$^{115}In(^{28}Si,2p3n\gamma)$ **1998Pr04**

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 146, 1 (2017)	30-Sep-2017

E=1998Pr04: E=145 MeV ^{28}Si beam was produced from the 15UD Pelletron Accelerator at the Nuclear Science Center (NSC), New Delhi. Target was about 800 $\mu g/cm^2$ thick natural Indium evaporated onto about 10 mg/cm^2 gold foil. γ rays were detected with a multiple detector array consisting of twelve Compton-suppressed HPGe detectors. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma\gamma(\theta)$(DCO). Deduced levels, J, π, γ-ray multipolarities, branching ratios, B(M1)/B(E2), band structures. Comparisons with shell-model calculations.

^{138}Pm Levels

E(level)[†]	J^{π}[‡]	$T_{1/2}$	Comments
0+x	5^-	3.24 min	Additional information 1. E(level): This level may be the ground state of ^{138}Pm.
149.92+x *8*	6^-		
327.37+x[&] *11*	6^-		
410.68+x *8*	7^-		
584.37+x[@] *12*	8^+	21 ns *5*	$T_{1/2}$: from Adopted Levels.
618.24+x *10*	8^-		
705.07+x[#] *12*	9^+		
762.81+x[&] *11*	7^-		
1044.28+x *11*	9^-		
1061.95+x[@] *14*	10^+		
1088.53+x *11*	(7^-)		
1104.63+x *11*	(7^-)		
1164.69+x[&] *13*	9^-		
1236.73+x[d] *11*	(8^-)		
1383.23+x *13*	10^-		
1411.47+x[#] *14*	11^+		
1464.03+x[d] *15*	(9^-)		
1616.51+x *17*	(10^-)		
1700.53+x[d] *18*	(10^-)		
1857.72+x *12*	11^-		
1863.09+x[&] *16*	11^-		
1888.64+x[@] *14*	12^+		
2096.73+x[d] *21*	(11^-)		
2280.51+x[#] *14*	13^+		
2366.93+x *16*	12^-		
2459.50+x[b] *19*	11^+		
2473.69+x[a] *19*	12^-		
2495.53+x[d] *23*	(12^-)		
2532.13+x *23*			
2627.23+x *15*	(12^-)		
2795.70+x[&] *19*	13^-		
2826.15+x[@] *15*	14^+		
2831.97+x[c] *14*	13^-		
2868.31+x *14*	(13^-)		
3004.40+x[b] *22*	13^+		
3050.73+x *25*			
3062.82+x[c] *14*	14^-		
3072.19+x[a] *21*	14^-		

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^{115}In(^{28}Si,2p3nγ) 1998Pr04 (continued)

^{138}Pm Levels (continued)

E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]
3275.76+x[#] *17*	15⁺	3852.06+x[@] *18*	16⁺	4623.3+x[a] *3*	18⁻	5695.3+x[a] *11*	20⁻
3304.12+x[c] *17*	15⁻	3974.72+x[c] *22*	17⁻	4868.1+x[c] *3*	(19⁻)	5994.97+x[e] *25*	20⁺
3592.12+x[c] *20*	16⁻	4338.4+x[#] *8*	17⁺	4922.1+x[@] *11*	18⁺	6864.1+x[e] *3*	21⁺
3688.40+x[b] *24*	(15⁺)	4373.54+x[c] *25*	18⁻	5133.26+x[e] *23*	19⁺		
3701.7+x *3*		4538.4+x[b] *11*	(17⁺)	5384.9+x[c] *3*	(20⁻)		
3771.59+x[a] *24*	16⁻	4578.66+x[e] *21*	18⁺	5456.4+x?[#] *10*	(19⁺)		

