

$^{40}\text{Ca}(^{28}\text{Si},2\alpha\gamma)$ 2002An20,2000An32

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	M. Shamsuzzoha Basunia		NDS 151, 1 (2018)	1-Apr-2018

Includes $^{28}\text{Si}(^{36}\text{Ar},\alpha\gamma)$ at 143 MeV (2000An32). Also 2002Ru06 report prompt proton decay from high spin states of ^{59}Cu .

2002An20: $E(^{28}\text{Si})=122$ MeV, 99.975% ^{40}Ca target; GAMMASPHERE array comprised of 101 Ge detectors in conjunction with the 4π charged-particle detector array Microball. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)(\text{DCO})$.

2000An32: $E(^{28}\text{Si})=125$ MeV, 99.975% ^{40}Ca target; GAMMASPHERE array consisting of 83 Ge detectors, in conjunction with the 4π charged-particle array Microball and 15 liquid scintillator neutron detectors. Measured $E\gamma$, charged-particle gated $\gamma\gamma$ and $\gamma\gamma\gamma$ coin, lifetimes, $\gamma\gamma(\theta)$ (DCO; $\theta\approx 30^\circ$ and $\approx 83^\circ$). Same research group of 2002An20.

Level scheme from 2002An20.

 ^{59}Cu Levels

E(level) [†]	J^π	Comments
0.0 [#]	3/2 ⁻	
491.23 25	1/2 ⁻	
913.70 ^c 15	5/2 ⁻	
1398.17 [#] 16	7/2 ⁻	
1864.04 [@] 17	7/2 ⁻	
2389.35 ^c 20	9/2 ⁻	
2585.82 [#] 20	11/2 ⁻	
2662.98 ^{&} 21	9/2 ⁻	
3041.30 ^d 20	9/2 ⁺	
3327.96 [@] 21	11/2 ⁻	
3445.48 ^c 22	13/2 ⁻	
4098.97 ^{&} 21	13/2 ⁻	
4526.48 ^d 23	13/2 ⁺	
4902.19 [@] 23	15/2 ⁻	
5425.23 ^d 24	17/2 ⁺	
5720.46 ^{&} 25	17/2 ⁻	
6048.1 ^b 3	17/2 ⁻	
6173.2 ^f 3	15/2 ⁺	
6608.9 [@] 3	19/2 ⁻	
6688.7 ^e 3	17/2 ⁺	
6748.4 5	(17/2 ⁺)	
6795.5 3	19/2 ⁺	
6921 3	(17/2 ⁻)	
7051.5 ^a 3	19/2 ⁻	
7072.8 8	17/2 ⁺	
7351.0 ^f 3	19/2 ⁺	
7443.1 ^{&} 3	21/2 ⁻	
7541.3 21		
7614.7 10	21/2 ⁻	
7706.8 5	19/2 ⁺	
7792.4 [‡] 4	17/2 ⁺	$E_{p.c.m.}=1.94\times 10^3$ keV 2 (doublet) feeds ^{58}Ni 4 ⁺ state at 2459.21 keV, branching 2% 1 and % $I_{p_{rel}}=0.1$ 1 compared to most intense 2890 γ from this level (2002Ru06).
7825.4 [‡] 4	17/2 ⁺	$E_{p.c.m.}=1.94\times 10^3$ keV 2 (doublet) feeds ^{58}Ni 4 ⁺ state at 2459.21 keV, branching 11% 3 and % $I_{p_{rel}}=0.7$ 2 compared to most intense 2923 γ from this level (2002Ru06).
8111.8 ^b 6	21/2 ⁻	
8114.3 ^e 3	21/2 ⁺	

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$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ **2002An20,2000An32** (continued) ^{59}Cu Levels (continued)

E(level) [†]	J ^π	Comments
8153.3 ^g 3	19/2 ⁺	
8512 4	(21/2 ⁻)	
8655.9 12	21/2 ⁺	
8727.5 ^h 4	21/2 ⁺	
8812.2 [@] 4	23/2 ⁻	
8850.8 5	21/2 ⁻	
8941.8 ^f 3	23/2 ⁺	
9173.0 ^a 6	23/2 ⁻	
9173.1 12	21/2 ⁺	
9291.9 15	21/2 ⁺	
9331.8 5	23/2 ⁻	
9431.4 7	21/2 ⁺	
9455.1 ^g 4	23/2 ⁺	
9624.3 11	21/2 ⁺	
9671.2 ^e 3	25/2 ⁺	
9921.6 10	21/2 ⁺	
10118.6 8	21/2 ⁺	
10141.2 7	21/2 ⁺	
10223.6 11	21/2 ⁺	
10276.1 ^h 4	25/2 ⁺	
10361.5 10	21/2 ⁺	
10370.7 ^b 6	25/2 ⁻	
10379.6 9	21/2 ⁺	
10603.5 ^f 4	27/2 ⁺	
10655.7 19	21/2 ⁻	
10677.4 ^o 9	21/2 ⁻	
10822.4 5	(25/2 ⁻)	
10865 3	23/2 ⁻	
11120.7 ^p 5	23/2 ⁻	
11211.5 ^g 4	27/2 ⁺	
11214.8 10	(23/2 ⁺)	
11248 3	23/2	
11369.7 11	25/2 ⁻	
11659.8 ^a 7	27/2 ⁻	
11719.6 ^o 5	25/2 ⁻	
11837.5 7	25/2 ⁺	
11917.5 [‡] 5	25/2 ⁺	Ep _{c.m.} =1.90×10 ³ keV 3 feeds ⁵⁸ Ni 8 ⁺ state at 6604.6 keV, branching 9% 2 and %I _{rel} =1.4 3 compared to most intense 1556γ from this level (2002Ru06).
11936.5 ^m 5	25/2 ⁻	
11982.2 ^{‡k} 14	23/2 ⁻	Ep _{c.m.} =2.47×10 ³ keV 3 feeds ⁵⁸ Ni 7 ⁻ state at 6084.7 keV, branching 53% 8 and %I _{rel} =0.6 2 compared to 4931γ intensity from this level (2002Ru06).
12038.9 [‡] 6	25/2 ⁺	Ep _{c.m.} =1.97×10 ³ keV 4 feeds ⁵⁸ Ni 8 ⁺ state at 6604.6 keV, branching 8% 3 and %I _{rel} =0.4 2 compared to most intense 3922γ from this level (2002Ru06).
12110.9 10	27/2 ⁻	
12243.6 9	25/2 ⁺	
12247.0 ^h 5	29/2 ⁺	
12373.7 ^p 5	27/2 ⁻	
12418.9 ^e 5	29/2 ⁺	
12552.3 ⁿ 5	27/2 ⁻	
12808.2 5	29/2	
12859.6 ^l 19	(25/2 ⁻)	
13103.8 ^o 5	29/2 ⁻	

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⁴⁰Ca(²⁸Si,2αpγ) **2002An20,2000An32 (continued)**

⁵⁹Cu Levels (continued)

E(level) [†]	J ^π	E(level) [†]	J ^π	E(level) [†]	J ^π	E(level) [†]	J ^π
13127.1 ^k 14	27/2 ⁻	14955.6 ^o 8	33/2 ⁻	18678 4		22684.7 ^o 17	45/2 ⁻
13193.8 ^m 5	29/2 ⁻	15330.2 ^j 16	31/2 ⁽⁺⁾	18883 ^k 3	39/2 ⁻	23459 ^l 3	(45/2 ⁻)
13351.7 ⁱ 7	29/2 ⁺	15724.3 ⁿ 6	35/2 ⁻	18953 4		23529 ^m 5	(45/2 ⁻)
13358.6 ^g 6	31/2 ⁺	15958.3 ^l 15	33/2 ⁻	19093.3 ⁱ 13	41/2 ⁺	24316.8 ^p 19	(47/2 ⁻)
13421.1 17	29/2 ⁻	15984.3 ^p 9	35/2 ⁻	19429.1 ^m 13	41/2 ⁻	24708 ⁱ 3	49/2 ⁺
13479.3 ^j 17	27/2 ⁽⁺⁾	16030.3 ^g 9	35/2 ⁺	19670.6 ^o 11	41/2 ⁻	24769 ^k 4	(47/2 ⁻)
13519.1 ^b 15	(29/2 ⁻)	16503.8 24		19834.3 ^g 17	(39/2 ⁺)	25677 ^j 5	(47/2 ⁺)
13526.9 5	31/2	16560.5 ^k 18	35/2 ⁻	19915 4	(39/2 ⁺)	26224 ^o 4	(49/2 ⁻)
13918.6 ^p 5	31/2 ⁻	16755.0 ^m 7	37/2 ⁻	19929.3 ^j 21	39/2 ⁽⁺⁾	26840 ^l 4	(49/2 ⁻)
13932.6 ⁿ 6	31/2 ⁻	16850.8 ⁱ 11	37/2 ⁺	20523.5 ^l 20	41/2 ⁻	28133 ⁱ 3	53/2 ⁺
14237.6 ^l 16	29/2 ⁻	17123.3 ^o 10	37/2 ⁻	20706 5		31960 ⁱ 3	(57/2 ⁺)
14517.7 5	33/2	17606.3 ^j 19	35/2 ⁽⁺⁾	21094.6 ^p 16	43/2 ⁻	x ^q	(J)
14585.1 ^h 6	33/2 ⁺	17828.3 ^h 15	(37/2 ⁺)	21256 ⁿ 4	(43/2 ⁻)	1631.0+x ^q 10	(J+2)
14653.4 ^k 15	31/2 ⁻	17882 4		21641 ^k 4	43/2 ⁻	3647.1+x ^q 15	(J+4)
14698.7 22		17961.4 ⁿ 12	39/2 ⁻	21704.3 ⁱ 16	45/2 ⁺	6005.1+x ^q 18	(J+6)
14782.5 ^m 5	33/2 ⁻	18028.5 ^l 17	37/2 ⁻	22048.4 20	(41/2 ⁺)	8812+x ^q 3	(J+8)
14951.0 ⁱ 9	33/2 ⁺	18308.6 ^p 11	39/2 ⁻	22578 ^j 3	(43/2 ⁺)		

[†] From least-squares fit to Eγ's. Uncertainty doubled for 1788.1γ and 819.8γ from 6688.7- and 10276.1-keV levels, respectively. Without these uncertainty increase, χ²=1.5 compared to χ²=1.3 (critical).

[‡] Level deexcitation: Prompt proton emission competes with γ rays.

Band(A): p_{3/2}.

@ Band(B): f_{7/2}⁻¹, α=-1/2.

& Band(b): f_{7/2}⁻¹, α=+1/2.

^a Band(C): Band based on 19/2⁻, α=-1/2.

^b Band(c): Band based on 17/2⁻, α=+1/2.

^c Band(D): f_{5/2}.

^d Band(E): Band based on 9/2⁺.

^e Band(F): Band based on 17/2⁺, α=+1/2.

^f Band(f): Band based on 15/2⁺, α=-1/2.

^g Band(G): Band based on 19/2⁺, α=-1/2. Average Q_t=1.25 +13-10, β₂=0.24 2.

^h Band(g): Band based on 21/2⁺, α=+1/2. Average Q_t=1.25 +13-10, β₂=0.24 2.

ⁱ Band(H): SD-1 band (2000An32,2002An20). Average Q_t=2.23 +27-22 (2002An20), β₂=0.41 5. Configuration=ν4²π4¹. Percent population=30% relative to I(γ+ce) Iγ(1399γ).

^j Band(h): SD-2 band (?), α=-1/2 (2002An20) Possible signature partner of SD-1 band (2002An20).

^k Band(I): Band based on 23/2⁻, α=-1/2. Average Q_t=1.95 +33-25 (2002An20), β₂=0.36 4. Highly-deformed band.

^l Band(i): Band based on 25/2⁻, α=+1/2. Average Q_t=1.95 +33-25 (2002An20), β₂=0.36 4. Highly-deformed band.

^m Band(J): Band based on 25/2⁻, α=+1/2.

ⁿ Band(j): Band based on 27/2⁻, α=-1/2.

^o Band(K): Band based on 21/2⁻, α=+1/2.

^p Band(k): Band based on 23/2⁻, α=-1/2.

^q Band(L): Band structure.

