). Q(transition)<2.24.
2975.8[&] *4*	17/2$^-$	0.82 ps *8*	T$_{1/2}$: measured mean lifetime τ=1.18 ps *11* from DSAM for 909.6γ (2012Ho16). Q(transition)=2.04 *+10−9*.
3323.3 *4*	17/2$^{(-)}$		
3427.2[a] *5*	19/2$^-$	0.638 ps *21*	T$_{1/2}$: measured mean lifetime τ=0.92 ps *3* from DSAM for 945.5γ (2012Ho16). Q(transition)=2.03 *3*.
3451.5[@] *4*	(19/2$^+$)	0.30 ps *+8−6*	T$_{1/2}$: measured mean lifetime τ=0.43 ps *+12−9* from DSAM for 1033.6γ (2012Ho16). Q(transition)=2.01 *+25−23*.
3521.4 *4*	19/2$^{(-)}$		Possible 3-qp state formed by coupling of g$_{9/2}$ neutron to 5$^-$ state at 3387 keV in ^{70}Se.
3635.2[#] *4*	21/2$^+$	0.284 ps *14*	T$_{1/2}$: measured mean lifetime τ=0.41 ps *2* from DSAM for 1186.9γ (2012Ho16). Q(transition)=1.69 *4*.
3989.1 *4*	21/2$^{(-)}$		
4039.4[&] *4*	(21/2$^-$)	0.485 ps *14*	T$_{1/2}$: measured mean lifetime τ=0.70 ps *2* from DSAM for 1063.6γ (2012Ho16). Q(transition)=1.70 *2*.
4254.3 *5*	(23/2$^-$)		
4497.2[@] *7*	(23/2$^+$)	<0.80 ps	T$_{1/2}$: measured mean lifetime τ<1.15 ps *11* from DSAM for 1045.7γ (2012Ho16).

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^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16 (continued)

^{71}Se Levels (continued)

E(level)[†]	J$^\pi$	T$_{1/2}$[‡]	Comments
			Q(transition)>1.07.
4504.9[a] *7*	23/2$^-$	0.333 ps *14*	T$_{1/2}$: measured mean lifetime τ=0.48 ps *2* from DSAM for 1077.7γ (2012Ho16). Q(transition)=1.95 *4*.
4834.4[#] *7*	(25/2$^+$)	0.326 ps *28*	T$_{1/2}$: measured mean lifetime τ=0.47 ps *4* from DSAM for 1199.2γ (2012Ho16). Q(transition)=1.46 *+7−6*.
5240.3[&] *11*	(25/2$^-$)	<0.17 ps	T$_{1/2}$: measured mean lifetime τ<0.24 ps from DSAM for 1200.9γ (2012Ho16). Q(transition)>2.08.
5645.6[a] *7*	(27/2$^-$)	0.395 ps *35*	T$_{1/2}$: measured mean lifetime τ=0.57 ps *5* from DSAM for 1140.7γ (2012Ho16). Q(transition)=1.52 *+7−6*.
5686.9[@] *8*	(27/2$^+$)		
6036.5[#] *13*	(29/2$^+$)	0.374 ps *28*	T$_{1/2}$: measured mean lifetime τ=0.54 ps *4* from DSAM for 1202.0γ (2012Ho16). Q(transition)=1.36 *5*.
6340.6 *8*	(29/2$^+$)		
6947.6[a] *11*	(31/2$^-$)	<0.17 ps	T$_{1/2}$: measured mean lifetime τ<0.24 ps *11* from DSAM for 1302.0γ (2012Ho16). Q(transition)>1.66.
7375.7[#] *16*	(33/2$^+$)	<0.09 ps	T$_{1/2}$: measured mean lifetime τ<0.13 ps *11* from DSAM for 1339.2γ (2012Ho16). Q(transition)>2.09.

[†] From a least-squares fit to Eγ data.
[‡] From DSAM (2012Ho16), averages of data at 35° and 145°.
[#] Band(A): $\nu g_{9/2}$ band,α=+1/2.
[@] Band(a): $\nu g_{9/2}$ band,α=−1/2.
[&] Band(B): Band based on 5/2$^-$.
[a] Band(C): Band based on 7/2$^-$.

