^{58}Ni(^{36}Ar,4pγ),(^{35}Cl,3pγ) 1992Ka27

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	S. K. Basu, E. A. Mccutchan	NDS 165, 1 (2020)	1-Mar-2020

1992Ka27: 99.98% enriched ^{58}Ni + ^{36}Ar reaction at E=149 MeV; OSIRIS array of 12 Compton-suppressed HPGe detectors; measured Eγ, Iγ, $\gamma\gamma(\theta)$, DCO ratios; deduced γ-ray multi-polarities.

Other measurements:

1993Ka24: general treatment of DCO ratio analysis applied to a few transitions in ^{90}Mo.

1994Ka20: 99.8% enriched ^{58}Ni(^{36}Ar,4p) reaction at E=140 MeV; measured Eγ, Iγ, $\gamma\gamma(\theta)$, DCO ratios; measured $T_{1/2}$ of excited levels using the recoil-distance Doppler-shift method (RDDS) and differential decay curve method (DDCM). OSIRIS array of 12 Compton-suppressed HPGe detectors.

^{58}Ni(^{36}Ar,4p), E=149 MeV. Measured $T_{1/2}$ of excited levels using the Doppler-shift attenuation method (DSA) (1992Ka27,1994Ka20).

^{58}Ni(^{35}Cl,3p), E=120 MeV. Measured $\gamma(\theta)$. Deduced δ using the Rose and Brink phase convention (1994Ka20).

2013Zh10: ^{58}Ni(^{36}Ar,4pγ) reaction. Measured $\gamma(\theta)$ and γ(lin pol) for 478γ and 1054γ.

Level scheme and DCO ratios (given in comments) are from 1992Ka27.

^{90}Mo Levels

E(level)†	J$^\pi$	$T_{1/2}$‡	E(level)†	J$^\pi$	$T_{1/2}$‡	E(level)†	J$^\pi$	$T_{1/2}$‡
0.0#	0+		4594.16 *25*	(9−)		8123.44& *20*	18−	
947.97# *9*	2+		4789.28 *19*	10−		8281.76 *22*	(17+)	
1896.48 *14*	2+		4841.91& *16*	11−	39 ps *2*	8525.18# *19*	18+	0.16 ps *2*
2002.06# *12*	4+		4895.04 *19*	(11−)		8616.74 *20*	(17+)	
2432.58 *17*	3−		5377.13 *17*	13+	1.0 ps *3*	8678.33& *23*	19−	
2548.75 *12*	5−	16 ps *3*	5499.32 *16*	(12−)		9079.08 *20*	(18−)	
2811.63# *13*	6+		5624.89# *17*	14+	2.7 ps *1*	9136.48 *19*	18+	
2859.14& *13*	5−		5699.57& *16*	13−	1.4 ps *4*	9318.91 *20*	19−	
2874.73# *15*	8+		5863.65 *17*	13−		9443.78 *20*	19+	
2901.18 *20*	(4−)		5903.64 *18*	14+	1.7 ps *4*	9739.26 *20*	19+	
2946.82 *14*	(6+)		6064.79 *19*	(13−)		9787.84# *21*	20+	
3106.11@ *16*	8+	4.9 ps *13*	6148.07 *18*	15+	<0.3 ps	9994.95 *22*	20−	
3294.03 *20*	(7+)		6475.82 *17*	14−	1.5 ps *10*	10235.02 *20*	(20+)	0.21 ps *6*
3367.31& *14*	7−	<0.69 ps	6643.03& *17*	15−	1.3 ps *1*	10477.23 *21*	(20+)	
3446.16 *20*	(7−)		6746.00# *18*	16+	3.6 ps *7*	10537.81 *25*	21−	
3659.66 *16*	(7−)		7170.88 *19*	(16+)		10855.48 *21*	21+	0.90 ps *14*
4078.82# *16*	10+	14.6 ps *28*	7385.49 *19*	16−	6.6 ps *15*	11135.63# *21*	22+	<0.07 ps
4192.43@ *15*	10+	<3.5 ps	7514.91& *19*	17−	7.4 ps *3*	11576.94 *24*	(22+)	
4297.67& *15*	9−	9.7 ps *21*	7629.51 *21*	(16+)		12016.47 *23*	23+	<1.2 ps
4555.77# *16*	12+	526 ps *3*	8066.65 *19*	17+	0.60 ps *4*	12383.5 *3*	(23−)	

† Deduced by evaluators from a least-squares fit to γ-ray energies.