$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ **2002An20,2000An32 (continued)** $\gamma(^{59}\text{Cu})$

DCO: Ratios given here correspond to 30°- 83° $\gamma\gamma$ matrix. For about 60 transitions **2002An20** give DCO ratios corresponding to 30°- 53° and 53°- 83° $\gamma\gamma$ matrices also. See Table 2 of **2002An20** for these additional DCO ratios.

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^{\text{@}}$	Comments
196.3 2	1.6 4	2585.82	11/2 ⁻	2389.35	9/2 ⁻	‡		The 196.3 γ is shown to de-excite 2663 level in Table 1 of 2002An20 , which is a misprint.
327.9 1	6.3 2	8153.3	19/2 ⁺	7825.4	17/2 ⁺	D+Q	+0.13 +7-9	DCO=0.65 11
360.9 1	4.8 2	8153.3	19/2 ⁺	7792.4	17/2 ⁺	D+Q	+0.15 7	DCO=0.61 10
422.6 4	0.7 2	913.70	5/2 ⁻	491.23	1/2 ⁻			Mult.: E2 in 2002An20 .
455.4 1	0.4 1	3041.30	9/2 ⁺	2585.82	11/2 ⁻	D		DCO=0.73 9 Mult.: E1 in 2002An20 .
465.8 1	36 1	1864.04	7/2 ⁻	1398.17	7/2 ⁻	D+Q ‡		DCO=0.94 7 δ : +1.19 +29-24 or -0.07 +11-10.
484.3 1	13.1 4	1398.17	7/2 ⁻	913.70	5/2 ⁻	D+Q	-0.05 1	DCO=0.50 8
491.3 3	0.7 2	491.23	1/2 ⁻	0.0	3/2 ⁻			Mult.: M1+E2 in 2002An20 .
515.4 2	1.9 3	6688.7	17/2 ⁺	6173.2	15/2 ⁺			
517 1	<0.1	10141.2	21/2 ⁺	9624.3	21/2 ⁺			
523.0 1	9.0 3	5425.23	17/2 ⁺	4902.19	15/2 ⁻			Mult.: E1 in 2002An20 .
555.3 2	0.7 2	7351.0	19/2 ⁺	6795.5	19/2 ⁺	‡		DCO=0.99 14
574.1 1	17.3 5	8727.5	21/2 ⁺	8153.3	19/2 ⁺	D+Q	+0.16 +5-12	DCO=0.71 7
598.8 1	4.0 3	11719.6	25/2 ⁻	11120.7	23/2 ⁻	D+Q	-0.06 +5-6	DCO=0.47 4
615.8 1	0.4 2	12552.3	27/2 ⁻	11936.5	25/2 ⁻			Mult.: M1+E2 in 2002An20 .
641.4 1	1.5 3	13193.8	29/2 ⁻	12552.3	27/2 ⁻	D+Q		DCO=1.06 12 δ : +2.8 +8-5 or +0.35 7.
653.5 ^a 1	6.3 7	4098.97	13/2 ⁻	3445.48	13/2 ⁻	D+Q ‡		DCO=0.95 6 δ : +1.04 +12-18 or -0.22 +11-12.
654.0 1	4.0 5	12373.7	27/2 ⁻	11719.6	25/2 ⁻	D+Q		DCO=0.50 4 δ : -0.01 5 or -6.4 +18-20.
662.2 ^a 2	7.0 8	7351.0	19/2 ⁺	6688.7	17/2 ⁺	D+Q		DCO=0.65 4
664.5 2	54 2	3327.96	11/2 ⁻	2662.98	9/2 ⁻	D+Q	+0.15 +4-5	DCO=0.76 4
703 1	0.2 1	11917.5	25/2 ⁺	11214.8	(23/2 ⁺)			Mult.: (M1+E2) in 2002An20 .
718.6 1	4.0 5	13526.9	31/2	12808.2	29/2	D+Q		DCO=0.68 5 δ : +0.67 +48-21 or -0.58 +17-28.
727.5 ^a 1	13 1	9455.1	23/2 ⁺	8727.5	21/2 ⁺	D+Q		DCO=0.81 5
729.4 ^a 1	11 1	9671.2	25/2 ⁺	8941.8	23/2 ⁺	D+Q		DCO=0.80 7
730.0 1	4.0 4	13103.8	29/2 ⁻	12373.7	27/2 ⁻	D+Q		DCO=0.51 4 δ : -0.74 +5-6 or -0.05 +14-17.
739 ^a 1	0.3 1	13932.6	31/2 ⁻	13193.8	29/2 ⁻	D+Q		DCO=0.91 6
741.7 ^b 2	14 1	3327.96	11/2 ⁻	2585.82	11/2 ⁻	D+Q ‡	+0.81 +30-22	DCO=1.00 9
762.9 2	12 1	8114.3	21/2 ⁺	7351.0	19/2 ⁺	D+Q	+0.10 +6-7	DCO=0.61 6
770.7 2	64 2	4098.97	13/2 ⁻	3327.96	11/2 ⁻	D+Q	+0.19 4	DCO=0.78 4
798.5 2	76 2	2662.98	9/2 ⁻	1864.04	7/2 ⁻	D+Q	+0.28 4	DCO=0.90 5
802.7 2	43 1	4902.19	15/2 ⁻	4098.97	13/2 ⁻	D+Q	+0.18 +5-6	DCO=0.82 6
814.6 2	2.0 1	13918.6	31/2 ⁻	13103.8	29/2 ⁻	D+Q		DCO=0.50 7
818.1 2	31 1	5720.46	17/2 ⁻	4902.19	15/2 ⁻	D+Q	+0.15 +4-5	DCO=0.74 4
819.8 ^a 2	6.6 4	10276.1	25/2 ⁺	9455.1	23/2 ⁺	D+Q		DCO=0.73 6 δ : +0.21 5 or +6.3 +78-14.
827.4 2	10 1	8941.8	23/2 ⁺	8114.3	21/2 ⁺	D+Q	+0.18 +5-6	DCO=0.75 5
833.7 2	15 1	7443.1	21/2 ⁻	6608.9	19/2 ⁻	D+Q	+0.20 +5-6	DCO=0.78 5
850 1	0.8 2	14782.5	33/2 ⁻	13932.6	31/2 ⁻	D+Q	\approx +1	DCO=1.24 10
860.1 2	4.0 5	3445.48	13/2 ⁻	2585.82	11/2 ⁻	D+Q		DCO=0.25 4 δ : -0.2 > δ > -2.6.

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$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ **2002An20,2000An32 (continued)** $\gamma(^{59}\text{Cu})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^{\text{@}}$	Comments
888.1 2	16.0 5	6608.9	19/2 ⁻	5720.46	17/2 ⁻	D+Q	+0.16 +4-5	DCO=0.75 5
898.7 2	22 1	5425.23	17/2 ⁺	4526.48	13/2 ⁺	Q		DCO=1.04 6
913.5 2	100 3	913.70	5/2 ⁻	0.0	3/2 ⁻	D+Q		DCO=0.44 4
								δ : -0.24 +7-11 or \approx -1.7.
932.1 2	14 1	10603.5	27/2 ⁺	9671.2	25/2 ⁺	D+Q	+0.24 5	DCO=0.89 6
935.0 ^a 2	4.1 3	11211.5	27/2 ⁺	10276.1	25/2 ⁺			Mult.: M1+E2 in 2002An20.
938.9 ^{&b} 4	2.0 3	3327.96	11/2 ⁻	2389.35	9/2 ⁻	D+Q		DCO=0.48 13
942 1	0.6 1	15724.3	35/2 ⁻	14782.5	33/2 ⁻	D+Q	\approx +2	DCO=0.77 11
950.5 2	61 2	1864.04	7/2 ⁻	913.70	5/2 ⁻	D+Q		DCO=0.65 5
								δ : +0.02 5 or -4.1 +9-11.
990.8 ^c 2	4.0 ^c 3	2389.35	9/2 ⁻	1398.17	7/2 ⁻	D+Q	-0.08 +7-10	DCO=0.48 4
								Mult.: M1+E2 in 2002An20.
990.8 ^c 2	3.7 ^c 5	14517.7	33/2	13526.9	31/2	D+Q	+0.16 6	DCO=0.71 7
1003.1 ^b 2	8.3 6	7051.5	19/2 ⁻	6048.1	17/2 ⁻	D+Q		DCO=1.32 7
1028 1	2.0 8	15984.3	35/2 ⁻	14955.6	33/2 ⁻	D+Q	-0.15 +5-7	DCO=0.43 5
1031 ^a 1	0.5 1	16755.0	37/2 ⁻	15724.3	35/2 ⁻	D+Q	\approx +1	DCO=1.12 8
1035.0 3	1.9 3	12247.0	29/2 ⁺	11211.5	27/2 ⁺	D+Q	+0.21 +10-11	DCO=0.59 6
1038 ^a 1	2.5 5	14955.6	33/2 ⁻	13918.6	31/2 ⁻	D+Q	-0.15 +5-7	DCO=0.35 4
1042.4 9	1.4 2	11719.6	25/2 ⁻	10677.4	21/2 ⁻	Q		DCO=1.11 22
1043 ^{&} 1	0.2 1	7792.4	17/2 ⁺	6748.4	(17/2 ⁺)	‡		
1056.3 3	21 1	3445.48	13/2 ⁻	2389.35	9/2 ⁻	Q		DCO=1.07 9
1060 1	2.0 5	8111.8	21/2 ⁻	7051.5	19/2 ⁻	D+Q		DCO=0.83 6
1061 ^a 1	1.5 5	9173.0	23/2 ⁻	8111.8	21/2 ⁻	D+Q		DCO=0.83 6
1064 2	0.2 1	11719.6	25/2 ⁻	10655.7	21/2 ⁻			
1077 ^{&} 1	<0.1	7825.4	17/2 ⁺	6748.4	(17/2 ⁺)	‡		
1083 1	0.3 1	13193.8	29/2 ⁻	12110.9	27/2 ⁻	D+Q		DCO=0.75 10
1101.1 ^{&} 4	0.5 2	8153.3	19/2 ⁺	7051.5	19/2 ⁻	‡		
1108 1	1.1 1	13351.7	29/2 ⁺	12243.6	25/2 ⁺	Q		DCO=0.89 12
1108.0 2	1.8 3	13526.9	31/2	12418.9	29/2 ⁺	D+Q [#]	+0.16 +11-8	DCO=0.63 6
1111.0 6	1.1 2	13358.6	31/2 ⁺	12247.0	29/2 ⁺	D+Q	+0.44 +10-12	DCO=1.12 14
1139 1	2.0 10	17123.3	37/2 ⁻	15984.3	35/2 ⁻	D+Q	+0.69 +6-8	DCO=0.55 6
1145 1	1.2 2	13127.1	27/2 ⁻	11982.2	23/2 ⁻	Q		DCO=1.23 19
1145.5 2	10.4 6	6048.1	17/2 ⁻	4902.19	15/2 ⁻	D+Q		DCO=0.92 6
								δ : +4.1 +16-8 or +0.32 6.
1177.5 2	8.5 4	3041.30	9/2 ⁺	1864.04	7/2 ⁻	D+Q	+0.03 1	DCO=0.59 4
								Mult.: E1+M2 in 2002An20.
1177.9 3	1.0 3	7351.0	19/2 ⁺	6173.2	15/2 ⁺	Q		DCO=0.89 14
1184.7 ^a 10	1.7 5	18308.6	39/2 ⁻	17123.3	37/2 ⁻	D+Q	+0.12 5	DCO=0.70 6
1187.5 3	31 2	2585.82	11/2 ⁻	1398.17	7/2 ⁻	Q		DCO=0.97 8
1197.8 6	0.7 1	10370.7	25/2 ⁻	9173.0	23/2 ⁻	D+Q		DCO=0.61 24
1198.2 2	2.3 3	4526.48	13/2 ⁺	3327.96	11/2 ⁻	D		DCO=0.65 14
								Mult.: E1 in 2002An20.
1225 ^b 1	0.9 2	14585.1	33/2 ⁺	13358.6	31/2 ⁺			Mult.: M1+E2 in 2002An20.
1253.6 3	2.9 5	12373.7	27/2 ⁻	11120.7	23/2 ⁻	Q		DCO=1.08 11
1257.9 3	0.6 3	13193.8	29/2 ⁻	11936.5	25/2 ⁻	Q		DCO=1.24 18
1263.4 3	2.1 3	6688.7	17/2 ⁺	5425.23	17/2 ⁺	D+Q [‡]		DCO=0.86 14
1264.4 3	5.4 4	2662.98	9/2 ⁻	1398.17	7/2 ⁻	D+Q	+0.48 +13-12	DCO=1.29 12
1290 ^{&} 1	0.4 3	11659.8	27/2 ⁻	10370.7	25/2 ⁻			Mult.: M1+E2 in 2002An20.
1302.1 ^a 3	4.0 5	9455.1	23/2 ⁺	8153.3	19/2 ⁺	Q		DCO=1.31 16
1304.8 ^a 5	0.4 1	15958.3	33/2 ⁻	14653.4	31/2 ⁻	D+Q		DCO=0.46 8
1313 1	4.9 3	13351.7	29/2 ⁺	12038.9	25/2 ⁺	Q		DCO=1.03 7
1322.9 4	1.8 3	6748.4	(17/2 ⁺)	5425.23	17/2 ⁺	‡		DCO=1.33 33

