

(HI,xnγ) 1994Es01,1991Mc04,1978Dr04

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 75,199 (1995)	31-May-1995

1994Es01: ¹⁴⁶Nd(³⁰Si,4nγ) E=160 MeV. Measured γ, γγ, γγ(θ) (DCO). Cranking-model calculations.
 1991Mc04 (also 1986Ra07): ¹²⁴Sn(⁵²Cr,4nγ) E=230 MeV. Measured γ, γγ, T_{1/2} by RDDS method. See also 1994McZZ for explicit T_{1/2} values from which Q(transition) were given in 1991Mc04.

Additional information 1.

1978Dr04 (also 1976Wa16): ¹⁶⁰Dy(¹⁶O,4nγ) E=89 MeV; ¹⁶¹Dy(¹⁶O,5nγ) E=105 MeV. Measured γ, γγ, ce, γ(t), γ(θ).
 1965St03 (also 1964St12): ¹⁶⁵Ho(¹⁴N,7nγ) E=117 MeV. ce spectra showing K, L, M lines of 123, 254, 350, 419, 470, 513, 550, 577 and 598 transitions.

¹⁷²W Levels

E(level)	J ^π ‡	T _{1/2} †	Comments
0.0@	0 ⁺		
123.2@ 1	2 ⁺	0.74 ns 6	
377.1@ 2	4 ⁺	33.7 ps 24	
727.6@ 2	6 ⁺	6.8 ps 7	
1146.8@ 2	8 ⁺	2.61 ps 28	
1433.9 ^a 4	(4 ⁻)	58 [#] ps 20	
1617.3@ 2	10 ⁺	1.54 ps 23	
1713.0 ^a 4	(6 ⁻)	11 [#] ps 1	
1762.2& 4	(7 ⁻)		
2074.2 ^a 4	(8 ⁻)	6.9 [#] ps 11	
2105.6& 3	(9 ⁻)	2.2 [#] ps 4	T _{1/2} : 1.2 ps if branching from 1991Mc04 is used.
2130.0@ 3	12 ⁺	1.03 ps 16	
2341.9 ^b 3	(9 ⁻)	1.4 [#] ps 2	
2475.9 ^c 4	(10 ⁻)	<8.7 [#] ps	
2517.9 ^a 4	(10 ⁻)		
2519.4& 3	(11 ⁻)	5.3 [#] ps 7	T _{1/2} : 3.5 ps if branching from 1991Mc04 is used.
2659.3 ^b 3	(11 ⁻)	7.7 [#] ps 20	
2679.6@ 4	14 ⁺	0.78 ps 21	
2848.9 ^c 4	(12 ⁻)		
2992.3& 3	(13 ⁻)	<1.6 [#] ps	
3064.1 ^b 4	(13 ⁻)	5.4 [#] ps 8	
3256.4@ 4	16 ⁺	0.50 ps 13	
3292.6 ^c 5	(14 ⁻)		
3511.3& 3	(15 ⁻)		
3554.2 ^b 4	(15 ⁻)	<1.8 [#] ps	
3804.0 ^c 7	(16 ⁻)		
3854.4@ 4	18 ⁺	0.40 ps 14	
4067.4& 3	(17 ⁻)		
4101.1 ^b 4	(17 ⁻)		
4360.0 ^c 7	(18 ⁻)		
4499.0@ 4	20 ⁺	0.31 ps 9	
4652.2& 3	(19 ⁻)		
4669.0 ^b 4	(19 ⁻)		
4946.6 ^c 7	(20 ⁻)		

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(HI,xn γ) 1994Es01,1991Mc04,1978Dr04 (continued)

^{172}W Levels (continued)

E(level)	J π^{\ddagger}	T $_{1/2}^{\dagger}$	E(level)	J π^{\ddagger}	E(level)	J π^{\ddagger}
5209.8 [@] 5	(22 ⁺)	0.27 ^d ps 11	5986.2 [@] 5	(24 ⁺)	7720.2 [@] 5	(28 ⁺)
5236.9 ^{&} 3	(21 ⁻)		6261.6 ^c 10	(24 ⁻)	8170.4 ^{&} 9	(29 ⁻)
5278.7 ^b 4	(21 ⁻)		6557.4 ^{&} 5	(25 ⁻)	8668.2 [@] 7	(30 ⁺)
5573.6 ^c 9	(22 ⁻)		6824.2 [@] 5	(26 ⁺)	9084.4 ^{&} 10	(31 ⁻)
5863.4 ^{&} 4	(23 ⁻)		7020.6 ^c 12	(26 ⁻)		
5937.7 ^b 7	(23 ⁻)		7326.4 ^{&} 7	(27 ⁻)		

[†] From RDDS method (1991Mc04). See also 1986Ra07.