‡ Average of recoil distance Doppler-shift, Doppler-shift attenuation, and differential decay curve methods (1994Ka20).

\# Seq.(A): Ground state sequence.

@ Seq.(B): Positive-parity sequence.

& Seq.(C): Negative-parity sequence.

^{58}Ni(^{36}Ar,4pγ),(^{35}Cl,3pγ) 1992Ka27 (continued)

γ(^{90}Mo)

DCO ratios in comments are from 1992Ka27. They are defined as Iγ(γ1 at 162° gated by γ2 at 65°,115°)/Iγ(γ1 at 65°,115° gated by γ2 at 162°). Expected values are 1.0 for stretched quadrupole and 0.5 for stretched dipole transitions.

E_γ[†]	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[#]	Comments
63.15 9	7.8 6	2874.73	8^+	2811.63	6^+			
105.78 9	0.48 8	4895.04	(11^-)	4789.28	10^-			
113.64 8	0.51 9	4192.43	10^+	4078.82	10^+			
129.41 7	3.8 10	7514.91	17^-	7385.49	16^-	D+Q[@]	0.14 14	Mult.: R(DCO)=0.24.
135.18 8	1.6 10	2946.82	(6^+)	2811.63	6^+			
167.11 9	7.7 9	6643.03	15^-	6475.82	14^-	D+Q		Mult.: R(DCO)=0.30 8.
231.43 8	33 5	3106.11	8^+	2874.73	8^+	D+Q[@]	−0.04 +10−40	Mult.: R(DCO)=0.71 7.
239.83 9	1.3 3	9318.91	19^-	9079.08	(18^-)			
244.46 8	11.4 8	6148.07	15^+	5903.64	14^+	D+Q[@]	0.12 3	Mult.: R(DCO)=0.38 7.
247.75 8	21 3	5624.89	14^+	5377.13	13^+	D+Q[@]	0.04 5	Mult.: R(DCO)=0.36 7.
262.84 17	3.1 2	2811.63	6^+	2548.75	5^-	D		Mult.: R(DCO)=0.43 7. Deviation from a expected value of 0.6 is due to the timing effect.
280.15 3	9.8 14	11135.63	22^+	10855.48	21^+	D+Q	0.12 +8−6	Mult.: R(DCO)=0.40 8.
292.30 24	1.3 1	3659.66	(7^-)	3367.31	7^-			R(DCO)≈0.7.
296.50 20	0.62 5	4594.16	(9^-)	4297.67	9^-	D+Q	−0.2 +4−3	Mult.: R(DCO)≈0.8.
310.39 6	1.6 1	2859.14	5^-	2548.75	5^-	[@]		R(DCO)=0.79 13.
335.00 15	1.9 3	8616.74	(17^+)	8281.76	(17^+)			
344.00 12	3.3 5	9787.84	20^+	9443.78	19^+	D+Q		Mult.: R(DCO)=0.46 6.
363.33 4	17.4 25	4555.77	12^+	4192.43	10^+	Q		Mult.: R(DCO)=0.95 9.
364.36 8	2.7 10	5863.65	13^-	5499.32	(12^-)			
365.20 20	0.8[‡] 2	6064.79	(13^-)	5699.57	13^-			
378.25 8	1.1 2	10855.48	21^+	10477.23	(20^+)			
411.00 13	1.0 2	6475.82	14^-	6064.79	(13^-)	D		Mult.: R(DCO)≈0.5.
437.20 31	1.8 3	8066.65	17^+	7629.51	(16^+)			
439.54 8	0.23 2	12016.47	23^+	11576.94	(22^+)			
458.59 9	18 3	8525.18	18^+	8066.65	17^+	D+Q		Mult.: R(DCO)=0.69 6.
458.70 20	≈1.3[‡]	7629.51	(16^+)	7170.88	(16^+)			
468.60 10	0.57 5	2901.18	(4^-)	2432.58	3^-			
476.95 10	32 5	4555.77	12^+	4078.82	10^+	E2		Mult.: R(DCO)=1.01 6. Mult.: A_2=+0.32 8, A_4=−0.10 1, Pol=+0.51 9 (2013Zh10).
482.40 15	2.3 2	3294.03	(7^+)	2811.63	6^+	D		Mult.: R(DCO)=0.70 9.
491.66 14	3.3 2	4789.28	10^-	4297.67	9^-	D+Q		Mult.: R(DCO)=0.49 8.
495.71 11	9.8 14	10235.02	(20^+)	9739.26	19^+	D+Q	0.14 23	Mult.: R(DCO)=0.70 6.
508.20 15	≤2.6[‡]	3367.31	7^-	2859.14	5^-			
519.7 3	4.8 7	9136.48	18^+	8616.74	(17^+)	D+Q		Mult.: R(DCO)=0.62 7.
523.18 10	26 4	6148.07	15^+	5624.89	14^+	D+Q	0.11 3	Mult.: R(DCO)=0.51 6.
526.53 8	11.3 20	5903.64	14^+	5377.13	13^+	D+Q	0.13 5	Mult.: R(DCO)=0.45 6.
536.10 10	1.4 1	2432.58	3^-	1896.48	2^+			
542.9 2	≤3.5[‡]	10537.81	21^-	9994.95	20^-	D		Mult.: R(DCO)=0.59 6.
544.22 9	18.0 13	4841.91	11^-	4297.67	9^-	Q		Mult.: R(DCO)=1.01 6.
546.69 4	32.4 23	2548.75	5^-	2002.06	4^+	D		Mult.: R(DCO)=0.60 6.
554.90 20	≈6[‡]	8678.33	19^-	8123.44	18^-	D		Mult.: R(DCO)=0.56 7.
555.65 9	6.0 4	3367.31	7^-	2811.63	6^+	D		Mult.: R(DCO)=0.62 7.
565.5 3	0.23 2	6064.79	(13^-)	5499.32	(12^-)			R(DCO)≈0.4.
598.00 10	19 3	6746.00	16^+	6148.07	15^+	D+Q	3.4 5	Mult.: R(DCO)=0.59 6.
602.77 10	6.5[‡]	9739.26	19^+	9136.48	18^+	D+Q		Mult.: R(DCO)=0.61 6.