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$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ **2002An20,2000An32 (continued)** $\gamma(^{59}\text{Cu})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^{\text{@}}$	Comments
1331.2 3	1.9 3	7051.5	19/2 ⁻	5720.46	17/2 ⁻	D+Q		DCO=0.49 11 $\delta: +0.5 > \delta > -1.7$.
1361.9 3	1.1 5	19670.6	41/2 ⁻	18308.6	39/2 ⁻	D+Q	+0.02 1	DCO=0.51 7
1368.7 3	9.0 5	8812.2	23/2 ⁻	7443.1	21/2 ⁻	D+Q	+0.14 6	DCO=0.78 9
1370.1 3	9.5 6	6795.5	19/2 ⁺	5425.23	17/2 ⁺	D(+Q)	0.00 +5-6	DCO=0.60 4
1378 ^a 1	0.6 2	14237.6	29/2 ⁻	12859.6	(25/2 ⁻)			Mult.: (E2) in 2002An20.
1379 1	1.0 2	13932.6	31/2 ⁻	12552.3	27/2 ⁻	Q		DCO=0.99 13
1385.1 9	4.0 1	13103.8	29/2 ⁻	11719.6	25/2 ⁻	Q		DCO=1.13 9
1398.4 3	80 2	1398.17	7/2 ⁻	0.0	3/2 ⁻	Q		DCO=0.95 7
1424 2	0.3 1	21094.6	43/2 ⁻	19670.6	41/2 ⁻	D+Q		DCO=0.68 14 $\delta: +0.27 > \delta > +0.02$.
1426.0 3	8.0 8	8114.3	21/2 ⁺	6688.7	17/2 ⁺	Q		DCO=0.90 11
1434 1	17 1	13351.7	29/2 ⁺	11917.5	25/2 ⁺	Q		DCO=1.07 7
1435.7 3	32 3	4098.97	13/2 ⁻	2662.98	9/2 ⁻	Q		DCO=1.02 6
1445 ^{&} 1	0.4 1	16030.3	35/2 ⁺	14585.1	33/2 ⁺			Mult.: M1+E2 in 2002An20.
1457.3 ^b 3	5.4 4	4902.19	15/2 ⁻	3445.48	13/2 ⁻	D+Q	-0.21 +8-11	DCO=0.38 3
1464.4 4	26 1	3327.96	11/2 ⁻	1864.04	7/2 ⁻	Q		DCO=1.06 6
1476 ^a 1	0.4 1	13193.8	29/2 ⁻	11719.6	25/2 ⁻			Mult.: E2 in 2002An20.
1476.4 ^a 3	34 1	2389.35	9/2 ⁻	913.70	5/2 ⁻	Q		DCO=0.95 5
1485.5 3	20 1	4526.48	13/2 ⁺	3041.30	9/2 ⁺	Q		DCO=0.95 6
1499.1 10	8.0 2	8941.8	23/2 ⁺	7443.1	21/2 ⁻	D		DCO=0.63 6 Mult., δ : E1 in 2002An20. $\delta=+0.02$ +5-6.
1505.5 3	5.0 2	8114.3	21/2 ⁺	6608.9	19/2 ⁻	D		DCO=0.47 6 Mult.: E1 in 2002An20. $\delta: -0.13 +7-10$ or $-4 +12-26$.
1513.0 4	2.7 4	4098.97	13/2 ⁻	2585.82	11/2 ⁻			Mult.: M1+E2 in 2002An20.
1514 1	4.1 3	13351.7	29/2 ⁺	11837.5	25/2 ⁺	Q		DCO=0.90 6
1526 1	2.7 3	14653.4	31/2 ⁻	13127.1	27/2 ⁻	Q		DCO=1.16 10
1538 1	1.1 2	11917.5	25/2 ⁺	10379.6	21/2 ⁺			Mult.: E2 in 2002An20.
1545.6 3	2.5 5	13918.6	31/2 ⁻	12373.7	27/2 ⁻	Q		DCO=1.01 10
1548.8 4	5.0 7	10276.1	25/2 ⁺	8727.5	21/2 ⁺	Q		DCO=1.18 27
1552 1	0.4 1	12373.7	27/2 ⁻	10822.4	(25/2 ⁻)			
1556 ^a 1	3.1 3	11917.5	25/2 ⁺	10361.5	21/2 ⁺	Q		DCO=1.25 10
1557.1 3	9 1	9671.2	25/2 ⁺	8114.3	21/2 ⁺	Q		DCO=0.99 7
1560 ^a 1	4.5 5	13932.6	31/2 ⁻	12373.7	27/2 ⁻	Q		DCO=1.26 9
1574.3 3	37 2	4902.19	15/2 ⁻	3327.96	11/2 ⁻	Q		DCO=1.15 7
1588.7 3	6.0 4	14782.5	33/2 ⁻	13193.8	29/2 ⁻	Q		DCO=0.98 10
1590 ^a 1	0.6 2	22684.7	45/2 ⁻	21094.6	43/2 ⁻	D+Q		DCO=0.72 11
1591 ^a 1	0.4 2	8512	(21/2 ⁻)	6921	(17/2 ⁻)	(Q)		DCO=1.00 12
1591.1 3	10 1	8941.8	23/2 ⁺	7351.0	19/2 ⁺	Q		DCO=1.01 8
1599.3 5	25 1	14951.0	33/2 ⁺	13351.7	29/2 ⁺	Q		DCO=1.05 6
1614 1	0.8 2	11837.5	25/2 ⁺	10223.6	21/2 ⁺	Q		DCO=1.30 15
1621.6 3	40 2	5720.46	17/2 ⁻	4098.97	13/2 ⁻	Q		DCO=1.07 7
1630.7 3	10 1	7351.0	19/2 ⁺	5720.46	17/2 ⁻	D		DCO=0.56 4 Mult., δ : E1 in 2002An20. $\delta=-0.02$ +5-6.
1631 1	0.4 1	1631.0+x	(J+2)	x	(J)			
1632 1	0.4 1	24316.8	(47/2 ⁻)	22684.7	45/2 ⁻			Mult.: (M1+E2) in 2002An20.
1643.5 3	22 1	3041.30	9/2 ⁺	1398.17	7/2 ⁻	D+Q	+0.02 1	DCO=0.58 3 Mult.: E1+M2 in 2002An20.
1662.0 3	8.0 6	10603.5	27/2 ⁺	8941.8	23/2 ⁺	Q		DCO=1.02 7
1696 2	0.5 1	11837.5	25/2 ⁺	10141.2	21/2 ⁺			Mult.: E2 in 2002An20.
1707.4 ^a 3	23 1	6608.9	19/2 ⁻	4902.19	15/2 ⁻	Q		DCO=1.12 7

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$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ 2002An20,2000An32 (continued) $\gamma(^{59}\text{Cu})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	δ^\oplus	Comments
1709.6 ^a 5	1.4 3	4098.97	13/2 ⁻	2389.35	9/2 ⁻			Mult.: E2 in 2002An20.
1718 ^a 1	0.5 1	11837.5	25/2 ⁺	10118.6	21/2 ⁺			Mult.: E2 in 2002An20.
1721 ^a 1	1.2 2	15958.3	33/2 ⁻	14237.6	29/2 ⁻	Q		DCO=1.06 11
1723.3 3	20 1	7443.1	21/2 ⁻	5720.46	17/2 ⁻	Q		DCO=0.94 5
1725 ^a 1	0.4 1	9431.4	21/2 ⁺	7706.8	19/2 ⁺	D+Q		DCO=0.77 18
1730 ^{ba} 1	1.4 3	9173.0	23/2 ⁻	7443.1	21/2 ⁻	D+Q		DCO=0.80 13
1753 ^d 2	<0.1	20706		18953				
1756.3 3	5.4 3	11211.5	27/2 ⁺	9455.1	23/2 ⁺	Q		DCO=1.14 11
1763 1	0.4 2	12038.9	25/2 ⁺	10276.1	25/2 ⁺	‡		
1776 1	2.3 1	11917.5	25/2 ⁺	10141.2	21/2 ⁺	Q		DCO=0.92 25
1788.1 4	12 1	6688.7	17/2 ⁺	4902.19	15/2 ⁻	D+Q	-0.05 1	DCO=0.53 5 Mult.: E1+M2 in 2002An20.
1791.6 4	2.5 3	15724.3	35/2 ⁻	13932.6	31/2 ⁻	Q		DCO=1.04 13
1798 ^{ba} 2	0.2 1	17828.3	(37/2 ⁺)	16030.3	35/2 ⁺			Mult.: (M1+E2) in 2002An20.
1800 1	0.5 1	11917.5	25/2 ⁺	10118.6	21/2 ⁺			Mult.: E2 in 2002An20.
1805 1	0.3 1	16503.8		14698.7				
1806 1	1.0 2	15724.3	35/2 ⁻	13918.6	31/2 ⁻	Q		DCO=0.88 10
1811 ^a 1	0.9 3	15330.2	31/2 ⁽⁺⁾	13519.1	(29/2 ⁻)	D [#]		DCO=0.67 7
1815.6 4	3.2 4	12418.9	29/2 ⁺	10603.5	27/2 ⁺	D+Q	+0.23 +7-8	DCO=0.88 10
1824 1	<0.1	13193.8	29/2 ⁻	11369.7	25/2 ⁻			Mult.: E2 in 2002An20.
1850.9 8	3.5 5	14955.6	33/2 ⁻	13103.8	29/2 ⁻	Q		DCO=1.13 13
1851 ^a 1	<0.1	15330.2	31/2 ⁽⁺⁾	13479.3	27/2 ⁽⁺⁾			Mult.: E2 in 2002An20.
1858.9 20	0.4 2	13519.1	(29/2 ⁻)	11659.8	27/2 ⁻			Mult.: (M1+E2) in 2002An20.
1864 1	0.3 1	12243.6	25/2 ⁺	10379.6	21/2 ⁺	Q		DCO=1.05 29
1864.2 4	31 1	1864.04	7/2 ⁻	0.0	3/2 ⁻	Q		DCO=1.06 9
1888.5 ^a 4	5.0 5	9331.8	23/2 ⁻	7443.1	21/2 ⁻			Mult.: M1+E2 in 2002An20.
1894 ^a 1	2.3 5	7614.7	21/2 ⁻	5720.46	17/2 ⁻			
1899.8 6	23 1	16850.8	37/2 ⁺	14951.0	33/2 ⁺	Q		DCO=1.12 6
1907 1	1.9 4	16560.5	35/2 ⁻	14653.4	31/2 ⁻	Q		DCO=1.01 8
1909 ^a 1	0.5 2	15330.2	31/2 ⁽⁺⁾	13421.1	29/2 ⁻	#		
1916 1	0.6 1	11837.5	25/2 ⁺	9921.6	21/2 ⁺			Mult.: E2 in 2002An20.
1925.8 7	2.0 3	7351.0	19/2 ⁺	5425.23	17/2 ⁺	D(+Q)	-0.04 +11-13	DCO=0.48 8
1930.3 4	7.2 4	3327.96	11/2 ⁻	1398.17	7/2 ⁻	Q		DCO=0.94 6
1941.2 4	1.6 4	4526.48	13/2 ⁺	2585.82	11/2 ⁻	D		DCO=0.40 16 Mult.: E1 in 2002An20.
1949.1 4	9.7 5	6048.1	17/2 ⁻	4098.97	13/2 ⁻	Q		DCO=0.98 7
1971.7 4	4.1 5	12247.0	29/2 ⁺	10276.1	25/2 ⁺	Q		DCO=0.93 8
1972.4 ^a 6	5.5 1	16755.0	37/2 ⁻	14782.5	33/2 ⁻	Q		DCO=1.06 7
1981.1 4	1.1 3	13193.8	29/2 ⁻	11211.5	27/2 ⁺			Mult.: E1 in 2002An20.
1996 2	0.3 1	11917.5	25/2 ⁺	9921.6	21/2 ⁺			Mult.: E2 in 2002An20.
2006 ^{&} 1	<0.1	19834.3	(39/2 ⁺)	17828.3	(37/2 ⁺)			E_γ : 2206 in figure 9 of 2002An20 is a misprint. Mult.: (M1+E2) in 2002An20.
2010.4 4	2.0 7	10822.4	(25/2 ⁻)	8812.2	23/2 ⁻	(D+Q)		DCO=1.16 26
2016 1	1.0 2	3647.1+x	(J+4)	1631.0+x	(J+2)			
2028 1	<0.1	20706		18678				
2055.5 4	1.9 5	8850.8	21/2 ⁻	6795.5	19/2 ⁺	D		DCO=0.65 26 Mult.: E1 in 2002An20.
2064 ^{&} 1	6.9 5	8111.8	21/2 ⁻	6048.1	17/2 ⁻	Q		DCO=1.03 7
2066 ^a 1	3.8 8	15984.3	35/2 ⁻	13918.6	31/2 ⁻	Q		DCO=0.96 7
2070.1 ^a 7	1.2 2	18028.5	37/2 ⁻	15958.3	33/2 ⁻	Q		DCO=1.19 13
2071 1	0.7 3	7792.4	17/2 ⁺	5720.46	17/2 ⁻	‡		