[‡] Based on $\gamma(\theta)$, $\gamma\gamma(\theta)$ and band assignments. See also Adopted Levels.

Deduced (evaluator) from transition probabilities (1994McZZ).

[@] Band(A): ($\pi=+$, $\alpha=0$) g.s. band. from T $_{1/2}$ for band members up to 20⁺, 1991Mc04 deduce Q(transition) for each member. The Q values vary from 6.4 to 7.2.

[&] Band(B): ($\pi=-$, $\alpha=1$) (octupole) band.

^a Band(C): ($\pi=-$, $\alpha=0$) (octupole) band.

^b Band(D): ($\pi=-$, $\alpha=1$) AE band.

^c Band(E): ($\pi=-$, $\alpha=0$) AF band.

^d From RDDS method (1986Ra07).

$\gamma(^{172}\text{W})$

DCO ratios (37°–79°)/(79°–37°) are from 1994Es01.

A $_2$ and A $_4$ coefficients are from $^{160}\text{Dy}(^{16}\text{O},4n\gamma)$ E=89 MeV (1978Dr04).

All γ -ray placements are from $\gamma\gamma$ data.

γ -ray intensities from other reactions:

$^{124}\text{Sn}(^{52}\text{Cr},4n\gamma)$ E=230 MeV (1991Mc04)					
E γ	I γ	E γ	I γ	E γ	I γ
123.4	100 a)	470.7	72	862.5	3.6
254.0	100 a)	473.0	9.8	894.2	
279.8	5.0	489.9	10	902	3.8
316.9	4.0	513.0	59	948	
344	4.8	549.9	48	958.6	3.1
350.7	94 a)	576.9	40	985.0	5.0
361.5	10	598.3	27	1043	1.9
401.7	8.8	645.5	24	1056	3.1
404.2	6.0	711.1	13	1195	2.9
413.9	7.8	776.4			
419.6	84	839.2			

a: transition intensity

$^{160}\text{Dy}(^{16}\text{O},4n\gamma)$ E=89 MeV (1978Dr04)					
E γ	I γ	E γ	I γ	E γ	I γ
122.9 3	53 11	443.1 3 a)	3 1	615.1 5 a)	7.3 15
253.9 2	100	470.5 1	59 3	645.0 3	7.6 25
279.8 2	3.8 4	473.0 3	4.4 8	862.1 2	2.5 15
344.0 5 a)	2.5 15	512.5 1 a)	45 5	901.8 2	4.8 10
351.0 2 a)	110 10	519.0 4 a)	6.2 15	958.6 2	7.3 9
361.5 2	8.6 9	549.7 2 a)	31 3	985.0 2	3.7 5
373.5 2	3.8 8	555.7 3	6.5 8	1034.4 3	2.3 10
401.7 3 a)	5 2	576.8 1	19.2 15	1056.1 2	2.9 6
413.9 3	4.6 8	584.9 5 a)	7.8 15		
419.4 1	87 5	597.9 2 a)	11.5 35		

a): contaminated by other reaction channels

Level	Transition	T(EL) in (ps ⁻¹)	T(E2)(1+ α)	T(E1)
1434	1056			0.012
1713	280	0.0327		
1713	985			0.032
2074	361	0.100		
2106	959			0.23
2342	1195			0.50
2476	402	>0.079		
2519	414	0.164		
2519	902			0.065
2659	317	0.0448		
2659	1043			0.028
2992	473	>0.32		
2992	862			>0.125
3064	404	0.128		
3554	490	>0.386		