γ(^{71}Se)

DCO ratios are for gates on ΔJ=2, quadrupole (E2) transitions. Expected values are 1.0 for ΔJ=2, quadrupole and ΔJ=0, dipole transitions, ≈0.5 for ΔJ=1, dipole or dipole+quadrupole with small mixing ratio. Weighted average is taken by 2012Ho16 when DCO values for the same transition is determined from gates on several stretched quadrupole transitions.
B(E2)(W.u.) values are from 2012Ho16. See also Adopted Levels, Gammas dataset.

E$_\gamma$	I$_\gamma$	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.[†]	Comments
122.9 *3*	5 *2*	171.60	3/2$^-$	48.57	1/2$^-$	D+Q	DCO=0.45 *16* Mult.: M1+E2 in 2012Ho16.
143.2 *7*	0.9 *5*	1297.8	13/2$^+$	1154.6	11/2$^+$		Mult.: M1+E2 in 2012Ho16.
171.7 *3*	6 *2*	171.60	3/2$^-$	0.0	5/2$^-$	D+Q	DCO=0.65 *13* Mult.: M1+E2 in 2012Ho16.
198.1 *4*	1.1 *3*	3521.4	19/2$^{(-)}$	3323.3	17/2$^{(-)}$		Mult.: (M1+E2) in 2012Ho16.
233.9 *1*	12 *2*	282.46	3/2$^-$	48.57	1/2$^-$	D+Q	DCO=0.62 *3* Mult.: M1+E2 in 2012Ho16.
260.5 *1*		260.5	9/2$^+$	0.0	5/2$^-$	[M2]	E$_\gamma$,Mult.: from the Adopted dataset.
265.2 *4*	2.3 *11*	4254.3	(23/2$^-$)	3989.1	21/2$^{(-)}$	(D+Q)	DCO=0.67 *38* Mult.: (M1+E2) in 2012Ho16.
282.4 *3*	6 *2*	282.46	3/2$^-$	0.0	5/2$^-$	(D+Q)	DCO=0.90 *24* Mult.: M1+E2 in 2012Ho16. DCO consistent with ΔJ=1, D+Q or ΔJ=2, Q.
337.2 *6*	2.3 *15*	4834.4	(25/2$^+$)	4497.2	(23/2$^+$)		Mult.: (M1+E2) in 2012Ho16.
467.7 *2*	8 *2*	3989.1	21/2$^{(-)}$	3521.4	19/2$^{(-)}$		Mult.: (M1+E2) in 2012Ho16.

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^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16 (continued)