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$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ **2002An20,2000An32 (continued)** $\gamma(^{59}\text{Cu})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^{\text{@}}$	Comments
2074.2 ^b 4	5.0 5	6173.2	15/2 ⁺	4098.97	13/2 ⁻	D		DCO=0.57 9 Mult.: E1 in 2002An20.
2105 1	0.5 2	7825.4	17/2 ⁺	5720.46	17/2 ⁻	‡		
2116 2	0.3 1	7541.3		5425.23	17/2 ⁺			
2118.7 7	2.1 5	8727.5	21/2 ⁺	6608.9	19/2 ⁻	D		DCO=0.55 15 Mult.: E1 in 2002An20.
2121.4 8	5.0 9	9173.0	23/2 ⁻	7051.5	19/2 ⁻	Q		DCO=1.27 14
2147 1	0.6 2	8941.8	23/2 ⁺	6795.5	19/2 ⁺	Q		DCO=0.82 11
2147.1 5	4.3 3	13358.6	31/2 ⁺	11211.5	27/2 ⁺	Q		DCO=1.01 13
2149.6 4	1.7 3	7051.5	19/2 ⁻	4902.19	15/2 ⁻	Q		DCO=1.03 21
2168 1	6.0 10	17123.3	37/2 ⁻	14955.6	33/2 ⁻	Q		DCO=1.20 11
2204.0 4	4.5 4	8812.2	23/2 ⁻	6608.9	19/2 ⁻	Q		DCO=0.92 8
2204.5 4	6.8 5	12808.2	29/2	10603.5	27/2 ⁺	D+Q [#]	-0.10 8	DCO=0.55 4
2214 1	0.3 1	22048.4	(41/2 ⁺)	19834.3	(39/2 ⁺)			Mult.: (M1+E2) in 2002An20.
2237 1	3.5 3	17961.4	39/2 ⁻	15724.3	35/2 ⁻	Q		DCO=0.99 8
2242.4 7	16 1	19093.3	41/2 ⁺	16850.8	37/2 ⁺	Q		DCO=1.10 6
2259 1	4.0 9	10370.7	25/2 ⁻	8111.8	21/2 ⁻	Q		DCO=1.01 18
2275.8 ^a 5	7.0 5	5720.46	17/2 ⁻	3445.48	13/2 ⁻	Q		DCO=1.25 9
2276 ^a 1	1.4 2	17606.3	35/2 ⁽⁺⁾	15330.2	31/2 ⁽⁺⁾	Q		DCO=1.1 2
2277 2	1.0 3	12552.3	27/2 ⁻	10276.1	25/2 ⁺	D		DCO=0.53 9 Mult.: E1 in 2002An20.
2281.1 ^a 5	2.4 8	7706.8	19/2 ⁺	5425.23	17/2 ⁺	D+Q		DCO=0.85 15
2315.5 ^{&} 6	7.0 8	4902.19	15/2 ⁻	2585.82	11/2 ⁻	Q		DCO=1.08 11
2322 2	1.9 2	18883	39/2 ⁻	16560.5	35/2 ⁻	Q		DCO=1.18 12
2323 ^a 1	1.1 3	19929.3	39/2 ⁽⁺⁾	17606.3	35/2 ⁽⁺⁾	Q		DCO=1.15 12
2324 1	3.4 3	18308.6	39/2 ⁻	15984.3	35/2 ⁻	Q		DCO=1.10 8
2328 1	0.8 3	11659.8	27/2 ⁻	9331.8	23/2 ⁻	Q		DCO=1.24 18
2338.3 5	2.2 3	14585.1	33/2 ⁺	12247.0	29/2 ⁺	Q		DCO=0.91 10
2358 1	0.9 2	6005.1+x	(J+6)	3647.1+x	(J+4)			
2372 1	0.4 1	13193.8	29/2 ⁻	10822.4	(25/2 ⁻)			Mult.: E2 in 2002An20.
2400 1	0.4 1	7825.4	17/2 ⁺	5425.23	17/2 ⁺	‡		
2410 2	0.2 1	10118.6	21/2 ⁺	7706.8	19/2 ⁺			Mult.: M1+E2 in 2002An20.
2432.8 6	5.1 4	8153.3	19/2 ⁺	5720.46	17/2 ⁻	D		DCO=0.46 6 Mult.: E1 in 2002An20.
2433 1	0.3 1	10141.2	21/2 ⁺	7706.8	19/2 ⁺	D+Q		DCO=0.38 6
2462 1	2.4 4	11917.5	25/2 ⁺	9455.1	23/2 ⁺	D+Q		DCO=0.69 8
2486 1	1.1 5	11659.8	27/2 ⁻	9173.0	23/2 ⁻	Q		DCO=1.00 23
2495 1	0.9 2	20523.5	41/2 ⁻	18028.5	37/2 ⁻	Q		DCO=1.02 15
2501 1	1.3 2	13103.8	29/2 ⁻	10603.5	27/2 ⁺	D		DCO=0.39 9
2506 1	0.4 1	11837.5	25/2 ⁺	9331.8	23/2 ⁻	D		DCO=0.73 21 Mult.: E1 in 2002An20.
2547 1	0.8 2	7072.8	17/2 ⁺	4526.48	13/2 ⁺	Q		DCO=1.19 17
2548 1	4.0 5	19670.6	41/2 ⁻	17123.3	37/2 ⁻	Q		DCO=1.06 8
2579 ^b 2	0.4 1	14237.6	29/2 ⁻	11659.8	27/2 ⁻	D+Q		DCO=0.85 14
2583 2	1.4 4	11917.5	25/2 ⁺	9331.8	23/2 ⁻	D		DCO=0.50 5 Mult.: E1 in 2002An20.
2584 1	1.0 3	12038.9	25/2 ⁺	9455.1	23/2 ⁺	D+Q		DCO=0.76 10
2591 1	3.0 4	13193.8	29/2 ⁻	10603.5	27/2 ⁺	D		DCO=0.55 4 Mult.: E1 in 2002An20.
2605 1	2.2 4	6048.1	17/2 ⁻	3445.48	13/2 ⁻	Q		DCO=0.97 11
2608 1	0.5 3	12038.9	25/2 ⁺	9431.4	21/2 ⁺			Mult.: E2 in 2002An20.
2611 1	8.0 5	21704.3	45/2 ⁺	19093.3	41/2 ⁺	Q		DCO=1.07 6
2626 2	0.2 1	11917.5	25/2 ⁺	9291.9	21/2 ⁺			Mult.: E2 in 2002An20.
2636 1	1.5 3	9431.4	21/2 ⁺	6795.5	19/2 ⁺	D+Q		DCO=0.63 11

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$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ 2002An20,2000An32 (continued) $\gamma(^{59}\text{Cu})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	$\delta^{\text{@}}$	Comments
2649 2	0.6 2	22578	(43/2 ⁺)	19929.3	39/2 ⁽⁺⁾			Mult.: (E2) in 2002An20.
2665 ^{&} 2	<0.1	11837.5	25/2 ⁺	9173.1	21/2 ⁺			E_γ : doublet. Mult.: E2 in 2002An20.
2672 ^a 1	1.7 3	16030.3	35/2 ⁺	13358.6	31/2 ⁺	Q		DCO=1.04 10
2674 ^{&a} 1	2.3 6	19429.1	41/2 ⁻	16755.0	37/2 ⁻	Q		DCO=0.99 8
2688 ^{&} 1	1.6 3	8114.3	21/2 ⁺	5425.23	17/2 ⁺			Mult.: E2 in 2002An20.
2724 1	0.9 2	9331.8	23/2 ⁻	6608.9	19/2 ⁻			DCO=1.20 13
2728 1	1.3 2	8153.3	19/2 ⁺	5425.23	17/2 ⁺	D+Q	+0.45 +13-10	Mult.: E2 in 2002An20.
2744 2	0.4 1	11917.5	25/2 ⁺	9173.1	21/2 ⁺			Mult.: E2 in 2002An20.
2748 1	2.0 1	12418.9	29/2 ⁺	9671.2	25/2 ⁺			Mult.: E2 in 2002An20.
2758 2	1.1 2	21641	43/2 ⁻	18883	39/2 ⁻	Q		DCO=0.94 14
2786 2	2.0 4	21094.6	43/2 ⁻	18308.6	39/2 ⁻	Q		DCO=0.95 13
2791 2	<0.1	10141.2	21/2 ⁺	7351.0	19/2 ⁺			Mult.: M1+E2 in 2002An20.
2807 2	0.5 1	8812+x	(J+8)	6005.1+x	(J+6)			
2824 2	0.8 3	13193.8	29/2 ⁻	10370.7	25/2 ⁻	Q		DCO=0.91 26
2870 1	0.8 2	11719.6	25/2 ⁻	8850.8	21/2 ⁻	Q		DCO=1.04 22
2883 ^a 2	0.8 3	12552.3	27/2 ⁻	9671.2	25/2 ⁺	D		DCO=0.75 20 Mult.: E1 in 2002An20.
2890 1	1.9 5	7792.4	17/2 ⁺	4902.19	15/2 ⁻	D		DCO=0.62 8 Mult., δ : E1 in 2002An20. $\delta=0.00$ +8-20.
2896 2	0.8 2	11837.5	25/2 ⁺	8941.8	23/2 ⁺	D+Q		DCO=0.48 19
2923 1	1.8 2	7825.4	17/2 ⁺	4902.19	15/2 ⁻	D		DCO=0.47 14 Mult., δ : E1 in 2002An20. $\delta=+0.05$ +13-20.
2928 1	0.8 3	10370.7	25/2 ⁻	7443.1	21/2 ⁻	Q		DCO=1.01 31
2935 2	0.4 1	23459	(45/2 ⁻)	20523.5	41/2 ⁻	(Q)		DCO=1.02 37
2998 2		11936.5	25/2 ⁻	8941.8	23/2 ⁺			Mult.: E1 in 2002An20.
3004 2	2.5 4	24708	49/2 ⁺	21704.3	45/2 ⁺	Q		DCO=1.03 7
3007 2	2.0 3	11120.7	23/2 ⁻	8114.3	21/2 ⁺	D		DCO=0.57 6 Mult., δ : E1 in 2002An20. $\delta=+0.03$ +5-6.
3014 2	0.8 3	22684.7	45/2 ⁻	19670.6	41/2 ⁻	Q		DCO=1.07 15
3042 2	1.2 3	12373.7	27/2 ⁻	9331.8	23/2 ⁻	Q		DCO=1.01 15
3050 3	0.8 3	13421.1	29/2 ⁻	10370.7	25/2 ⁻	Q		DCO=1.01 15
3069 1	0.3 1	10141.2	21/2 ⁺	7072.8	17/2 ⁺			Mult.: E2 in 2002An20.
3097 2	0.2 1	12038.9	25/2 ⁺	8941.8	23/2 ⁺			Mult.: M1+E2 in 2002An20.
3099 3	0.3 2	25677	(47/2 ⁺)	22578	(43/2 ⁺)			Mult.: (E2) in 2002An20.
3101 ^a 2	<0.1	11214.8	(23/2 ⁺)	8114.3	21/2 ⁺			Mult.: (M1+E2) in 2002An20.
3104 2	0.8 2	11917.5	25/2 ⁺	8812.2	23/2 ⁻	D		DCO=0.40 9 Mult.: E1 in 2002An20.
3110 ^a 3	0.4 2	13479.3	27/2 ⁽⁺⁾	10370.7	25/2 ⁻	D [#]		DCO=0.6 2
3128 2	0.3 1	24769	(47/2 ⁻)	21641	43/2 ⁻			Mult.: (E2) in 2002An20.
3148 3	0.9 2	13519.1	(29/2 ⁻)	10370.7	25/2 ⁻	(Q)		DCO=1.3 3
3192 2	0.2 1	11917.5	25/2 ⁺	8727.5	21/2 ⁺			Mult.: E2 in 2002An20.
3202 3	1.1 6	12373.7	27/2 ⁻	9173.0	23/2 ⁻	Q		DCO=1.27 21
3223 3	0.6 2	24316.8	(47/2 ⁻)	21094.6	43/2 ⁻			Mult.: (E2) in 2002An20.
3230 2	2.4 3	8655.9	21/2 ⁺	5425.23	17/2 ⁺			DCO=1.07 12
3234 2	0.3 1	10677.4	21/2 ⁻	7443.1	21/2 ⁻	‡		DCO=1.02 15
3243 2	0.6 2	17828.3	(37/2 ⁺)	14585.1	33/2 ⁺			Mult.: (E2) in 2002An20.
3261 2	1.0 3	11917.5	25/2 ⁺	8655.9	21/2 ⁺	Q		DCO=0.87 15
3266 2	0.2 1	7792.4	17/2 ⁺	4526.48	13/2 ⁺			Mult.: E2 in 2002An20.
3295 3	0.6 2	21256	(43/2 ⁻)	17961.4	39/2 ⁻			Mult.: (E2) in 2002An20.
3298 2	0.3 1	7825.4	17/2 ⁺	4526.48	13/2 ⁺			Mult.: E2 in 2002An20.