E_γ [†]	I_γ [†]	E_i (level)	J_i^π	E_f	J_f^π	Mult.	α^b	Comments
123.2 1	47.3 7	123.2	2 ⁺	0.0	0 ⁺	E2	1.78	DCO=1.03 18. Mult.: K/L ratio (1965St03), $\gamma\gamma(\theta)$ and RUL. Q(transition)=7.0 3 (1991Mc04).
189.5 5	3.1 5	2848.9	(12 ⁻)	2659.3	(11 ⁻)			
214.4 5		3064.1	(13 ⁻)	2848.9	(12 ⁻)			
229 ^d		3292.6	(14 ⁻)	3064.1	(13 ⁻)			Weak transition (1994Es01).
253.9 1	90.7 10	377.1	4 ⁺	123.2	2 ⁺	E2 [@]	0.143	DCO=0.94 7. A ₂ =0.277 15, A ₄ =-0.01 4. Q(transition)=6.98 24 (1991Mc04).
279.0 2	7.6 4	1713.0	(6 ⁻)	1433.9	(4 ⁻)	E2 [@]	0.106	DCO=0.99 22. A ₂ =0.27 5, A ₄ =-0.09 6. Q(transition)=6.7 3 (1991Mc04).
317.4 2	4.6 2	2659.3	(11 ⁻)	2341.9	(9 ⁻)	&		DCO=1.02 23. Q(transition)=5.6 3 (1991Mc04).
331.0 5	1.0 5	2848.9	(12 ⁻)	2517.9	(10 ⁻)			
343.3 5	2.1 2	2105.6	(9 ⁻)	1762.2	(7 ⁻)			$I_\gamma(343)/I_\gamma(959\gamma)=1.5$ (1991Mc04) is in disagreement.
350.5 1	100.0 11	727.6	6 ⁺	377.1	4 ⁺	E2 [@]	0.054	DCO=0.99 6. A ₂ =0.291 15, A ₄ =-0.075 20. Q(transition)=6.91 26 (1991Mc04).
361.1 2	8.4 3	2074.2	(8 ⁻)	1713.0	(6 ⁻)	(E2)&		DCO=0.93 13. A ₂ =0.28 3, A ₄ =-0.04 4. Q(transition)=6.2 5 (1991Mc04).
372.9 2	6.0 3	2848.9	(12 ⁻)	2475.9	(10 ⁻)	&		DCO=0.93 19.
^x 373.5 [#] 2								A ₂ =0.25 6, A ₄ =-0.06 6. Tentative placement: 1433-1059 (1978Dr04).
401.6 2	8.3 3	2475.9	(10 ⁻)	2074.2	(8 ⁻)	&		DCO=1.05 21 d. Q(transition)>4.2 (1991Mc04).
404.7 2	8.0 5	3064.1	(13 ⁻)	2659.3	(11 ⁻)	&		DCO=1.01 23. Q(transition)=5.2 4 (1991Mc04).
413.8 2	6.8 2	2519.4	(11 ⁻)	2105.6	(9 ⁻)	(E2)&		DCO=1.0 4. A ₂ =0.29 3, A ₄ =-0.04 4. Q(transition)=5.6 4 (1991Mc04).
419.3 1	93.5 10	1146.8	8 ⁺	727.6	6 ⁺	E2 [@]	0.033	DCO=0.98 6. A ₂ =0.320 10, A ₄ =-0.085 11. Q(transition)=7.0 4 (1991Mc04).
443.7 ^c 2	8.6 ^c 4	2517.9	(10 ⁻)	2074.2	(8 ⁻)	&		DCO=1.07 16.
443.7 ^c 2	8.6 ^c 4	3292.6	(14 ⁻)	2848.9	(12 ⁻)	&		

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(HI,xny) **1994Es01,1991Mc04,1978Dr04 (continued)**

$\gamma(^{172}\text{W})$ (continued)