$\gamma(^{71}Se)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.†	Comments
474.5 *6*	1.4 *3*	756.9	$5/2^-$	282.46	$3/2^-$	D+Q	DCO=0.56 *38* Mult.: M1+E2 in 2012Ho16.
562.0 *4*	4 *1*	3989.1	$21/2^{(-)}$	3427.2	$19/2^-$	D+Q	DCO=0.50 *9* Mult.: (M1+E2) in 2012Ho16.
581.6 *5*	2.4 *5*	1378.7	$9/2^-$	797.1	$5/2^-$	(Q)	DCO=0.97 *31* Mult.: E2 in 2012Ho16.
621.8 *5*	2.8 *6*	1378.7	$9/2^-$	756.9	$5/2^-$	(Q)	DCO=0.85 *19* Mult.: E2 in 2012Ho16.
640.1 *4*	44 *3*	1680.7	$11/2^-$	1040.66	$7/2^-$	Q	DCO=0.99 *13* Mult.: E2 in 2012Ho16.
653.7 *3*	4 *1*	6340.6	$(29/2^+)$	5686.9	$(27/2^+)$		Mult.: (M1+E2) in 2012Ho16.
665.8 *2*	3 *1*	3989.1	$21/2^{(-)}$	3323.3	$17/2^{(-)}$		Mult.: (E2) in 2012Ho16.
687.5 *2*	7 *1*	2066.2	$13/2^-$	1378.7	$9/2^-$	Q	DCO=1.06 *20* Mult.: E2 in 2012Ho16.
732.9 *6*	3 *1*	4254.3	$(23/2^-)$	3521.4	$19/2^{(-)}$		Mult.: (E2) in 2012Ho16.
756.9 *6*	2.4 *4*	756.9	$5/2^-$	0.0	$5/2^-$	D+Q	DCO=1.13 *44* Mult.: ΔJ=0 transition. Mult.: M1+E2 in 2012Ho16.
758.2 *1*	17 *3*	1040.66	$7/2^-$	282.46	$3/2^-$	Q	DCO=1.00 *10* Mult.: E2 in 2012Ho16.
797.1 *5*	4 *2*	797.1	$5/2^-$	0.0	$5/2^-$	D+Q	DCO=0.94 *28* Mult.: ΔJ=0 transition. Mult.: M1+E2 in 2012Ho16.
800.9 *3*	40 *3*	2481.6	$15/2^-$	1680.7	$11/2^-$	(E2)	DCO=0.86 *16* B(E2)(W.u.)<71 Mult.: E2 in 2012Ho16.
833.2 *3*	14 *2*	2066.2	$13/2^-$	1233.0	$9/2^-$	Q	DCO=1.08 *10* Mult.: E2 in 2012Ho16.
841.7 *5*	4.5 *7*	3323.3	$17/2^{(-)}$	2481.6	$15/2^-$	D+Q	DCO=0.49 *6* Mult.: (M1+E2) in 2012Ho16.
862.0 *10*	8 *3*	4497.2	$(23/2^+)$	3635.2	$21/2^+$		Mult.: (M1+E2) in 2012Ho16.
868.9 *8*	3 *1*	1040.66	$7/2^-$	171.60	$3/2^-$		Mult.: E2 in 2012Ho16.
894.1 *3*	10 *2*	1154.6	$11/2^+$	260.5	$9/2^+$		Mult.: M1+E2 in 2012Ho16.
909.6 *2*	25 *2*	2975.8	$17/2^-$	2066.2	$13/2^-$	(E2)	DCO=0.87 *25* B(E2)(W.u.)=64 *+7−5* Mult.: E2 in 2012Ho16.
945.5 *3*	34 *5*	3427.2	$19/2^-$	2481.6	$15/2^-$	(E2)	DCO=0.80 *25* B(E2)(W.u.)=67 *2* Mult.: E2 in 2012Ho16.
1003.2 *4*	11 *2*	3451.5	$(19/2^+)$	2448.3	$17/2^+$		Mult.: (M1+E2) in 2012Ho16.
1013.3 *9*	3 *2*	3989.1	$21/2^{(-)}$	2975.8	$17/2^-$		Mult.: (E2) in 2012Ho16.
1033.6 *4*	10 *4*	3451.5	$(19/2^+)$	2417.9	$(15/2^+)$	(E2)	DCO=0.83 *20* B(E2)(W.u.)=66 *+17−14* Mult.: (E2) in 2012Ho16. Evaluators obtain B(E2)(W.u.)=44 *+22−23*.
1037.3 *3*	100	1297.8	$13/2^+$	260.5	$9/2^+$	E2	DCO=1.17 *6* B(E2)(W.u.)<19 Mult.: E2 in 2012Ho16.
1040.6 *4*	23 *4*	1040.66	$7/2^-$	0.0	$5/2^-$	(D+Q)	DCO=0.91 *10* Mult.: M1+E2 in 2012Ho16. DCO consistent with ΔJ=1, D+Q or ΔJ=2, Q.
1045.7 *7*	19 *3*	4497.2	$(23/2^+)$	3451.5	$(19/2^+)$	(E2)	DCO=0.75 *26* B(E2)(W.u.)>20 Mult.: (E2) in 2012Ho16.
1063.6 *2*	21 *7*	4039.4	$(21/2^-)$	2975.8	$17/2^-$	[E2]	B(E2)(W.u.)=49 *1* Mult.: (E2) in 2012Ho16.