[†] From a least-squares fit γ-ray energies. In the fitting procedure, uncertainties are increased to ΔEγ=0.5 keV for 195.6γ and 451.0γ, and ΔEγ=0.8 keV for 1013.0γ to reduce χ^2 to 3.5 from 14.8.
[‡] As given by 1998Pr04, based on γ multipolarities and comparison with Cranking Shell Model results.
[#] Band(A): Yrast band, α=1. Configuration=$\pi h_{11/2}\otimes\nu h_{11/2}$.
[@] Band(a): Yrast band, α=0. Configuration=$\pi h_{11/2}\otimes\nu h_{11/2}$.
[&] Band(B): $\pi h_{11/2}\otimes\nu$1/2[400]. This band bifurcates into two bands above 11⁻.
[a] Band(C): Band bases on 12⁻. Favored doubly-decoupled band. Bifurcation of band based on 6⁻.
[b] Band(D): $\pi h_{11/2}\otimes\nu$1/2[530]. Favored doubly-decoupled band. Bifurcation of band based on 6⁻.
[c] Band(E): π5/2[413]⊗ν9/2[514].
[d] Band(F): π3/2[411]⊗$\nu h_{11/2}$.
[e] Band(G): Band based on 18⁺.

γ(^{138}Pm)

Eγ[†]	Iγ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[‡]	Comments
120.6 *1*	29.1 *16*	705.07+x	9⁺	584.37+x	8⁺	D	DCO=0.83 *5* (1998Pr04).
132.1 *1*	8.9 *5*	1236.73+x	(8⁻)	1104.63+x	(7⁻)	D	DCO=0.96 *15* (1998Pr04).
148.4 *1*	4.9 *3*	1236.73+x	(8⁻)	1088.53+x	(7⁻)	D	DCO=0.96 *14* (1998Pr04).
150.0 *1*	54 *3*	149.92+x	6⁻	0+x	5⁻	D	DCO=0.91 *7* (1998Pr04).
173.6 *1*	100	584.37+x	8⁺	410.68+x	7⁻	D	DCO=0.95 *7* (1998Pr04).
177.4 *1*	5.8 *4*	327.37+x	6⁻	149.92+x	6⁻	D+Q	DCO=0.85 *10*, gating on a ΔJ=2 quadrupole transition (1998Pr04).
195.6 *1*	3.5 *3*	3062.82+x	14⁻	2868.31+x	(13⁻)	D+Q	Eγ: poor fit, level-energy difference=194.5. DCO=1.5 *4* (1998Pr04).
227.3 *1*	21.1 *8*	1464.03+x	(9⁻)	1236.73+x	(8⁻)	D	DCO=1.08 *13* (1998Pr04).
231.1 *1*	9.5 *7*	3062.82+x	14⁻	2831.97+x	13⁻	D	DCO=0.51 *12* (1998Pr04).
236.5 *1*	16.5 *6*	1700.53+x	(10⁻)	1464.03+x	(9⁻)	D	DCO=0.86 *12* (1998Pr04).
241.3[#] *1*	10.7[#] *5*	2868.31+x	(13⁻)	2627.23+x	(12⁻)		
241.3[#] *1*	10.7[#] *5*	3304.12+x	15⁻	3062.82+x	14⁻		DCO=0.73 *11* (probably for the doublet) (1998Pr04).
260.8 *1*	77 *3*	410.68+x	7⁻	149.92+x	6⁻	D	DCO=0.97 *4* (1998Pr04).
276 *1*	<1.0	3072.19+x	14⁻	2795.70+x	13⁻		
288.0 *1*	10.9 *5*	3592.12+x	16⁻	3304.12+x	15⁻	D	DCO=1.06 *9* (1998Pr04).
337[@] *1*	<1.0	2795.70+x	13⁻	2459.50+x	11⁺		
349.5 *1*	13.2 *6*	1411.47+x	11⁺	1061.95+x	10⁺	D	DCO=0.95 *1* (1998Pr04).
352.2 *1*	12.1 *6*	762.81+x	7⁻	410.68+x	7⁻	D+Q	DCO=1.10 *25* (1998Pr04).
356.9 *1*	21.8 *8*	1061.95+x	10⁺	705.07+x	9⁺	D	DCO=0.72 *5* (1998Pr04).
[x]372.5 *1*	2.2 *2*						
382.6 *1*	9.5 *5*	3974.72+x	17⁻	3592.12+x	16⁻	D	DCO=0.60 *13* (1998Pr04).
391.6 *1*	2.9 *3*	2280.51+x	13⁺	1888.64+x	12⁺		Iγ: for 391.6+392.3 (1998Pr04).
[x]392.3 *1*	2.9 *3*						Iγ: for 391.6+392.3.
396.2 *1*	15.1 *7*	2096.73+x	(11⁻)	1700.53+x	(10⁻)	D	DCO=0.89 *12* (1998Pr04).