E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	α^b	Comments
470.5 1	78.0 12	1617.3	10 ⁺	1146.8	8 ⁺	E2 [@]	0.025	DCO=1.01 7. A ₂ =0.298 16, A ₄ =-0.059 19. Q(transition)=6.8 5 (1991Mc04).
472.9 1	10.8 5	2992.3	(13 ⁻)	2519.4	(11 ⁻)	(E2) ^{&}		DCO=1.04 30. A ₂ =0.28 7, A ₄ =-0.02 7. Q(transition)>5.6 (1991Mc04).
490.0 2	7.0 5	3554.2	(15 ⁻)	3064.1	(13 ⁻)	&		DCO=0.86 20. Q(transition)>5.6 (1991Mc04).
511.4 [‡] 5	7.1 [‡] 3	3804.0	(16 ⁻)	3292.6	(14 ⁻)	&		DCO=1.14 21.
512.6 [‡] 5	76.8 [‡] 12	2130.0	12 ⁺	1617.3	10 ⁺	E2 [@]		DCO=1.32 16. Q(transition)=6.7 5 (1991Mc04).
519.1 1	12.8 5	3511.3	(15 ⁻)	2992.3	(13 ⁻)	&		DCO=0.89 17. A ₂ =0.17 3, A ₄ =-0.05 4.
546.7 2	6.9 5	4101.1	(17 ⁻)	3554.2	(15 ⁻)	&		DCO=0.90 17.
549.6 1	55.4 10	2679.6	14 ⁺	2130.0	12 ⁺	E2 [@]		DCO=0.96 12. A ₂ =0.302 18, A ₄ =-0.078 21. Q(transition)=6.4 8 (1991Mc04).
556.0 2	5.1 3	4360.0	(18 ⁻)	3804.0	(16 ⁻)	&		DCO=0.92 31.
556.1 1	11.8 6	4067.4	(17 ⁻)	3511.3	(15 ⁻)	&		DCO=0.87 18. A ₂ =0.36 5, A ₄ =-0.08 5.
567.7 ^c 2	5.3 ^c 5	4669.0	(19 ⁻)	4101.1	(17 ⁻)	&		DCO=0.86 21.
567.7 ^c 2	5.3 ^c 5	5236.9	(21 ⁻)	4669.0	(19 ⁻)			
576.8 1	49.5 9	3256.4	16 ⁺	2679.6	14 ⁺	E2 [@]		DCO=1.08 10. A ₂ =0.323 16, A ₄ =-0.091 20. Q(transition)=7.1 9 (1991Mc04).
584.8 ^c 1	12.4 ^c 7	4652.2	(19 ⁻)	4067.4	(17 ⁻)	&		DCO=1.01 18. A ₂ =0.18 4, A ₄ =-0.05 4.
584.8 ^c 1	12.4 ^c 7	5236.9	(21 ⁻)	4652.2	(19 ⁻)			
586.6 2	5.4 3	4946.6	(20 ⁻)	4360.0	(18 ⁻)	&		DCO=1.05 22.
598.0 1	34.6 7	3854.4	18 ⁺	3256.4	16 ⁺	E2 [@]		DCO=0.97 8. A ₂ =0.31 3, A ₄ =-0.10 3. Q(transition)=7.2 12 (1991Mc04).
610.0 5	2.0 5	5278.7	(21 ⁻)	4669.0	(19 ⁻)	&		DCO=0.80 19.
615.1 ^{#d} 5		1762.2	(7 ⁻)	1146.8	8 ⁺			A ₂ =0.18 4, A ₄ =0.00 5. The intensity of this γ -ray as reported by 1978Dr04 is too large to be missed by 1994Es01. Moreover, sign of A ₂ reported by 1978Dr04 is inconsistent with a $\Delta J=1$ (dipole) transition expected from ΔJ^π . These considerations make this transition suspect.
626.5 ^c 2	8.1 ^c 6	5278.7	(21 ⁻)	4652.2	(19 ⁻)	&		DCO=0.83 22.
626.5 ^c 2	8.1 ^c 6	5863.4	(23 ⁻)	5236.9	(21 ⁻)	&		
627.0 5	3.6 3	5573.6	(22 ⁻)	4946.6	(20 ⁻)	&		DCO=0.86 20.
644.6 1	21.4 5	4499.0	20 ⁺	3854.4	18 ⁺	E2 [@]		DCO=1.20 28. A ₂ =0.32 5, A ₄ =-0.15 6. Q(transition)=6.7 9 (1991Mc04).
659.0 5		5937.7	(23 ⁻)	5278.7	(21 ⁻)			
688.0 5	2.6 2	6261.6	(24 ⁻)	5573.6	(22 ⁻)	&		DCO=1.1 4.
694.0 2	5.7 4	6557.4	(25 ⁻)	5863.4	(23 ⁻)			
710.8 2	9.7 4	5209.8	(22 ⁺)	4499.0	20 ⁺	&		DCO=0.93 19.
759.0 5	1.4 2	7020.6	(26 ⁻)	6261.6	(24 ⁻)			
769.0 5	3.2 5	7326.4	(27 ⁻)	6557.4	(25 ⁻)			
776.4 2	5.9 4	5986.2	(24 ⁺)	5209.8	(22 ⁺)	&		DCO=0.87 23.
832.0 5		3511.3	(15 ⁻)	2679.6	14 ⁺			
838.0 1	2.8 3	6824.2	(26 ⁺)	5986.2	(24 ⁺)	&		DCO=1.10 32.
844.0 5		8170.4	(29 ⁻)	7326.4	(27 ⁻)			
862.2 2	4.7 4	2992.3	(13 ⁻)	2130.0	12 ⁺			B(E1)(W.u.)>6×10 ⁻⁵ (1991Mc04)
896.0 1	2.5 3	7720.2	(28 ⁺)	6824.2	(26 ⁺)			
902.3 2	6.9 4	2519.4	(11 ⁻)	1617.3	10 ⁺	^a		B(E1)(W.u.)=2.8×10 ⁻⁵ 4 (1991Mc04)