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^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16 (continued)

$\gamma(^{71}Se)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	Comments
1073.1 *4*	13 *2*	3521.4	$19/2^{(-)}$	2448.3	$17/2^+$	D	DCO=0.47 *9* Mult.: (E1) in 2012Ho16.
1077.7 *5*	15 *2*	4504.9	$23/2^-$	3427.2	$19/2^-$	E2	DCO=1.25 *29* B(E2)(W.u.)=67 *3* Mult.: E2 in 2012Ho16.
1120.1 *5*	9 *2*	2417.9	$(15/2^+)$	1297.8	$13/2^+$		Mult.: (M1+E2) in 2012Ho16.
1140.7 *1*	7 *2*	5645.6	$(27/2^-)$	4504.9	$23/2^-$	[E2]	B(E2)(W.u.)=42 *+4−3* Mult.: (E2) in 2012Ho16.
1150.5 *1*	89 *6*	2448.3	$17/2^+$	1297.8	$13/2^+$	(E2)	DCO=0.72 *4* B(E2)(W.u.)=30 *2* Mult.: E2 in 2012Ho16. DCO is not quite consistent with ΔJ=2, Q transition (evaluators).
1186.9 *3*	63 *7*	3635.2	$21/2^+$	2448.3	$17/2^+$	(E2)	DCO=1.29 *45* B(E2)(W.u.)=48 *2* Mult.: E2 in 2012Ho16.
1189.6 *8*	16 *5*	5686.9	$(27/2^+)$	4497.2	$(23/2^+)$		Mult.: (E2) in 2012Ho16.
1199.2 *10*	36 *9*	4834.4	$(25/2^+)$	3635.2	$21/2^+$	[E2]	B(E2)(W.u.)=38 *+4−3* Mult.: (E2) in 2012Ho16.
1200.9 *10*	6 *2*	5240.3	$(25/2^-)$	4039.4	$(21/2^-)$	[E2]	B(E2)(W.u.)>78 Mult.: (E2) in 2012Ho16.
1202.0 *10*	17 *4*	6036.5	$(29/2^+)$	4834.4	$(25/2^+)$	[E2]	B(E2)(W.u.)=34 *+3−2* Mult.: (E2) in 2012Ho16.
1233.0 *4*	16 *3*	1233.0	$9/2^-$	0.0	$5/2^-$	Q	DCO=1.01 *10* Mult.: E2 in 2012Ho16.
1263.3 *6*	8 *2*	2417.9	$(15/2^+)$	1154.6	$11/2^+$	[E2]	B(E2)(W.u.)=37 *+13−8* Mult.: (E2) in 2012Ho16. Evaluators obtain B(E2)(W.u.)=18 *+7−8*.
1302.0 *8*	6 *3*	6947.6	$(31/2^-)$	5645.6	$(27/2^-)$	[E2]	B(E2)(W.u.)>52 Mult.: (E2) in 2012Ho16.
1339.2 *10*	12 *7*	7375.7	$(33/2^+)$	6036.5	$(29/2^+)$	[E2]	B(E2)(W.u.)>84 Mult.: (E2) in 2012Ho16.
1378.7 *4*	8 *3*	1378.7	$9/2^-$	0.0	$5/2^-$	(Q)	DCO=0.92 *32* Mult.: E2 in 2012Ho16.
1506.1 *3*	4 *2*	6340.6	$(29/2^+)$	4834.4	$(25/2^+)$		Mult.: (E2) in 2012Ho16.

[†] From $\gamma\gamma(\theta)$(DCO) data in 2012Ho16, assigned by evaluators as D+Q for ΔJ=1 or 0 transitions and mult=Q for ΔJ=2, in cases where level lifetimes are not available. RUL is used to assign E2 or (E2) for ΔJ=2 and (M1+E2) for ΔJ=1 transitions. Authors′ assignments are listed in comments.