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ **2002An20,2000An32 (continued)** $\gamma(^{59}\text{Cu})$ (continued)

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.†	Comments
3299 2	1.2 1	12110.9	27/2 ⁻	8812.2	23/2 ⁻	Q	DCO=1.28 32
3302 1	2.1 2	8727.5	21/2 ⁺	5425.23	17/2 ⁺	Q	DCO=1.10 19
3311 2	0.2 1	12038.9	25/2 ⁺	8727.5	21/2 ⁺		Mult.: E2 in 2002An20.
3323 2	0.2 1	10118.6	21/2 ⁺	6795.5	19/2 ⁺		Mult.: M1+E2 in 2002An20.
3382 ^d 3	<0.1	26840?	(49/2 ⁻)	23459	(45/2 ⁻)		Mult.: (E2) in 2002An20.
3383& 2	<0.1	12038.9	25/2 ⁺	8655.9	21/2 ⁺		Mult.: E2 in 2002An20.
3422 3	1.0 3	10865	23/2 ⁻	7443.1	21/2 ⁻	D+Q	DCO=0.61 12
3424 1	0.2 1	28133	53/2 ⁺	24708	49/2 ⁺	Q	DCO=0.93 15
3425 ^d 3	<0.1	11936.5	25/2 ⁻	8512	(21/2 ⁻)		Mult.: E2 in 2002An20.
3431 2	0.4 1	12243.6	25/2 ⁺	8812.2	23/2 ⁻	D	DCO=0.64 12
							Mult.: E1 in 2002An20.
3475 3	0.9 1	6921	(17/2 ⁻)	3445.48	13/2 ⁻	(Q)	DCO=0.90 18
3505 2	0.5 1	11120.7	23/2 ⁻	7614.7	21/2 ⁻	D+Q	DCO=0.39 14
3512 2	0.2 1	10118.6	21/2 ⁺	6608.9	19/2 ⁻		Mult.: E1 in 2002An20.
3539 3	0.2 1	26224	(49/2 ⁻)	22684.7	45/2 ⁻		Mult.: (E2) in 2002An20.
3561 2	2.0 5	12373.7	27/2 ⁻	8812.2	23/2 ⁻	Q	DCO=1.00 16
3586 3	0.3 1	10379.6	21/2 ⁺	6795.5	19/2 ⁺		Mult.: M1+E2 in 2002An20.
3607& 3	0.3 1	11719.6	25/2 ⁻	8111.8	21/2 ⁻		
3611 3	<0.1	10361.5	21/2 ⁺	6748.4	(17/2 ⁺)		Mult.: (E2) in 2002An20.
3615 3	0.4 1	10223.6	21/2 ⁺	6608.9	19/2 ⁻		Mult.: E1 in 2002An20.
3678 2	1.7 2	11120.7	23/2 ⁻	7443.1	21/2 ⁻	D+Q	DCO=0.19 5
							$\delta: -0.2 > \delta > -2.0$.
3743 3	<0.1	12552.3	27/2 ⁻	8812.2	23/2 ⁻		Mult.: E2 in 2002An20.
3748 2	0.6 1	9173.1	21/2 ⁺	5425.23	17/2 ⁺	Q	DCO=1.07 15
3753 ^a 2	0.8 5	10361.5	21/2 ⁺	6608.9	19/2 ⁻		Mult.: E1 in 2002An20.
3770 2	0.5 2	10379.6	21/2 ⁺	6608.9	19/2 ⁻		Mult.: E1 in 2002An20.
3802 2	0.8 3	11917.5	25/2 ⁺	8114.3	21/2 ⁺		Mult.: E2 in 2002An20.
3804 3	0.4 1	19834.3	(39/2 ⁺)	16030.3	35/2 ⁺		Mult.: (E2) in 2002An20.
3805 3	0.9 2	11248	23/2	7443.1	21/2 ⁻	D [#]	DCO=0.62 16
3827 1	<0.1	31960	(57/2 ⁺)	28133	53/2 ⁺		Mult.: (E2) in 2002An20.
3867 2	0.6 2	9291.9	21/2 ⁺	5425.23	17/2 ⁺	Q	DCO=0.87 13
3885 3	0.3 1	19915	(39/2 ⁺)	16030.3	35/2 ⁺	(Q)	DCO=1.05 39
3922 2	1.4 3	12038.9	25/2 ⁺	8114.3	21/2 ⁺	Q	DCO=1.11 10
3926 3	0.9 5	11369.7	25/2 ⁻	7443.1	21/2 ⁻	Q	DCO=0.85 21
4047 4	0.4 1	10655.7	21/2 ⁻	6608.9	19/2 ⁻		
4072 4	<0.1	10677.4	21/2 ⁻	6608.9	19/2 ⁻		Mult.: M1+E2 in 2002An20.
4095 3	0.5 1	14698.7		10603.5	27/2 ⁺		
4100 4	0.2 1	23529	(45/2 ⁻)	19429.1	41/2 ⁻		Mult.: (E2) in 2002An20.
4160 4	0.2 1	18678		14517.7	33/2		
4200 3	0.3 1	9624.3	21/2 ⁺	5425.23	17/2 ⁺		
4277 3	2.0 2	11719.6	25/2 ⁻	7443.1	21/2 ⁻	Q	DCO=0.94 11
4313 2	1.4 2	13127.1	27/2 ⁻	8812.2	23/2 ⁻	Q	DCO=0.97 11
4328 3	0.2 1	14698.7		10370.7	25/2 ⁻		
4420 3	<0.1	11214.8	(23/2 ⁺)	6795.5	19/2 ⁺		Mult.: (E2) in 2002An20.
4435 4	0.2 1	18953		14517.7	33/2		
4498 3	0.3 1	9921.6	21/2 ⁺	5425.23	17/2 ⁺		Mult.: E2 in 2002An20.
4523 4	0.2 1	17882		13358.6	31/2 ⁺		
4629 3	0.2 1	10677.4	21/2 ⁻	6048.1	17/2 ⁻		Mult.: E2 in 2002An20.
4716 2	0.8 2	10141.2	21/2 ⁺	5425.23	17/2 ⁺	Q	DCO=0.95 13
4931 2	<0.1	11982.2	23/2 ⁻	7051.5	19/2 ⁻		Mult.: E2 in 2002An20.
4937 4	0.3 1	10361.5	21/2 ⁺	5425.23	17/2 ⁺	Q	DCO=0.93 23
4957 4	0.2 1	10677.4	21/2 ⁻	5720.46	17/2 ⁻	Q	DCO=1.09 45

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(^{28}\text{Si},2\alpha p\gamma)$ [2002An20,2000An32](#) (continued)

$\gamma(^{59}\text{Cu})$ (continued)

† From DCO ratios by evaluator. [2002An20](#) list sign for the multipolarity. D+Q for E2/M1, Q for E2, and for other cases [2002An20](#) assignments are listed in comments sections along with cases for which no DCO ratios are reported in [2002An20](#).

‡ $\Delta J=0$ transition.

$\Delta J=1$ transition.

@ Sign has been reversed by the evaluator for ENSDF phase convention.

& From level-energy difference ([2002An20](#)).

^a doublet structure.

^b doublet with intense transitions in ^{57}Co or ^{58}Ni .

^c Multiply placed with intensity suitably divided.

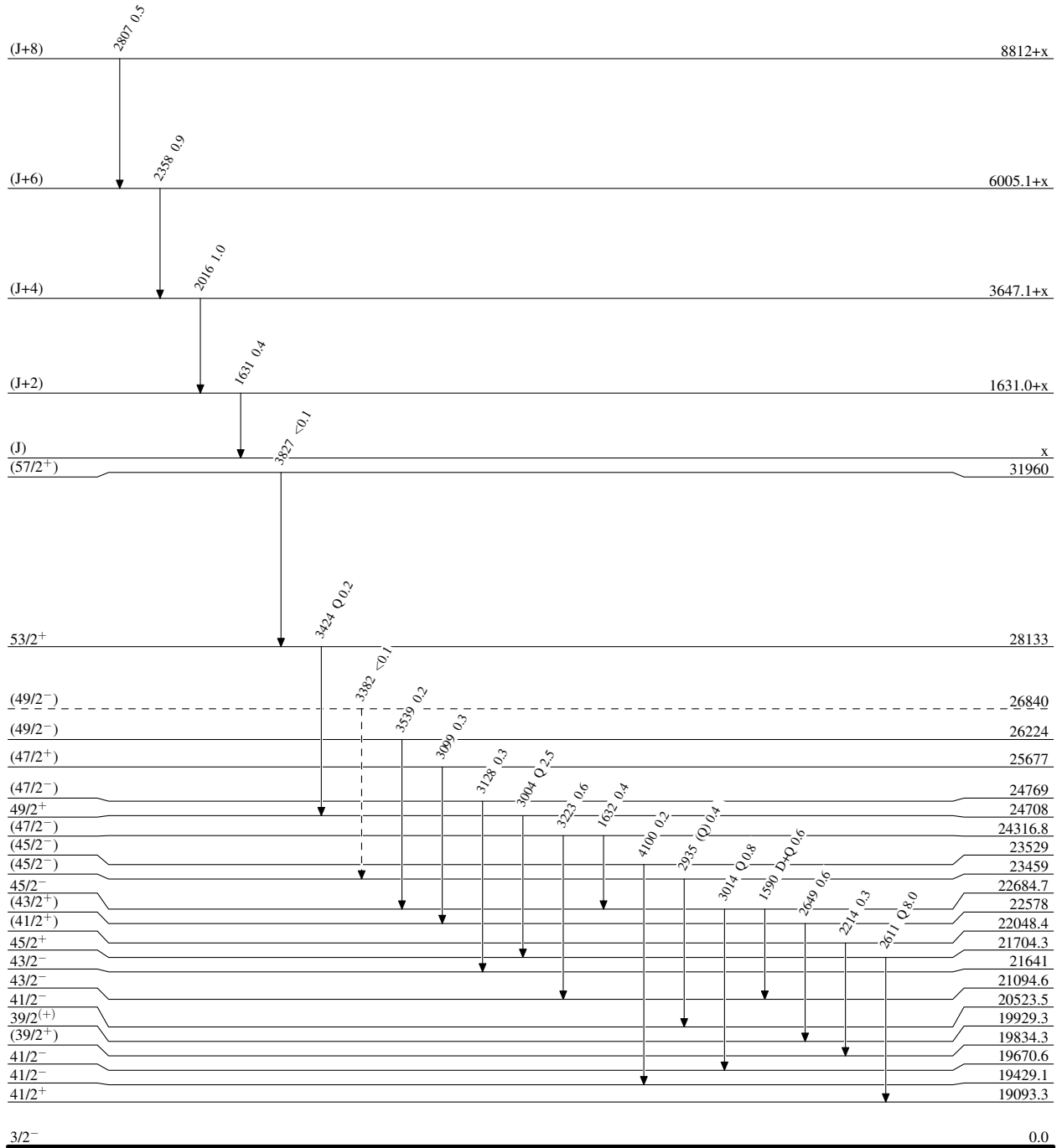
^d Placement of transition in the level scheme is uncertain.

⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Legend

Level Scheme
Intensities: Relative I_γ

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - -→ γ Decay (Uncertain)



⁵⁹Cu₃₀

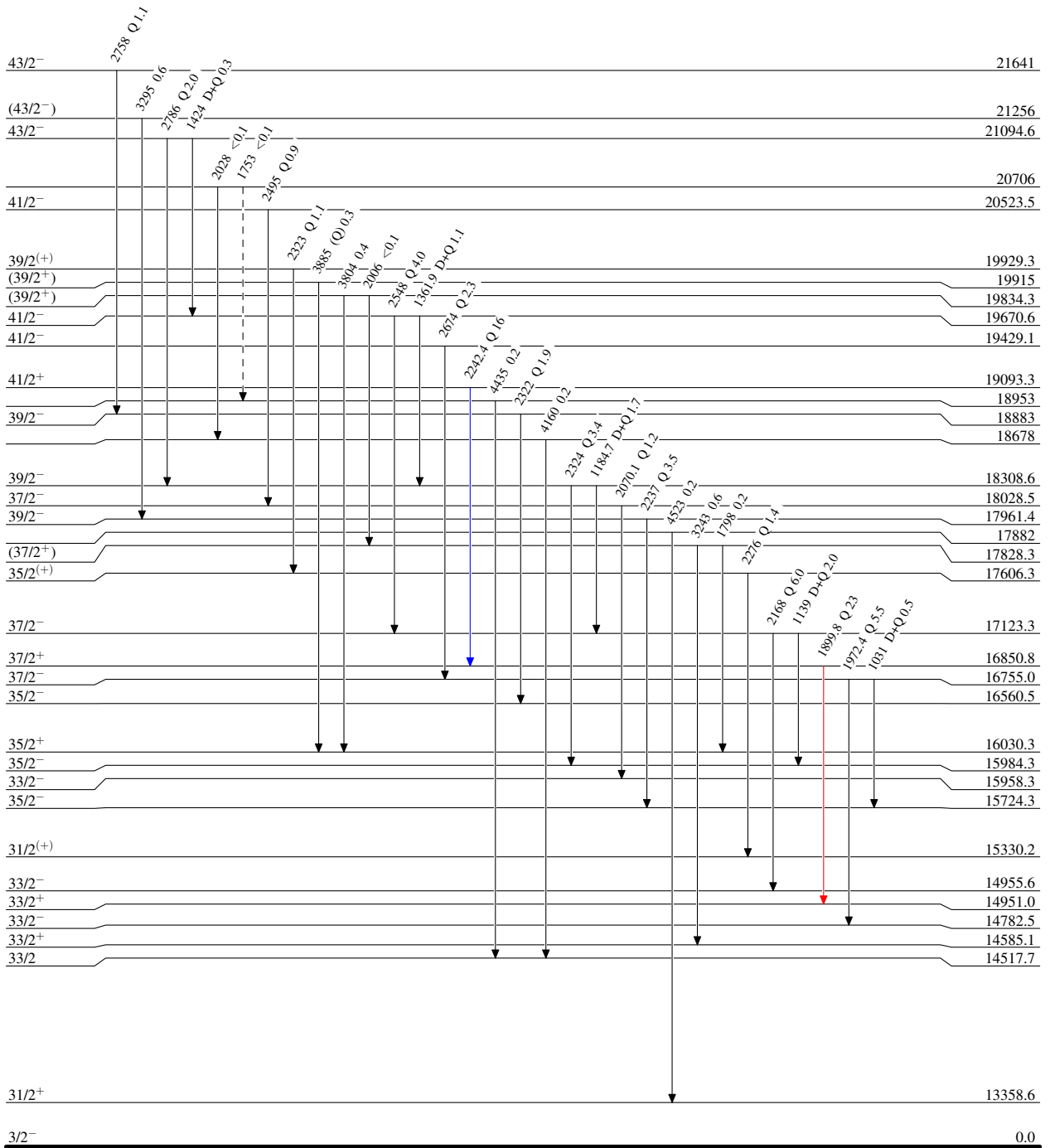
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Legend

Level Scheme (continued)

Intensities: Relative I_γ

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



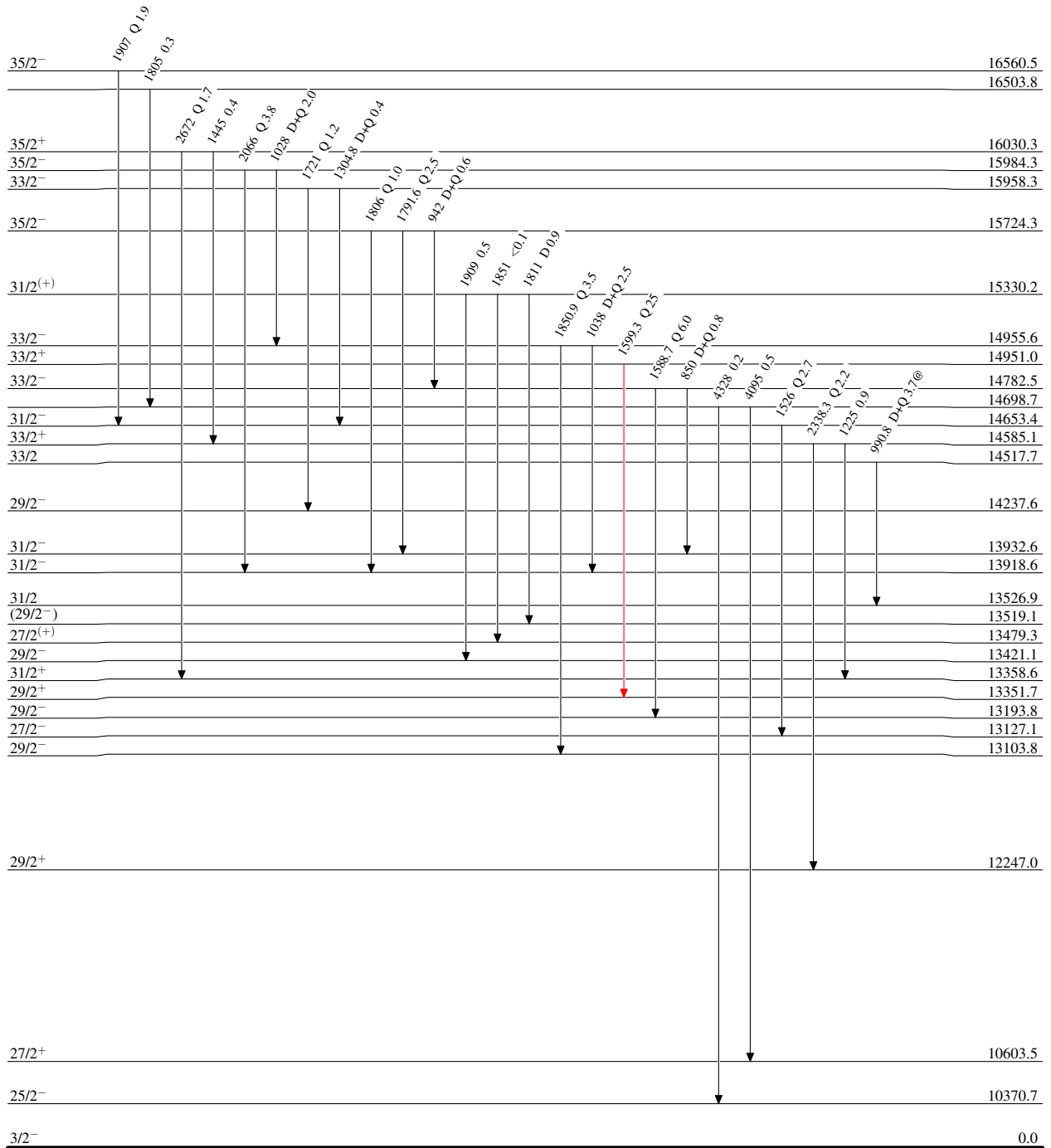
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Legend

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



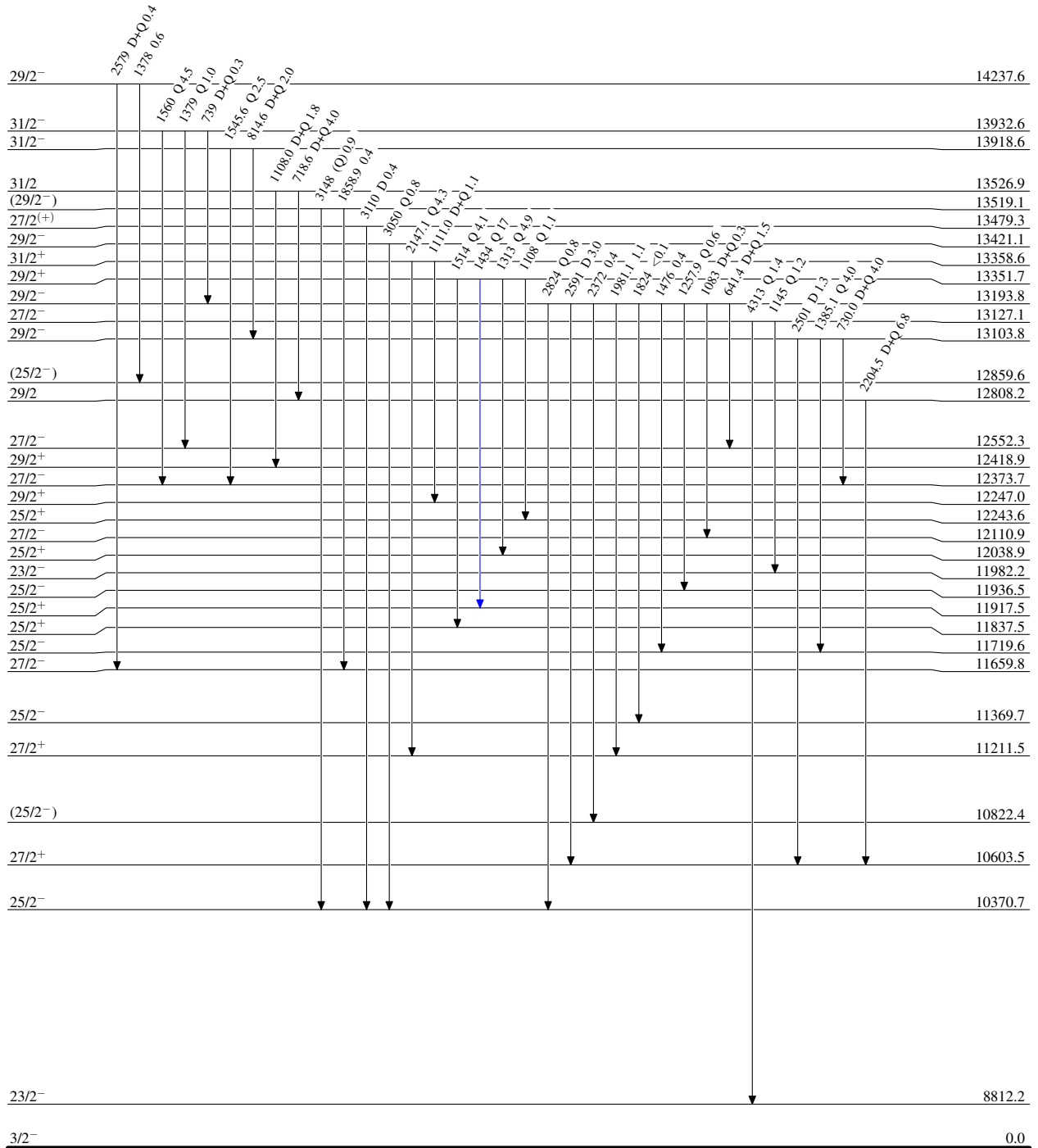
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Legend