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(HI,xn γ) 1994Es01,1991Mc04,1978Dr04 (continued) $\gamma(^{172}\text{W})$ (continued)

E_γ^\dagger	I_γ^\dagger	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	Comments
							$I_\gamma(902\gamma)/I_\gamma(414\gamma)=0.49$ (1991Mc04) is in disagreement. DCO=1.4 3. $A_2=-0.14$ 4, $A_4=-0.01$ 6.
914.0 5		9084.4	(31 ⁻)	8170.4	(29 ⁻)		
948.0 5		8668.2	(30 ⁺)	7720.2	(28 ⁺)		
958.8 2	5.4 4	2105.6	(9 ⁻)	1146.8	8 ⁺	^a	$B(E1)(\text{W.u.})=8.2\times 10^{-5}$ 14 (1991Mc04) DCO=1.4 4. $A_2=-0.22$ 4, $A_4=0.05$ 5.
985.5 5	4.7 5	1713.0	(6 ⁻)	727.6	6 ⁺		$B(E1)(\text{W.u.})=1.0\times 10^{-5}$ 1 (1991Mc04) $A_2=0.35$ 6, $A_4=0.03$ 7.
1034.5 5	1.2 3	1762.2	(7 ⁻)	727.6	6 ⁺		
1041.8 5	2.2 4	2659.3	(11 ⁻)	1617.3	10 ⁺		$B(E1)(\text{W.u.})=7.8\times 10^{-6}$ 19 (1991Mc04)
1056.0 5	4.9 8	1433.9	(4 ⁻)	377.1	4 ⁺		$B(E1)(\text{W.u.})=3.2\times 10^{-6}$ 11 (1991Mc04) $A_2=0.32$ 8, $A_4=0.07$ 10.
1195.0 2	4.4 4	2341.9	(9 ⁻)	1146.8	8 ⁺	^a	$B(E1)(\text{W.u.})=9.0\times 10^{-5}$ 11 (1991Mc04) DCO=1.4 4.

[†] From 1994Es01 unless otherwise stated. Based on a general statement by 1994Es01, uncertainties on I_γ 's are assigned (evaluator) as follows: 0.1 ($I_\gamma \geq 10$), 0.2 ($I_\gamma = 5-10$), 0.5 ($I_\gamma \leq 5$), 0.5 (contaminants).

[‡] Contaminated by annihilation radiation.

[#] γ reported by 1978Dr04 only.

[@] From $\gamma(\theta)$, $\gamma\gamma(\theta)$ and RUL (for E2 and M2).

[&] $\gamma\gamma(\theta)$ and/or $\gamma(\theta)$ consistent with $\Delta J=2$. RUL (for E2 and M2) suggests E2.

^a $\gamma\gamma(\theta)$ and $\gamma(\theta)$ consistent with $\Delta J=1$.

^b 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.

^c Multiply placed with undivided intensity.