^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16

Level Scheme

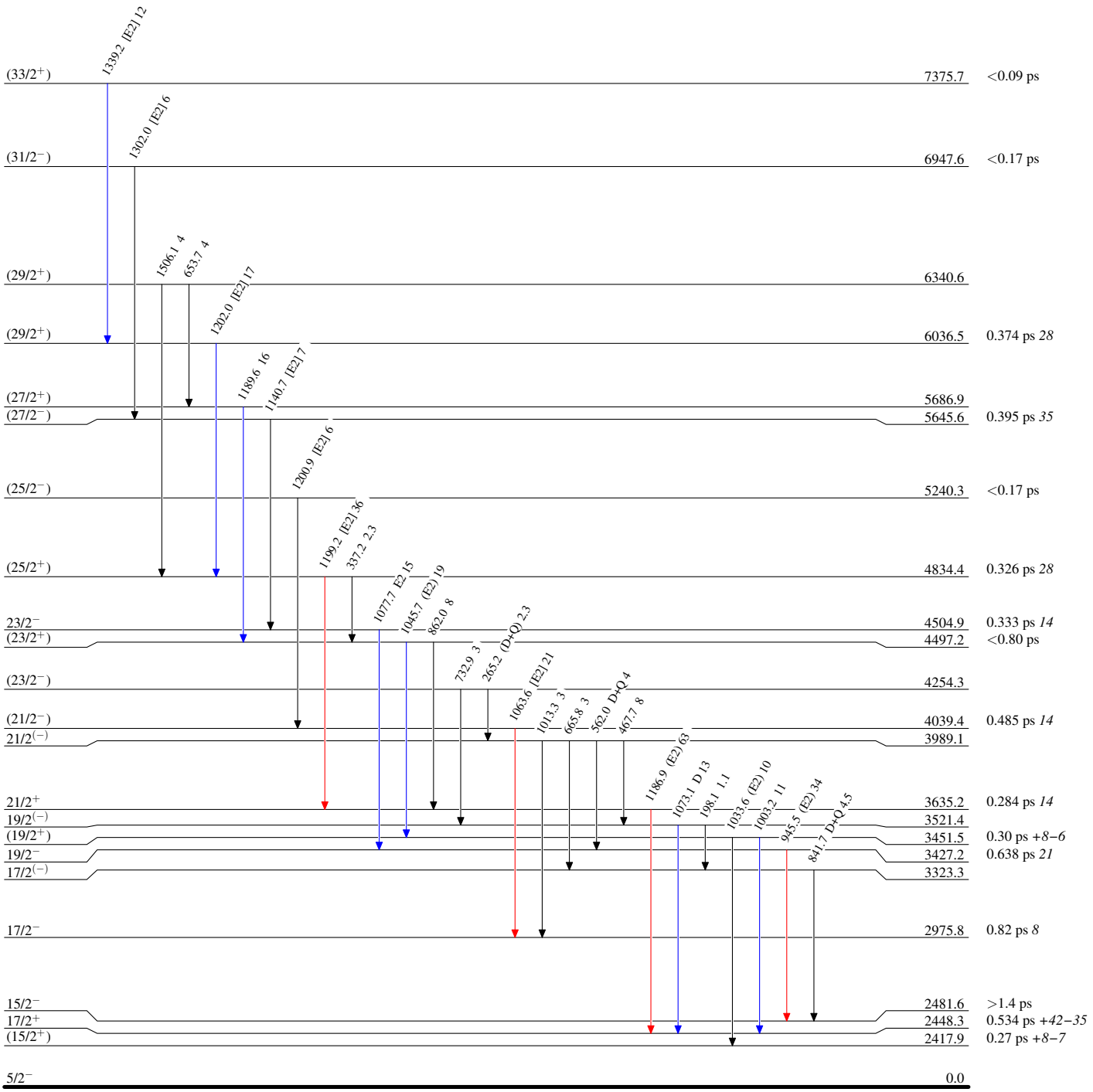
Intensities: Relative I_γ

Legend

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