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^{58}Ni(^{36}Ar,4pγ),(^{35}Cl,3pγ) 1992Ka27 (continued)

γ(^{90}Mo) (continued)

E_γ †	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	δ#	Comments
604.33 *15*	1.4 *2*	5499.32	(12⁻)	4895.04	(11⁻)	(D+Q)		Mult.: R(DCO)=0.45 *4*.
608.54 *9*	11.4 *16*	8123.44	18⁻	7514.91	17⁻	D+Q		Mult.: R(DCO)=0.49 *7*.
612.10 *8*	0.32 *2*	6475.82	14⁻	5863.65	13⁻			R(DCO)≈0.3.
620.47 *4*	16.0 *22*	10855.48	21⁺	10235.02	(20⁺)	D+Q	0.16 *9*	Mult.: R(DCO)=0.38 *11*.
638.00 *15*	0.69 *5*	4297.67	9⁻	3659.66	(7⁻)	(Q)		Mult.: R(DCO)≈1.2.
640.60 *20*	0.9 *2*	9318.91	19⁻	8678.33	19⁻			
649.64 *16*	11.5 *4*	4841.91	11⁻	4192.43	10⁺	D		Mult.: R(DCO)=0.66 *8*.
657.41 *5*	2.7 *7*	5499.32	(12⁻)	4841.91	11⁻	D		Mult.: R(DCO)≈0.5.
676.03 *9*	3.1 *7*	9994.95	20⁻	9318.91	19⁻	D+Q		Mult.: R(DCO)=0.56 *8*.
738.00 *20*	0.5 *2*	10477.23	(20⁺)	9739.26	19⁺			
742.46 *14*	5.8 *15*	7385.49	16⁻	6643.03	15⁻	D+Q	3.1 *8*	Mult.: R(DCO)=0.69 *7* too large because of contamination from 2⁺ to 0⁺ transition in ^{88}Mo.
768.89 *10*	8.6 *6*	7514.91	17⁻	6746.00	16⁺	D		Mult.: R(DCO)=0.60 *7*.
776.24 *6*	7.4 *9*	6475.82	14⁻	5699.57	13⁻	D+Q	3.1 *+10−7*	Mult.: R(DCO)=0.51 *8*.
779.43 *6*	1.4 *5*	6643.03	15⁻	5863.65	13⁻	Q		Mult.: R(DCO)=0.97 *23*.
800.52 *15*	0.78 *5*	3659.66	(7⁻)	2859.14	5⁻	(Q)		Mult.: R(DCO)≈1.0.
809.57 *6*	62 *4*	2811.63	6⁺	2002.06	4⁺	Q		Mult.: R(DCO)=0.99 *6*.
818.56 *10*	19.5 *14*	3367.31	7⁻	2548.75	5⁻	Q		Mult.: R(DCO)=0.99 *6*.
821.37 *9*	31 *5*	5377.13	13⁺	4555.77	12⁺	D+Q	0.09 *4*	Mult.: R(DCO)=0.49 *6*.
857.10 *12*	≤2‡	2859.14	5⁻	2002.06	4⁺			E_γ: From level energy difference. R(DCO)=0.92 *6*, for the 857-keV doublet.
857.65 *11*	20 *5*	5699.57	13⁻	4841.91	11⁻	Q		Mult.: R(DCO)=0.88 *3* for doublet.
872.0 *3*	26 *6*	7514.91	17⁻	6643.03	15⁻	Q		Mult.: R(DCO)=1.03 *6*.