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



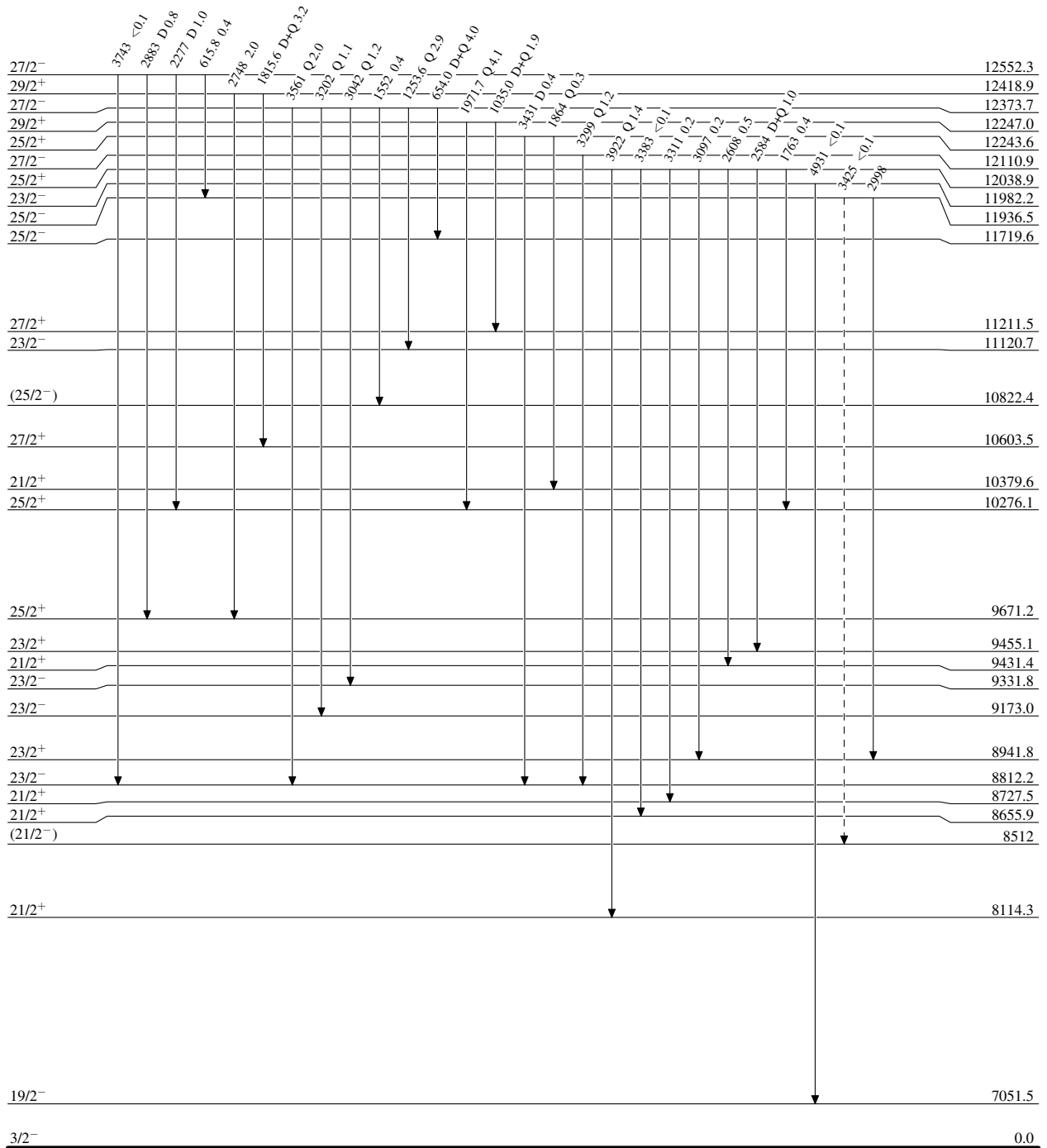
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



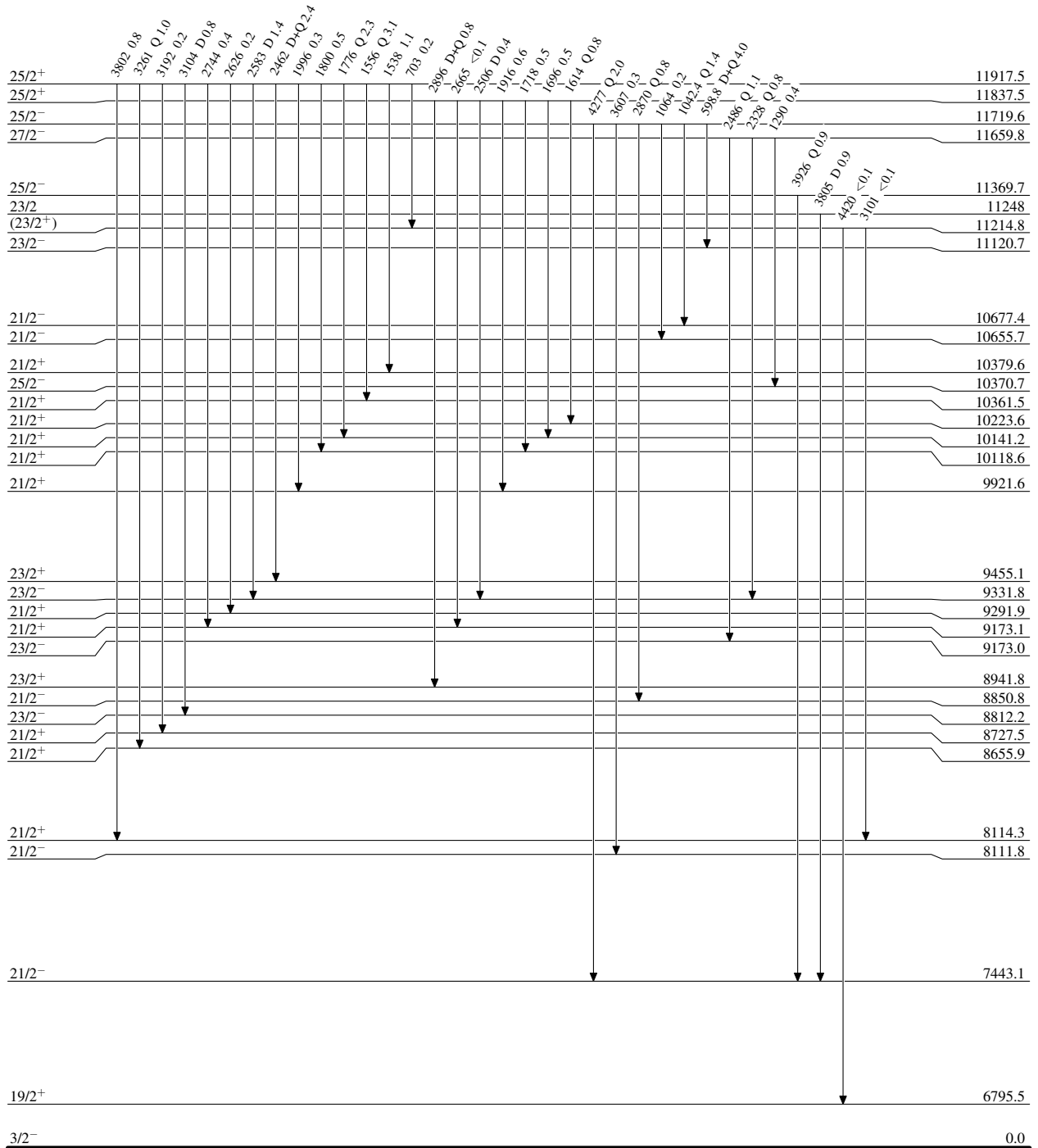
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Legend

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



⁵⁹Cu₃₀

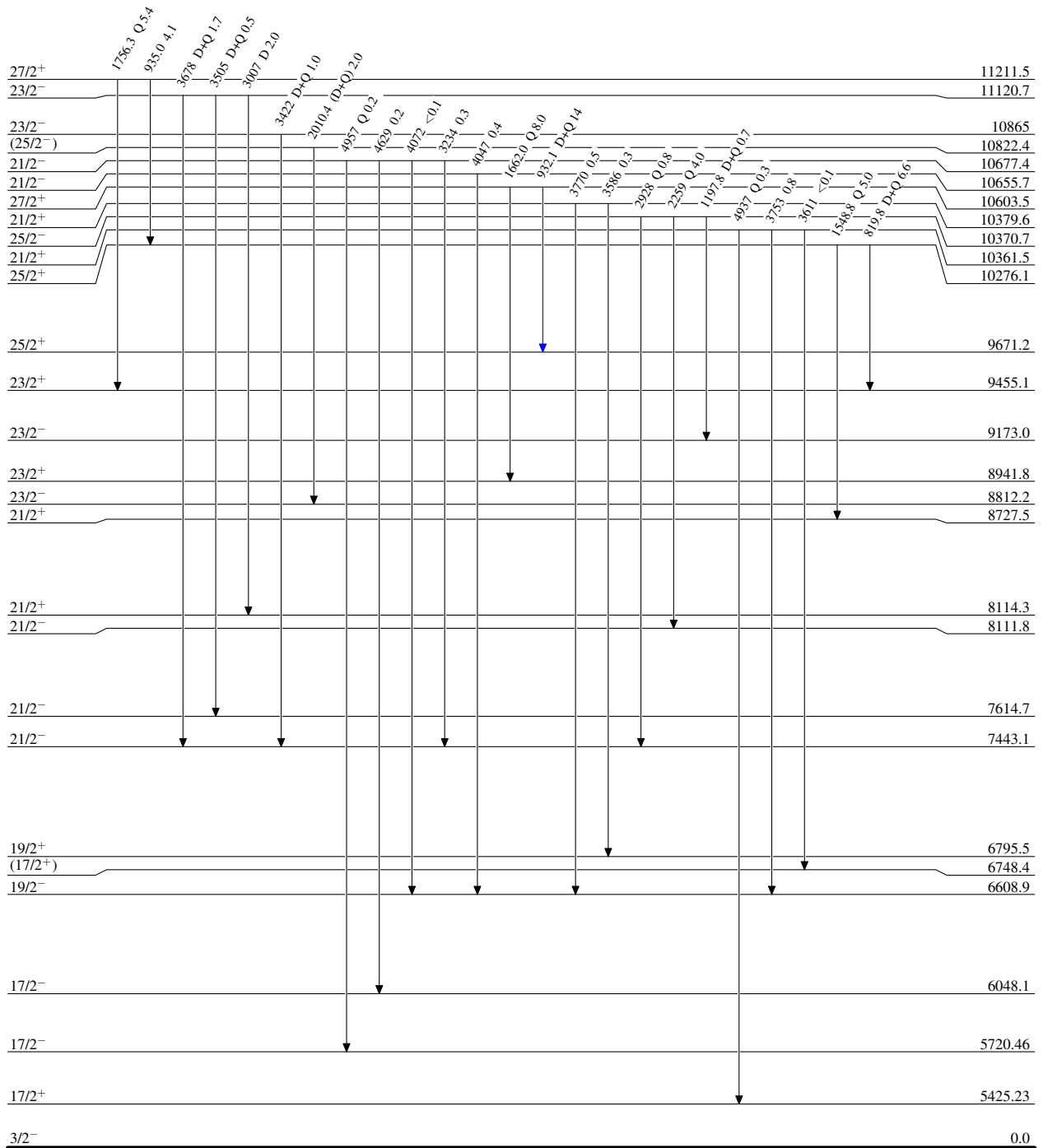
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Legend