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^{115}In(^{28}Si,2p3nγ) 1998Pr04 (continued)

γ(^{138}Pm) (continued)

Eγ[†]	Iγ[†]	Ei(level)	J^π_i	Ef	J^π_f	Mult.[‡]	Comments
398.8[#] 1	16.2[#] 8	2495.53+x	(12⁻)	2096.73+x	(11⁻)		DCO=0.49 14 (probably for the doublet) (1998Pr04).
398.8[#] 1	16.2[#] 8	4373.54+x	18⁻	3974.72+x	17⁻		
401.9 1	23.7 9	1164.69+x	9⁻	762.81+x	7⁻	Q	DCO=2.05 23 (1998Pr04).
[x]409.4 1	25.4 12						Iγ: for 410.6+409.4.
410.6 1	25.4 12	410.68+x	7⁻	0+x	5⁻		Iγ: for 410.6+409.4 (1998Pr04). DCO=1.00 11 (probably for the doublet) (1998Pr04).
426.2 1	6.7 5	1044.28+x	9⁻	618.24+x	8⁻	D	DCO=0.7 4 (1998Pr04).
435.4[#] 1	15.0[#] 9	762.81+x	7⁻	327.37+x	6⁻	D	DCO=0.40 13 (probably for the doublet), gating on a ΔJ=2 quadrupole transition (1998Pr04).
435.4[#] 1	15.0[#] 9	2532.13+x		2096.73+x	(11⁻)		
435.4[#] 1	15.0[#] 9	3062.82+x	14⁻	2627.23+x	(12⁻)		
[x]440.8 1	2.5 4						
451.0 1	3.4 3	3275.76+x	15⁺	2826.15+x	14⁺		Eγ: poor fit, level-energy difference=449.6. Iγ: for 451.0+452 (1998Pr04). DCO=0.55 15 (1998Pr04).
452 1	3.4 3	1863.09+x	11⁻	1411.47+x	11⁺		Iγ: for 452+451.0 (1998Pr04).
459.6 1	1.7 3	1164.69+x	9⁻	705.07+x	9⁺		DCO=0.32 (1998Pr04).
465.5 10	<1.0	2831.97+x	13⁻	2366.93+x	12⁻		
468.2 1	24.8 1	618.24+x	8⁻	149.92+x	6⁻	Q	DCO=1.6 3 (1998Pr04).
474.4 1	3.3 4	1857.72+x	11⁻	1383.23+x	10⁻	D	DCO=0.9 3 (1998Pr04).
477.0 1	11.9 7	1888.64+x	12⁺	1411.47+x	11⁺	D	DCO=0.67 9 (1998Pr04).
486 1	<1.0	4338.4+x	17⁺	3852.06+x	16⁺		
494.5 1	3.1 5	4868.1+x	(19⁻)	4373.54+x	18⁻		
[x]508.8 1	4.2 6						
516.8 1	2.6 3	5384.9+x	(20⁻)	4868.1+x	(19⁻)		