^d Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

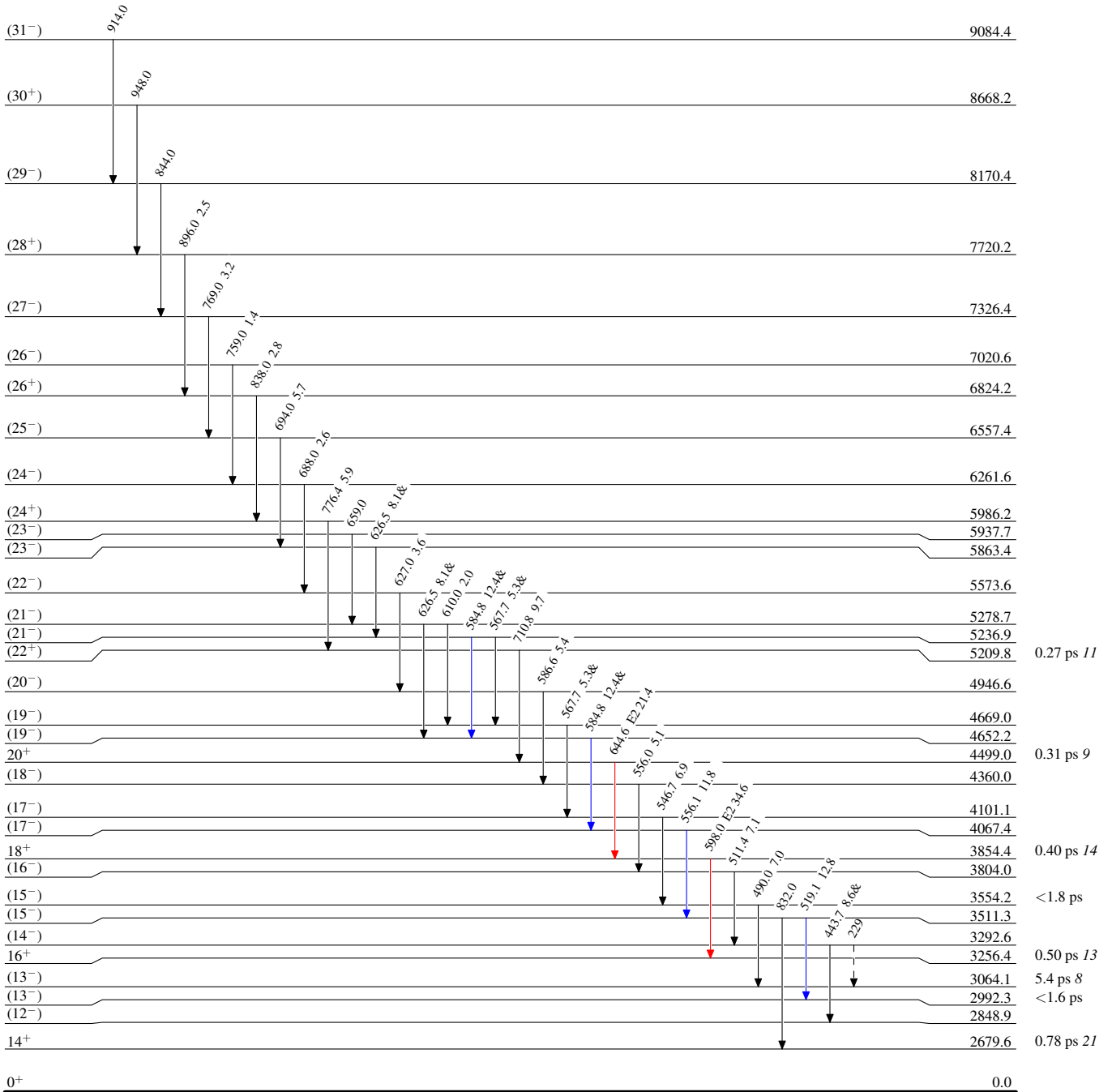
(HI,xn γ) 1994Es01,1991Mc04,1978Dr04

Level Scheme

Intensities: Relative I γ
& Multiply placed: undivided intensity given

Legend

- \longrightarrow I γ < 2% \times I γ^{max}
- \longrightarrow I γ < 10% \times I γ^{max}
- \longrightarrow I γ > 10% \times I γ^{max}
- \dashrightarrow γ Decay (Uncertain)