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

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

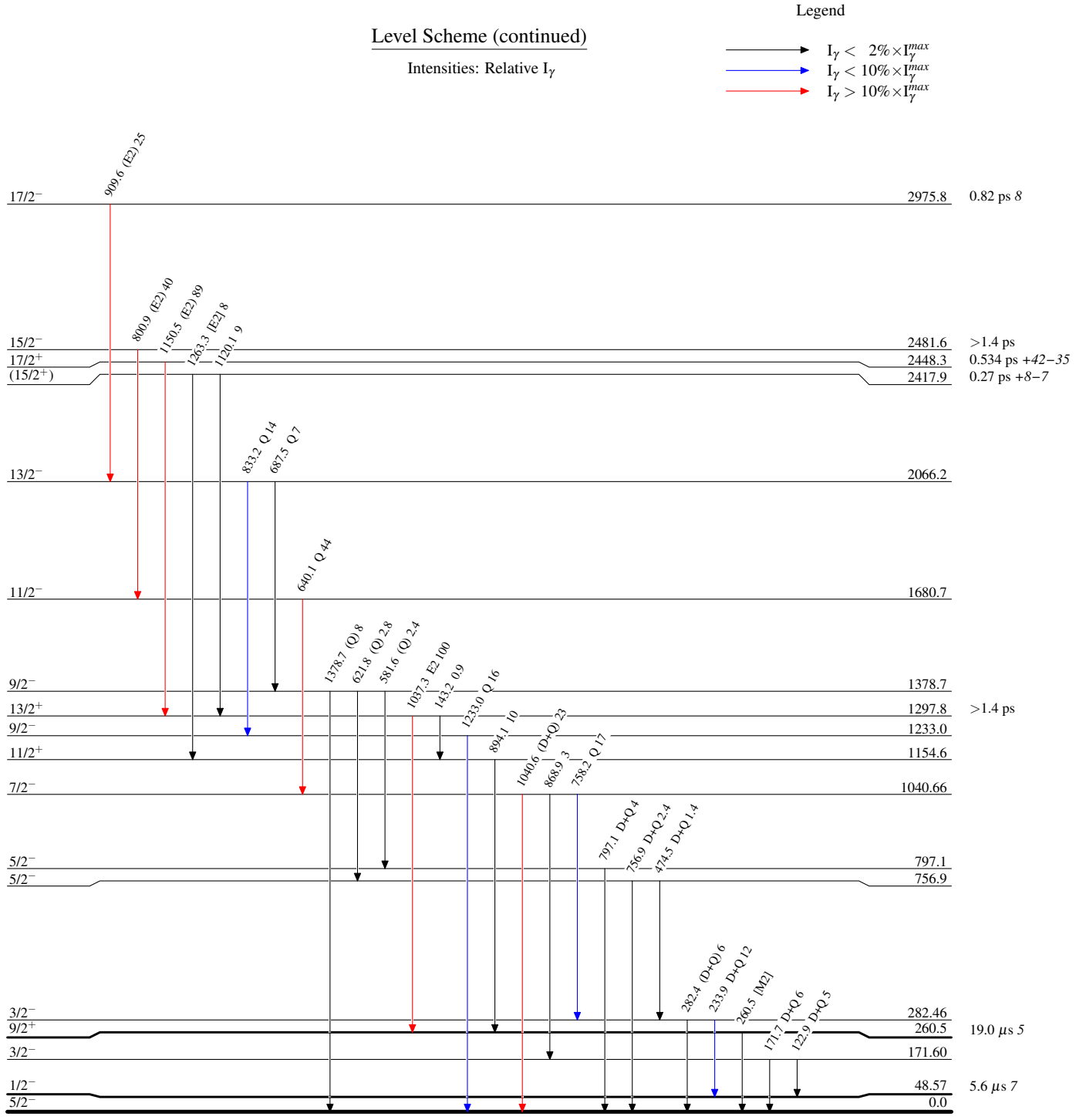


$^{71}_{34}Se_{37}$

^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16