518.6 1	3.5 5	3050.73+x		2532.13+x			
534[@] 1		5456.4+x?	(19⁺)	4922.1+x	18⁺		
544.9 1	11.6 8	3004.40+x	13⁺	2459.50+x	11⁺	Q	DCO=1.2 3, gating on a ΔJ=2 quadrupole transition (1998Pr04).
545.6 1	2.3 3	2826.15+x	14⁺	2280.51+x	13⁺	D	DCO=0.89 10 (1998Pr04).
[x]551.5 1	3.9 5						
554.6[#] 1	11.6[#] 8	1616.51+x	(10⁻)	1061.95+x	10⁺		DCO=1.10 14 (probably for the doublet) (1998Pr04).
554.6[#] 1	11.6[#] 8	5133.26+x	19⁺	4578.66+x	18⁺		
576.3		3852.06+x	16⁺	3275.76+x	15⁺		
584[@] 1		4922.1+x	18⁺	4338.4+x	17⁺		
596.4 1	6.6 8	2459.50+x	11⁺	1863.09+x	11⁻	D+Q	DCO=1.20 24 (1998Pr04).
598.5 1	13.4 10	3072.19+x	14⁻	2473.69+x	12⁻	Q	DCO=0.93 9, gating on a ΔJ=2 quadrupole transition (1998Pr04).
610.6 1	12.4 9	2473.69+x	12⁻	1863.09+x	11⁻	D	DCO=0.65 7, gating on a ΔJ=2 quadrupole transition (1998Pr04).
618.3 1	3.4 7	1236.73+x	(8⁻)	618.24+x	8⁻	D+Q	DCO=1.2 4 (1998Pr04).
633.6 1	5.0 6	1044.28+x	9⁻	410.68+x	7⁻		
651.0 1	4.8 6	3701.7+x		3050.73+x			
684.0 1	8.6 6	3688.40+x	(15⁺)	3004.40+x	13⁺		Iγ: for 686.0+684.0 (1998Pr04).
[x]686.0 1	8.6 6						Iγ: for 686.0+684.0.
696[@] 1	≈1.0	3062.82+x	14⁻	2366.93+x	12⁻		
698.4 1	33.4 15	1863.09+x	11⁻	1164.69+x	9⁻		Iγ: for 698.4+699.4 (1998Pr04). DCO=1.62 13 (probably for the doublet) (1998Pr04).
699.4 1	33.4 15	3771.59+x	16⁻	3072.19+x	14⁻		Iγ: for 699.4+698.4 (1998Pr04).
706.3 1	12.1 7	1411.47+x	11⁺	705.07+x	9⁺	Q	DCO=1.90 18 (1998Pr04).
726.6 1	6.5 12	4578.66+x	18⁺	3852.06+x	16⁺	Q	DCO=2.1 3 (1998Pr04).
764.9 1	14.1 11	1383.23+x	10⁻	618.24+x	8⁻	Q	DCO=2.75 9 (1998Pr04).
782.2 1	2.4 5	3062.82+x	14⁻	2280.51+x	13⁺		
800.8 10	<1.0	1863.09+x	11⁻	1061.95+x	10⁺		