880.80 *19*	7.9 *11*	12016.47	23⁺	11135.63	22⁺	D+Q		Mult.: R(DCO)=0.56 *7*.
895.73 *8*	1.3 *2*	8066.65	17⁺	7170.88	(16⁺)			
897.40 *15*	3.2 *2*	3446.16	(7⁻)	2548.75	5⁻	(Q)		Mult.: R(DCO)≈0.8.
918.59 *7*	4.6 *7*	9443.78	19⁺	8525.18	18⁺	D+Q		Mult.: R(DCO)=0.60 *7*.
930.34 *9*	22.1 *16*	4297.67	9⁻	3367.31	7⁻	Q		Mult.: R(DCO)=1.00 *6*.
943.50 *20*	19.6 *5*	6643.03	15⁻	5699.57	13⁻	Q		Mult.: R(DCO)=0.97 *7*.
944.80 *14*	≤2‡	2946.82	(6⁺)	2002.06	4⁺			
948.01 *9*	108 *8*	947.97	2⁺	0.0	0⁺	Q		Mult.: R(DCO)=1.00 *6*.
948.50 *10*	1.5 *1*	1896.48	2⁺	947.97	2⁺			
972.73 *8*	32 *5*	4078.82	10⁺	3106.11	8⁺	Q		Mult.: R(DCO)=0.99 *9*.
1018.10 *12*	8.2 *12*	6643.03	15⁻	5624.89	14⁺	D		Mult.: R(DCO)=0.65 *7*.
1054.10 *7*	100.0	2002.06	4⁺	947.97	2⁺	E2		Mult.: R(DCO)=1.00 *6*. Mult.: A_2=+0.32 *3*, A_4=−0.02 *1*, Pol=+0.57 *6* (2013Zh10).
1069.12 *12*	20 *3*	5624.89	14⁺	4555.77	12⁺	Q		Mult.: R(DCO)=0.91 *7*.
1086.37 *12*	0.38 *6*	4192.43	10⁺	3106.11	8⁺			
1143.78 *10*	10.7 *15*	5699.57	13⁻	4555.77	12⁺	D		Mult.: R(DCO)=0.66 *8*.
1161.00 *20*	1.0 *2*	12016.47	23⁺	10855.48	21⁺	Q		Mult.: R(DCO)=1.10 *20*.
1195.45 *10*	1.1 *3*	9318.91	19⁻	8123.44	18⁻	D+Q		Mult.: R(DCO)=0.51 *9*.
1214.10 *10*	1.5 *2*	9739.26	19⁺	8525.18	18⁺			
1262.70 *10*	1.4 *2*	9787.84	20⁺	8525.18	18⁺	Q		Mult.: R(DCO)=1.00 *10*.
1267.15 *17*	1.0 *2*	7170.88	(16⁺)	5903.64	14⁺			
1317.68 *7*	28 *4*	4192.43	10⁺	2874.73	8⁺	Q		Mult.: R(DCO)=1.00 *8*.
1320.75 *11*	3.6 *5*	8066.65	17⁺	6746.00	16⁺			
1377.00 *20*	0.11 *4*	9443.78	19⁺	8066.65	17⁺			
1446.0 *3*	0.76 *11*	8616.74	(17⁺)	7170.88	(16⁺)			
1481.40 *15*	0.45 *6*	7629.51	(16⁺)	6148.07	15⁺	(D+Q)		Mult.: From R(DCO)=0.59 *14*.
1545.92 *18*	2.5 *4*	7170.88	(16⁺)	5624.89	14⁺			
1564.10 *20*	<0.5‡	9079.08	(18⁻)	7514.91	17⁻			
1672.52 *14*	1.6 *2*	9739.26	19⁺	8066.65	17⁺	Q		Mult.: R(DCO)=0.94 *8*.
1693.60 *10*	0.8 *2*	9079.08	(18⁻)	7385.49	16⁻			