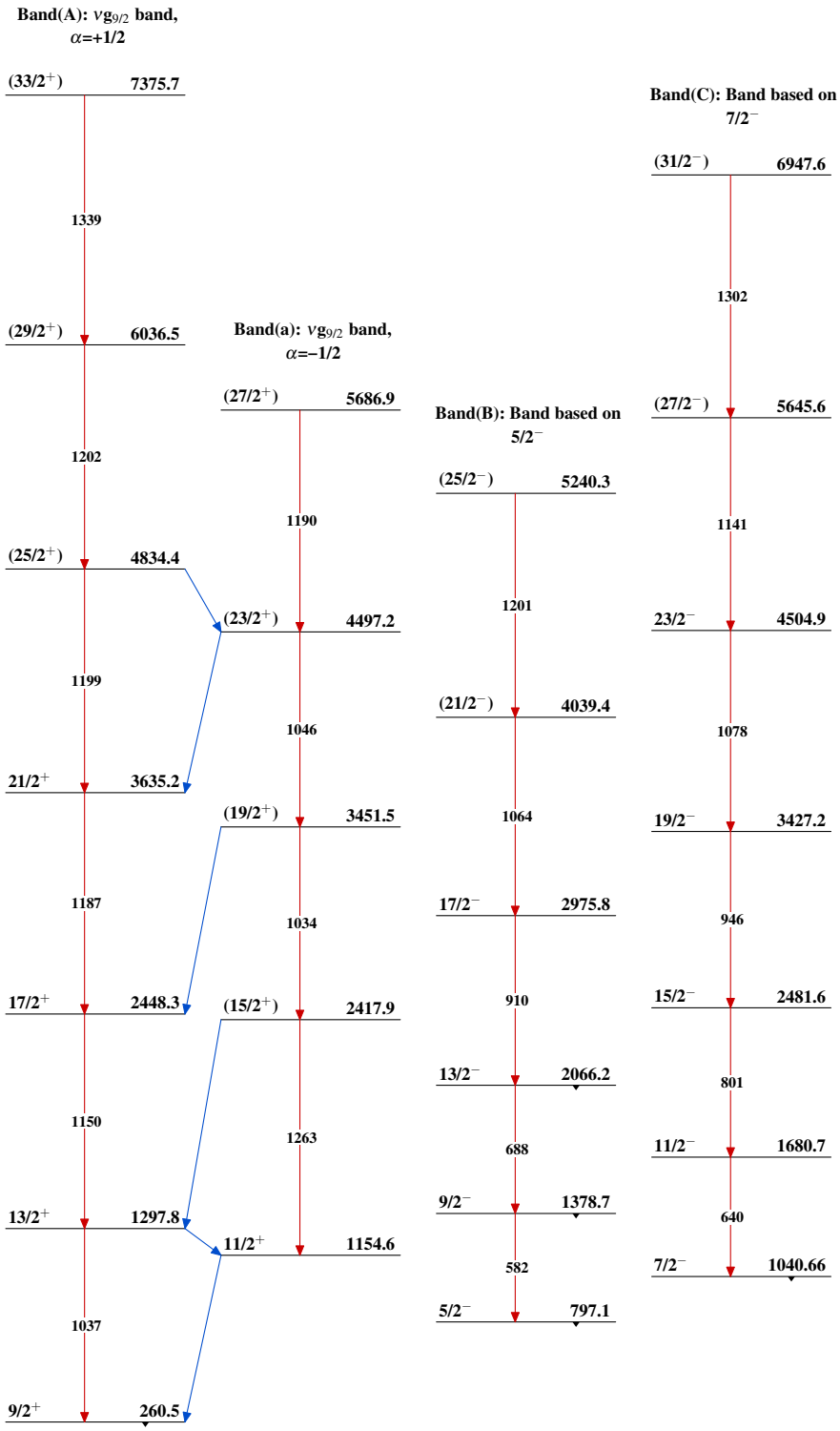
Level Scheme (continued)

Intensities: Relative I_γ



$^{71}_{34}Se_{37}$

^{54}Fe(^{23}Na,np$\alpha\gamma$) 2012Ho16



$^{71}_{34}Se_{37}$