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$^{115}In(^{28}Si,2p3n\gamma)$ 1998Pr04 (continued)

$\gamma(^{138}Pm)$ (continued)

E_γ †	I_γ †	E_i(level)	J^π_i	E_f	J^π_f	Mult. ‡	Comments
x808.7 *1*	4.3 *6*						
813.6 *1*	9.7 *8*	1857.72+x	11⁻	1044.28+x	9⁻	Q	DCO=2.1 *10* (1998Pr04).
825.2	9.2 *3*	1236.73+x	(8⁻)	410.68+x	7⁻	D+Q	I_γ: for 825.2+826.7 (1998Pr04). DCO=1.3 *3* (1998Pr04).
826.7 *1*	9.2 *3*	1888.64+x	12⁺	1061.95+x	10⁺	Q	I_γ: for 826.7+825.2 (1998Pr04). DCO=2.3 *3* (1998Pr04).
850 *1*		4538.4+x	(17⁺)	3688.40+x	(15⁺)		
851.7 *1*	3.9 *6*	4623.3+x	18⁻	3771.59+x	16⁻	Q	DCO=0.97 *19*, gating on a ΔJ=2 quadrupole transition (1998Pr04).
861.7 *1*	6.7 *7*	5994.97+x	20⁺	5133.26+x	19⁺	D	DCO=1.07 *10* (1998Pr04).
869.1# *1*	11.2# *10*	2280.51+x	13⁺	1411.47+x	11⁺		DCO=1.70 *10* (probably for the doublet) (1998Pr04).
869.1# *1*	11.2# *10*	6864.1+x	21⁺	5994.97+x	20⁺		
895 *1*	1.0 *4*	4868.1+x	(19⁻)	3974.72+x	17⁻		
932.6 *1*	7.1 *5*	2795.70+x	13⁻	1863.09+x	11⁻	Q	DCO=1.7 *4* (1998Pr04).
937.6 *1*	6.9 *5*	2826.15+x	14⁺	1888.64+x	12⁺	Q	DCO=1.80 *14* (1998Pr04).
938.8 *1*	4.5 *3*	1088.53+x	(7⁻)	149.92+x	6⁻	D+Q	DCO=1.4 *4* (1998Pr04).
x943 *1*	3.7 *5*						
x948 *1*	7.0 *6*						
954.7 *1*	9.1 *7*	1104.63+x	(7⁻)	149.92+x	6⁻	D	DCO=1.07 *25* (1998Pr04).