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^{58}Ni(^{36}Ar,4pγ),(^{35}Cl,3pγ) 1992Ka27 (continued)

γ(^{90}Mo) (continued)

E_γ †	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	Comments
1709.86 *11*	9.4 *13*	10235.02	(20$^+$)	8525.18	18$^+$	Q	Mult.: R(DCO)=1.18 *10*.
1779.20 *17*	3.0 *4*	8525.18	18$^+$	6746.00	16$^+$	Q	Mult.: R(DCO)=1.05 *11*.
1789.12 *20*	0.8 *1*	11576.94	(22$^+$)	9787.84	20$^+$	Q	Mult.: R(DCO)=1.04 *30*.
1803.97 *11*	8.5 *20*	9318.91	19$^-$	7514.91	17$^-$	Q	Mult.: R(DCO)=0.91 *8*.
1845.68 *10*	2.7 *5*	12383.5	(23$^-$)	10537.81	21$^-$	Q	Mult.: R(DCO)=0.87 *12*.
1859.45 *15*	3.2 *7*	10537.81	21$^-$	8678.33	19$^-$		
1870.70 *15*	1.9 *3*	8616.74	(17$^+$)	6746.00	16$^+$		
1871.6 *5*	0.6 *2*	9994.95	20$^-$	8123.44	18$^-$		
1918.60 *20*	15.2 *21*	8066.65	17$^+$	6148.07	15$^+$	Q	Mult.: R(DCO)=0.95 *6*.
1952.00 *20*	0.76 *10*	10477.23	(20$^+$)	8525.18	18$^+$		
2133.70 *20*	0.50 *7*	8281.76	(17$^+$)	6148.07	15$^+$		
2390.46 *7*	1.7 *4*	9136.48	18$^+$	6746.00	16$^+$	Q	Mult.: R(DCO)=1.00 *10*.
2468.55 *19*	0.91 *12*	8616.74	(17$^+$)	6148.07	15$^+$		

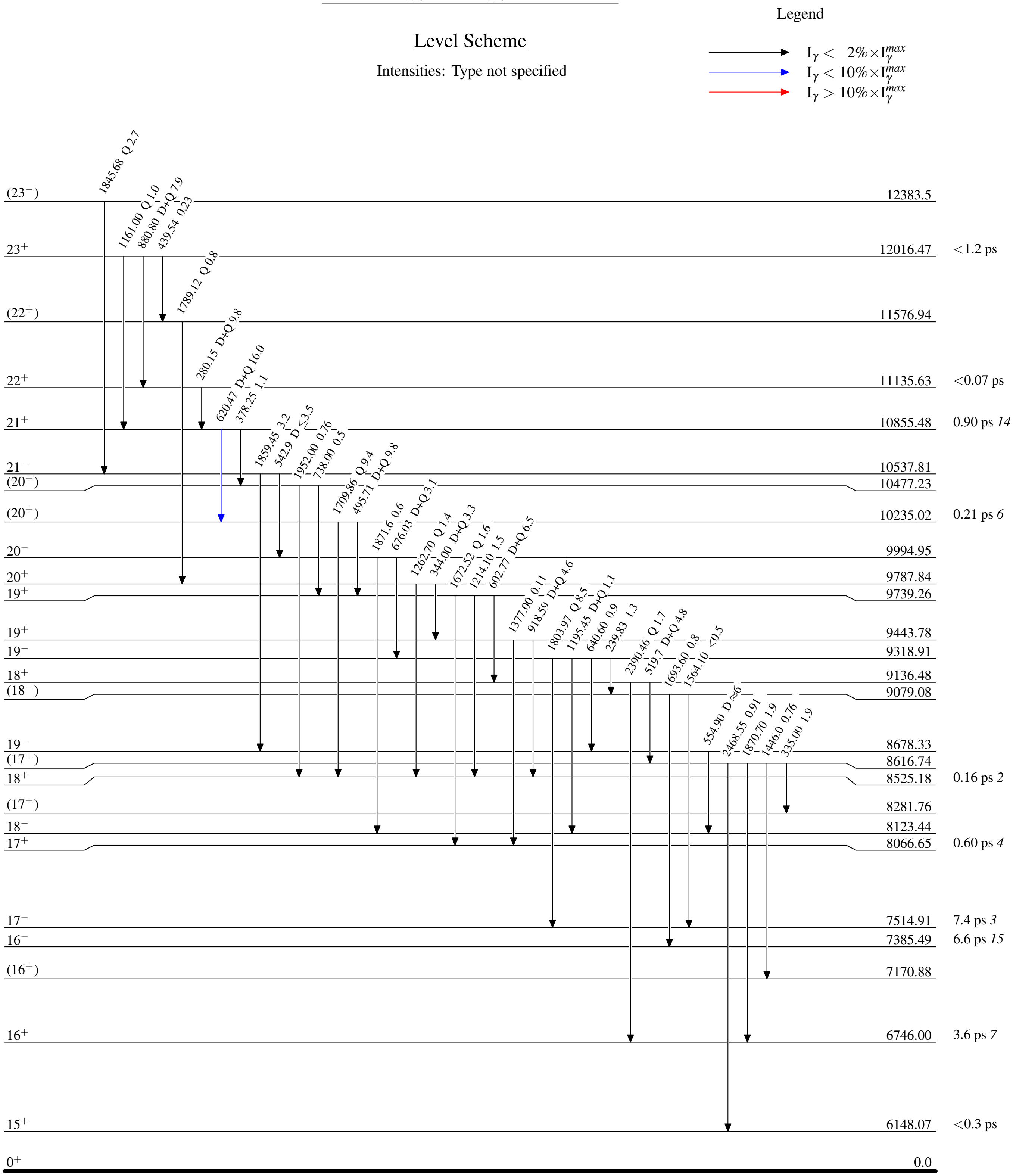
† From 1992Ka27, except where noted.