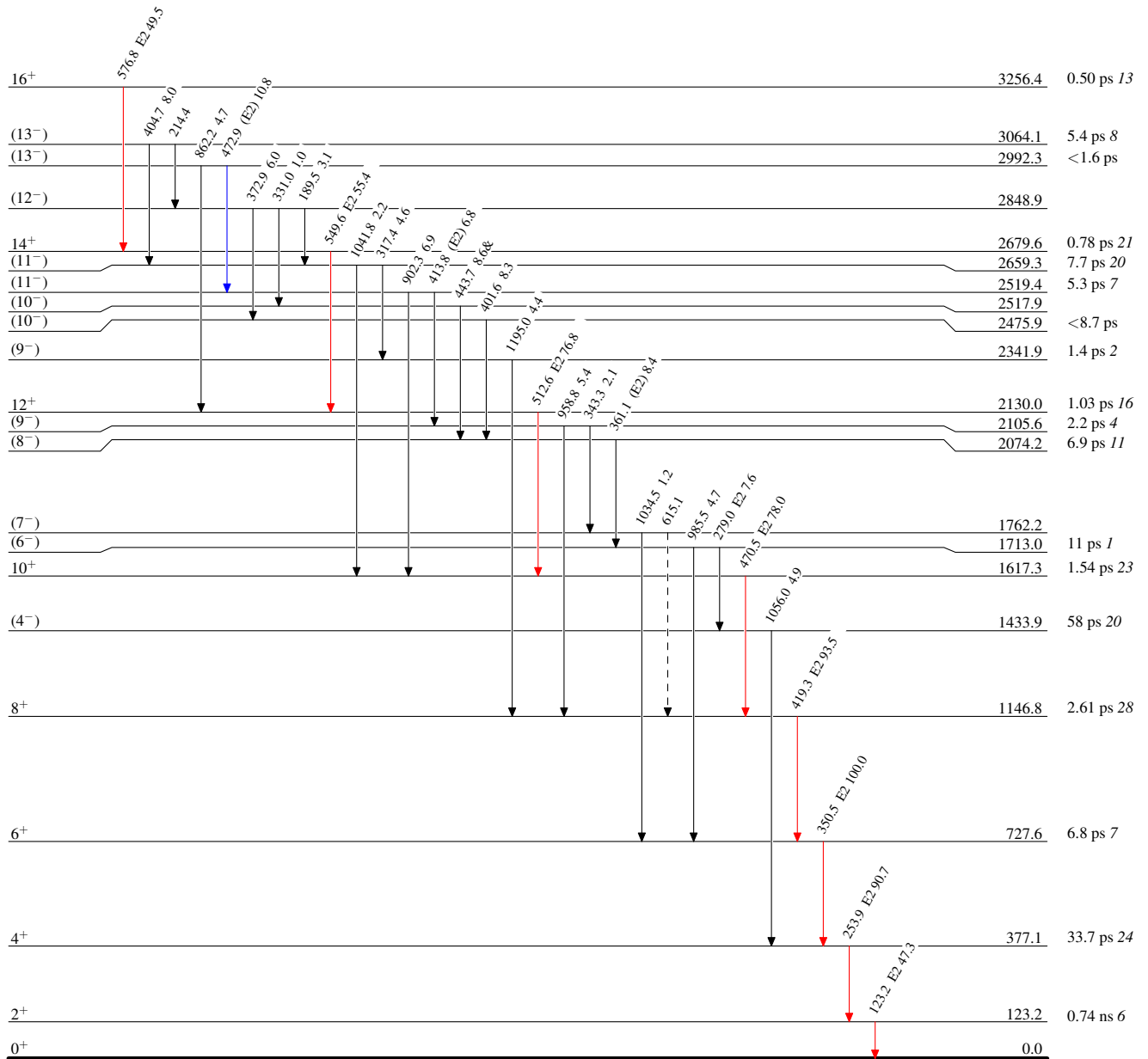
(HI,xn γ) 1994Es01,1991Mc04,1978Dr04

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



(HI,xn γ) 1994Es01,1991Mc04,1978Dr04