974.5 *1*	6.7 *8*	2831.97+x	13⁻	1857.72+x	11⁻	Q	DCO=2.5 *12* (1998Pr04).
983.7 *1*	2.6 *5*	2366.93+x	12⁻	1383.23+x	10⁻		
995.2 *1*	3.3 *6*	3275.76+x	15⁺	2280.51+x	13⁺		DCO=1.7 *7* (1998Pr04).
1010.4 *1*	1.8 *6*	2868.31+x	(13⁻)	1857.72+x	11⁻		
1013.0 *1*	2.7 *8*	2627.23+x	(12⁻)	1616.51+x	(10⁻)		E_γ: poor fit, level-energy difference=1010.7.
1013.0@ *1*	2.7 *8*	5384.9+x	(20⁻)	4373.54+x	18⁻		
1025.9 *1*	2.6 *5*	3852.06+x	16⁺	2826.15+x	14⁺	Q	DCO=1.9 *5* (1998Pr04).
1063 *1*		4338.4+x	17⁺	3275.76+x	15⁺		
1070 *1*		4922.1+x	18⁺	3852.06+x	16⁺		
1072 *1*		5695.3+x	20⁻	4623.3+x	18⁻		
1118@ *1*		5456.4+x?	(19⁺)	4338.4+x	17⁺		

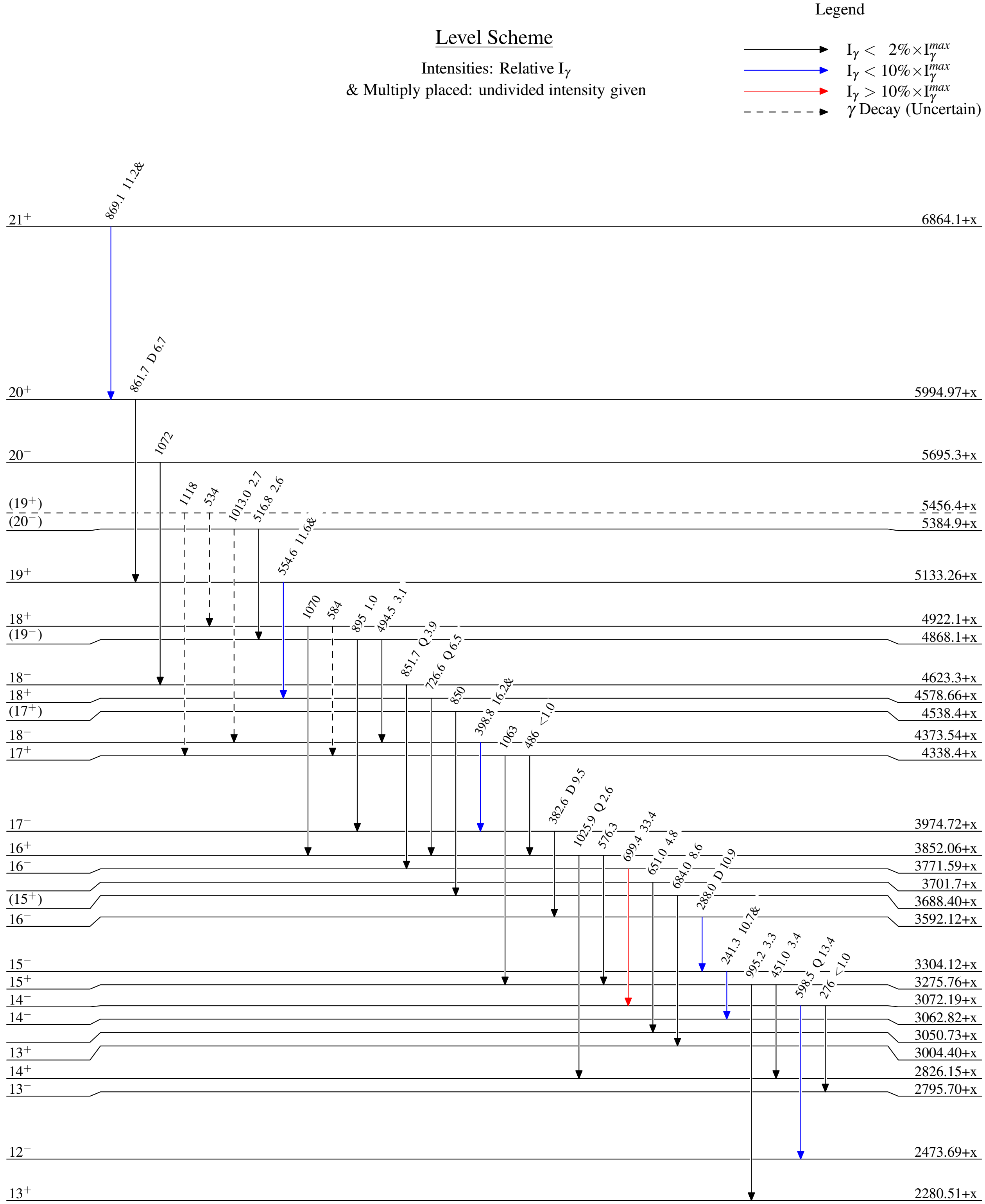
† From 1998Pr04.
‡ Deduced based on measured DCO ratios in 1998Pr04. DCO ratios are obtained as R(DCO)=Iγ(153°,99°)/Iγ(99°,153°) by gating on ΔJ=2, quadrupole or ΔJ=1 dipole transitions. Typical values are ≈2.0 and ≈1.0 for stretched Q or D transitions, respectively, with a ΔJ=1 gating transition; or ≈1.0 and ≈0.5 for stretched Q or D transitions, respectively, with a ΔJ=2 gating transition. Quoted DCO ratios are for ΔJ=1 dipole gating transitions, unless otherwise noted.
# Multiply placed with undivided intensity.
@ Placement of transition in the level scheme is uncertain.
x γ ray not placed in level scheme.