‡ From transition intensity balance.

\# From γ(θ) in ^{58}Ni(^{35}Cl,3pγ) and DCO ratios in ^{58}Ni(^{36}Ar,4pγ) (1992Ka27).

@ DCO ratio underestimated due to different detector timing characteristics.

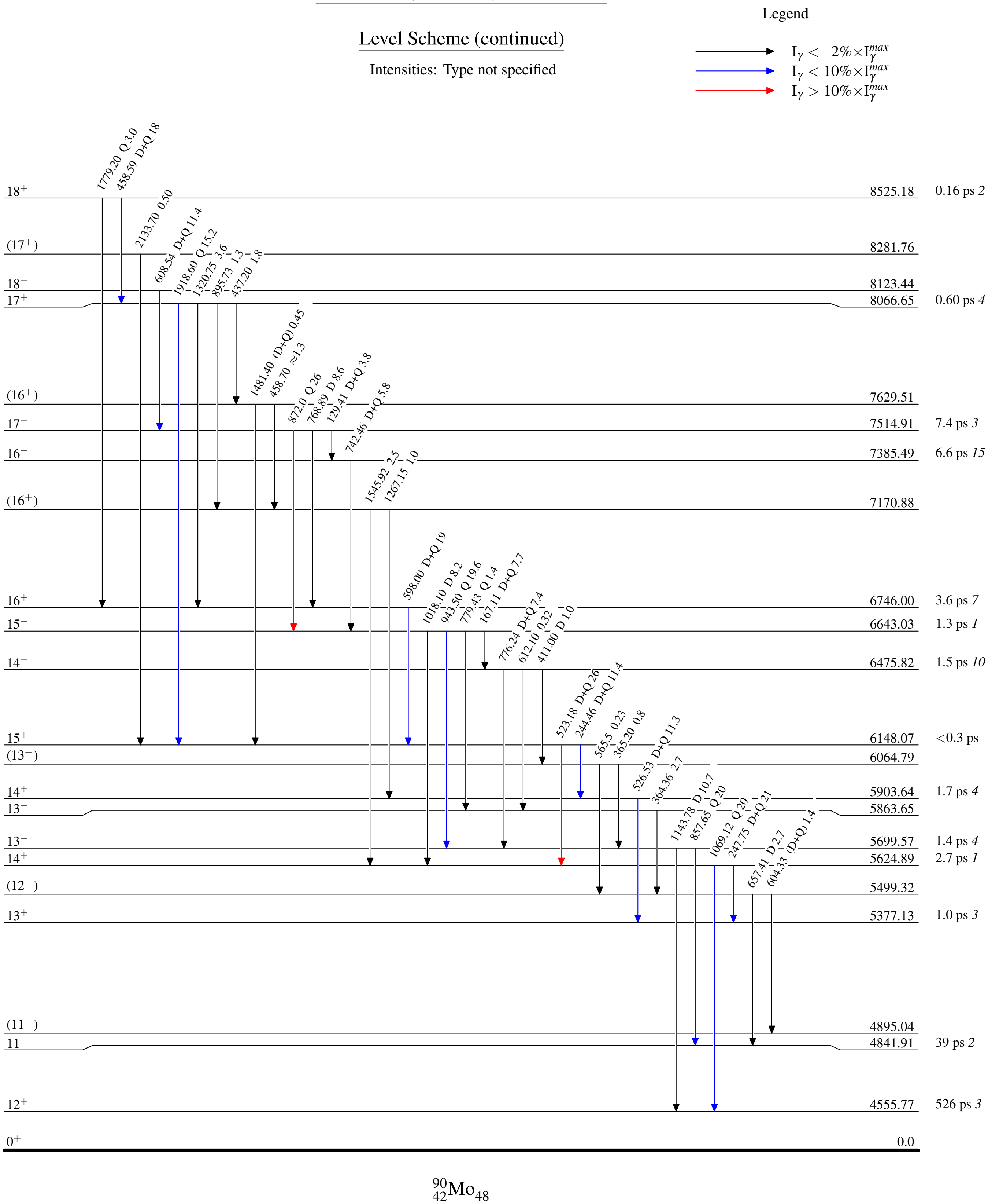
$^{58}Ni(^{36}Ar,4p\gamma),(^{35}Cl,3p\gamma)$ 1992Ka27