^{115}In(^{28}Si,2p3nγ) 1998Pr04

Level Scheme

Intensities: Relative I_γ

& Multiply placed: undivided intensity given

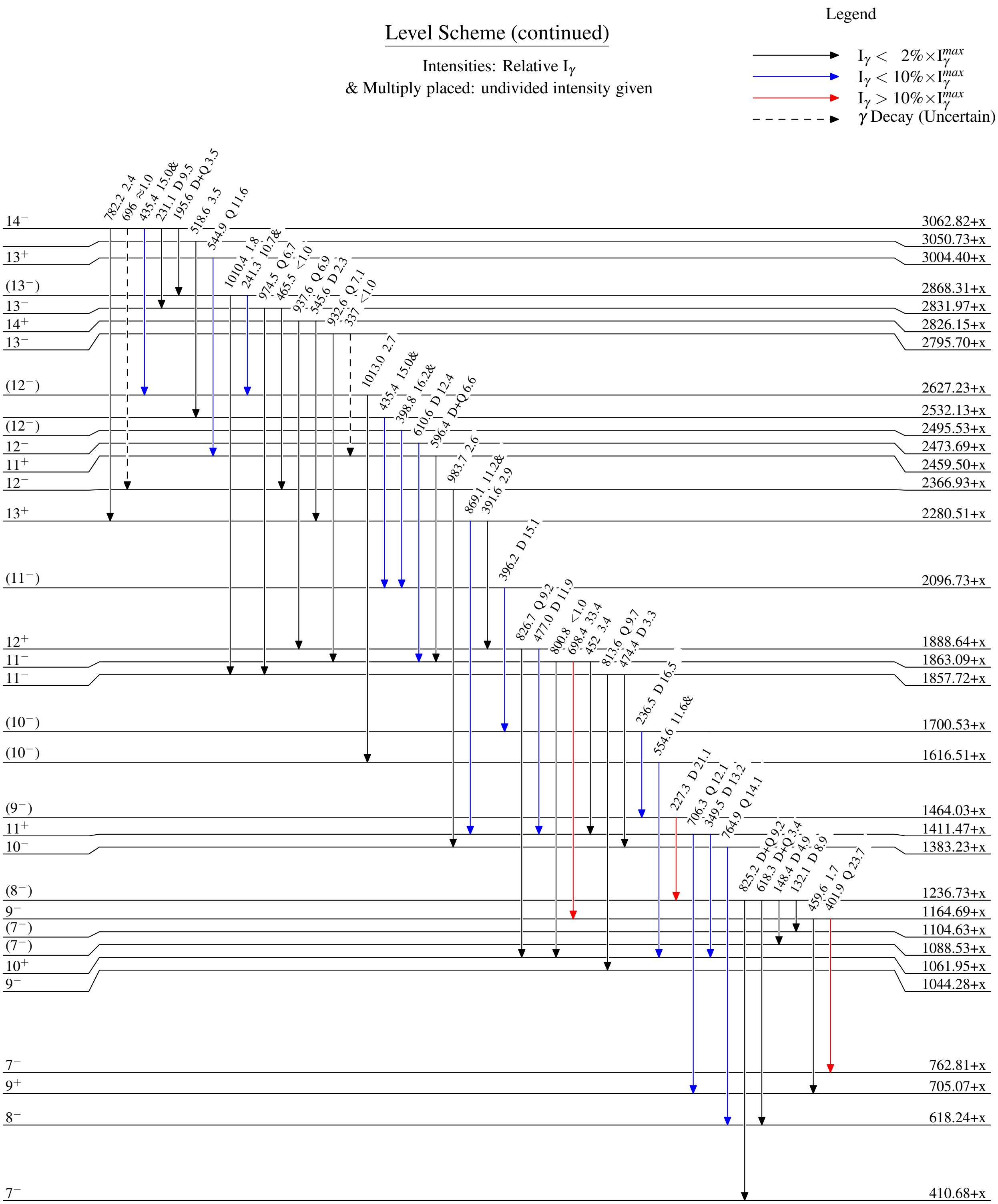


$^{138}_{61}Pm_{77}$

$^{115}In(^{28}Si,2p3n\gamma)$ 1998Pr04

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given



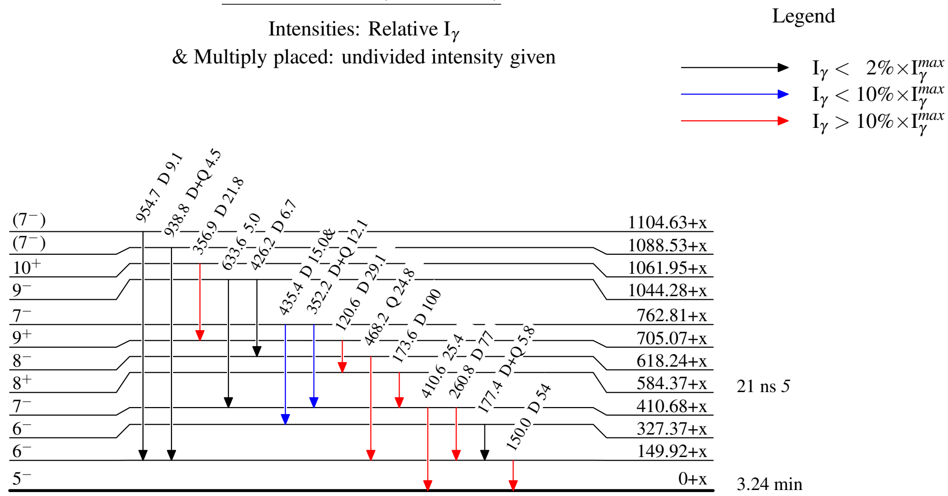
$^{138}_{61}Pm_{77}$

$^{115}In(^{28}Si,2p3n\gamma)$ 1998Pr04

Level Scheme (continued)

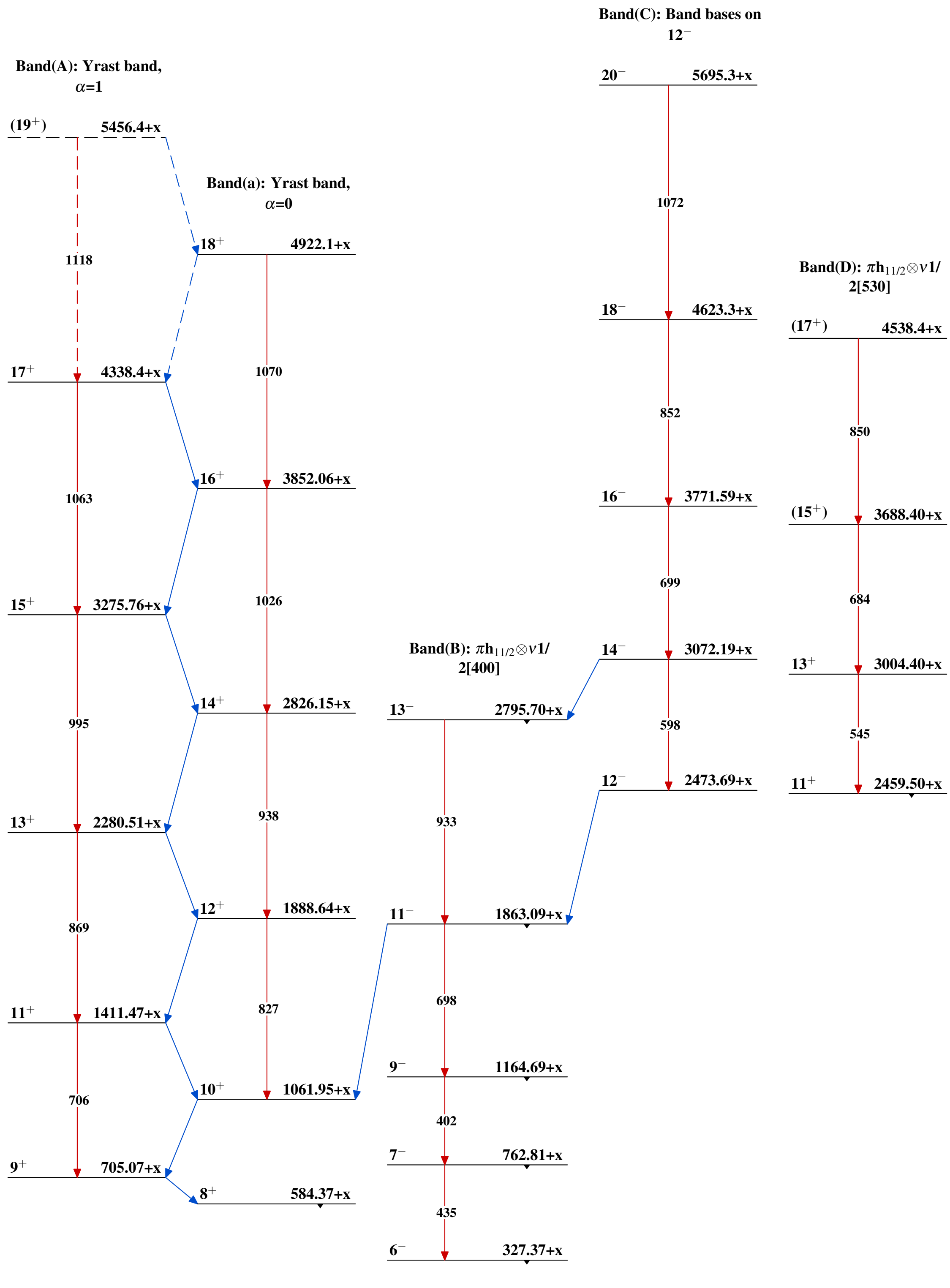
Intensities: Relative I_γ

& Multiply placed: undivided intensity given



$^{138}_{61}Pm_{77}$

$^{115}In(^{28}Si,2p3n\gamma)$ 1998Pr04



$^{138}_{61}Pm_{77}$

^{115}In(^{28}Si,2p3nγ) 1998Pr04 (continued)