^{58}Ni(^{36}Ar,4pγ),(^{35}Cl,3pγ) 1992Ka27

Level Scheme (continued)

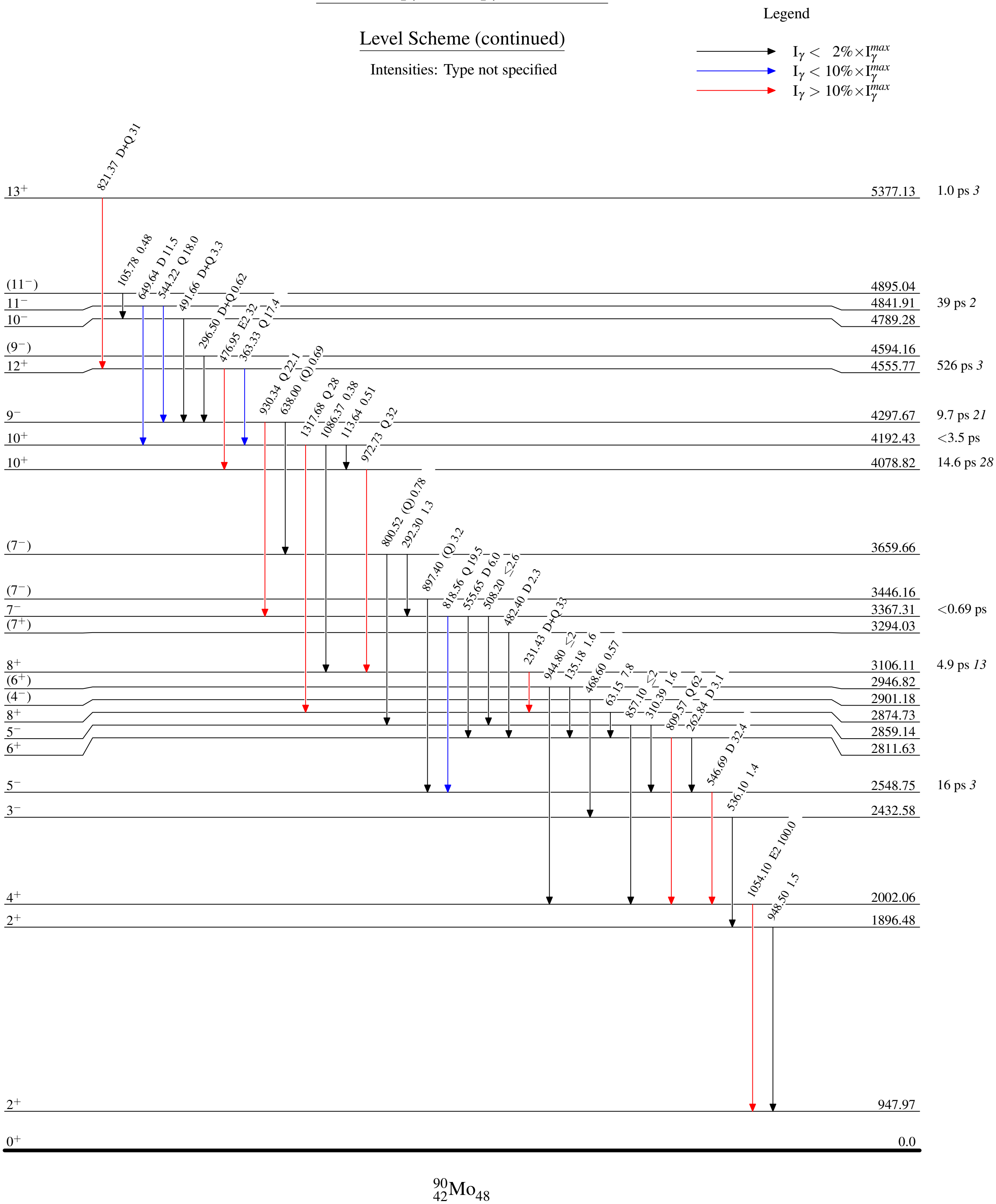
Intensities: Type not specified



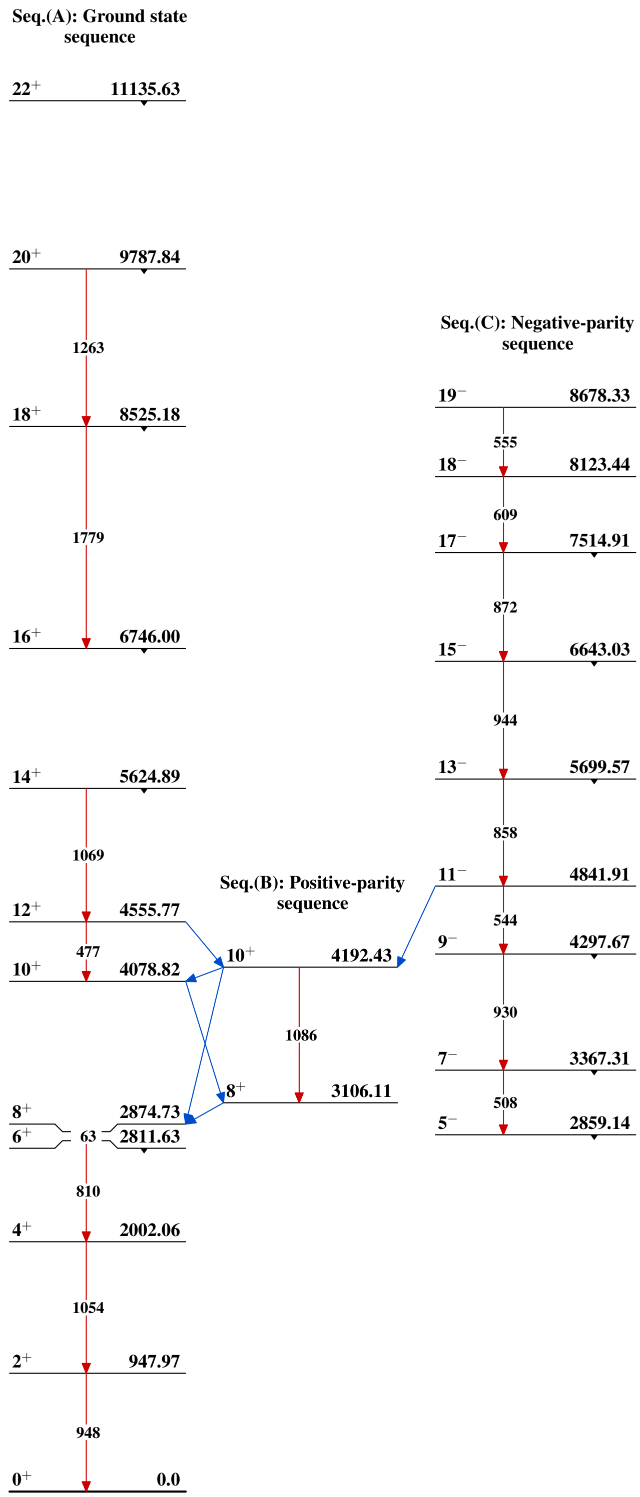
$^{58}Ni(^{36}Ar,4p\gamma),(^{35}Cl,3p\gamma)$ 1992Ka27

Level Scheme (continued)

Intensities: Type not specified



^{58}Ni(^{36}Ar,4pγ),(^{35}Cl,3pγ) 1992Ka27



$^{90}_{42}Mo_{48}$