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



⁵⁹Cu₃₀

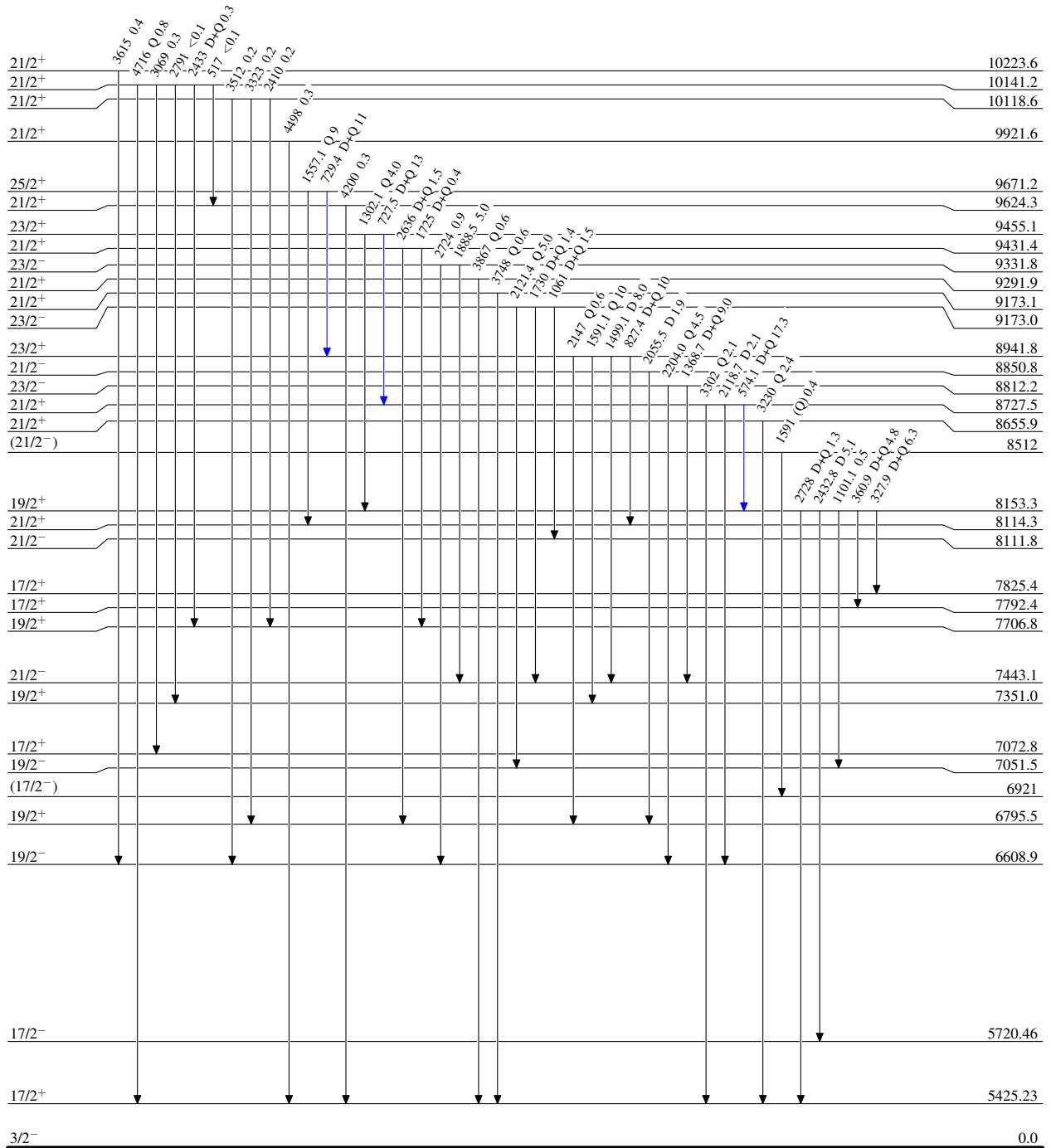
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Legend

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}



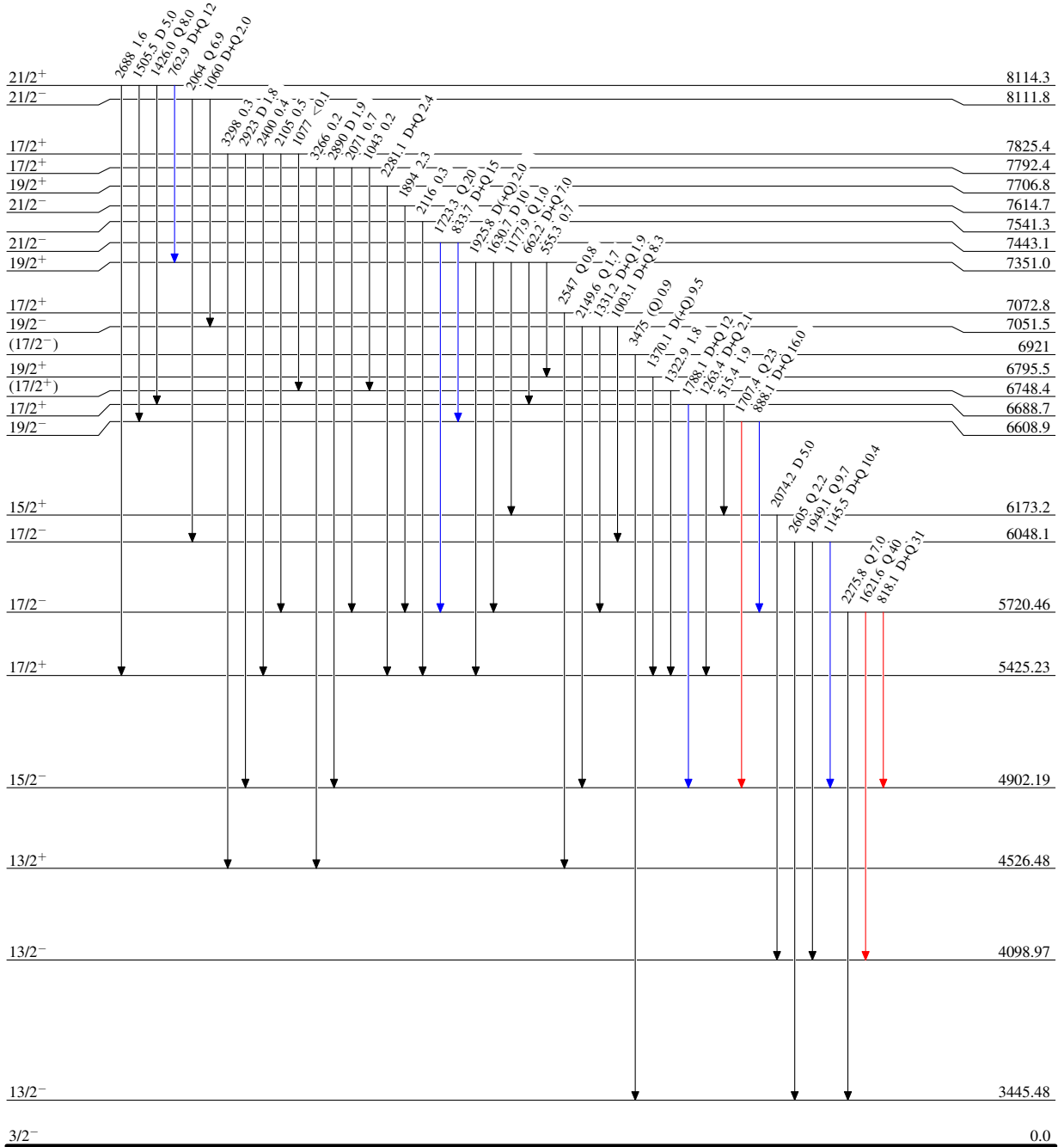
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32

Level Scheme (continued)

Legend

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

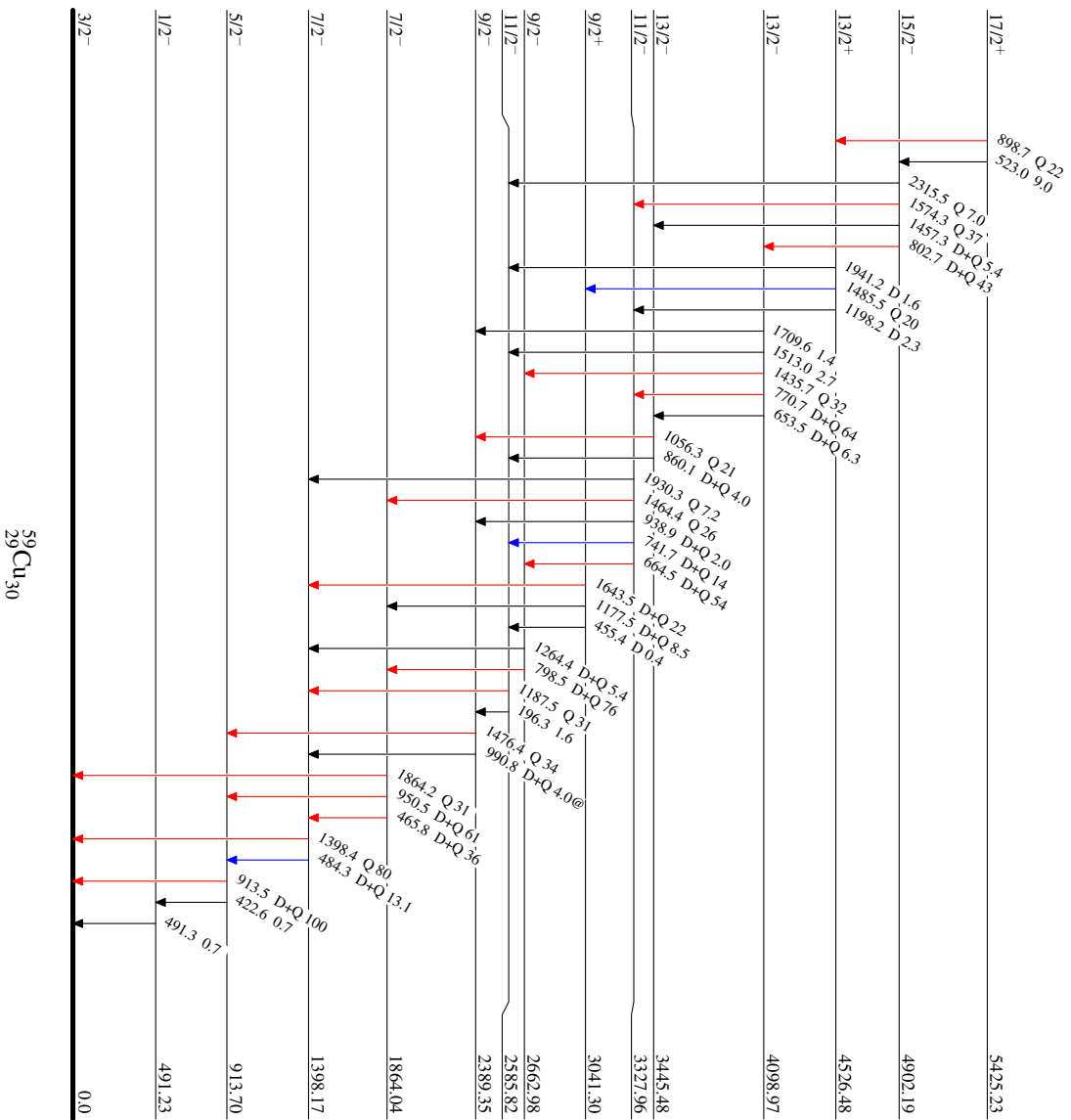
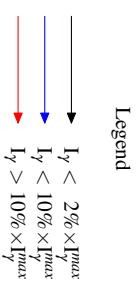
- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}

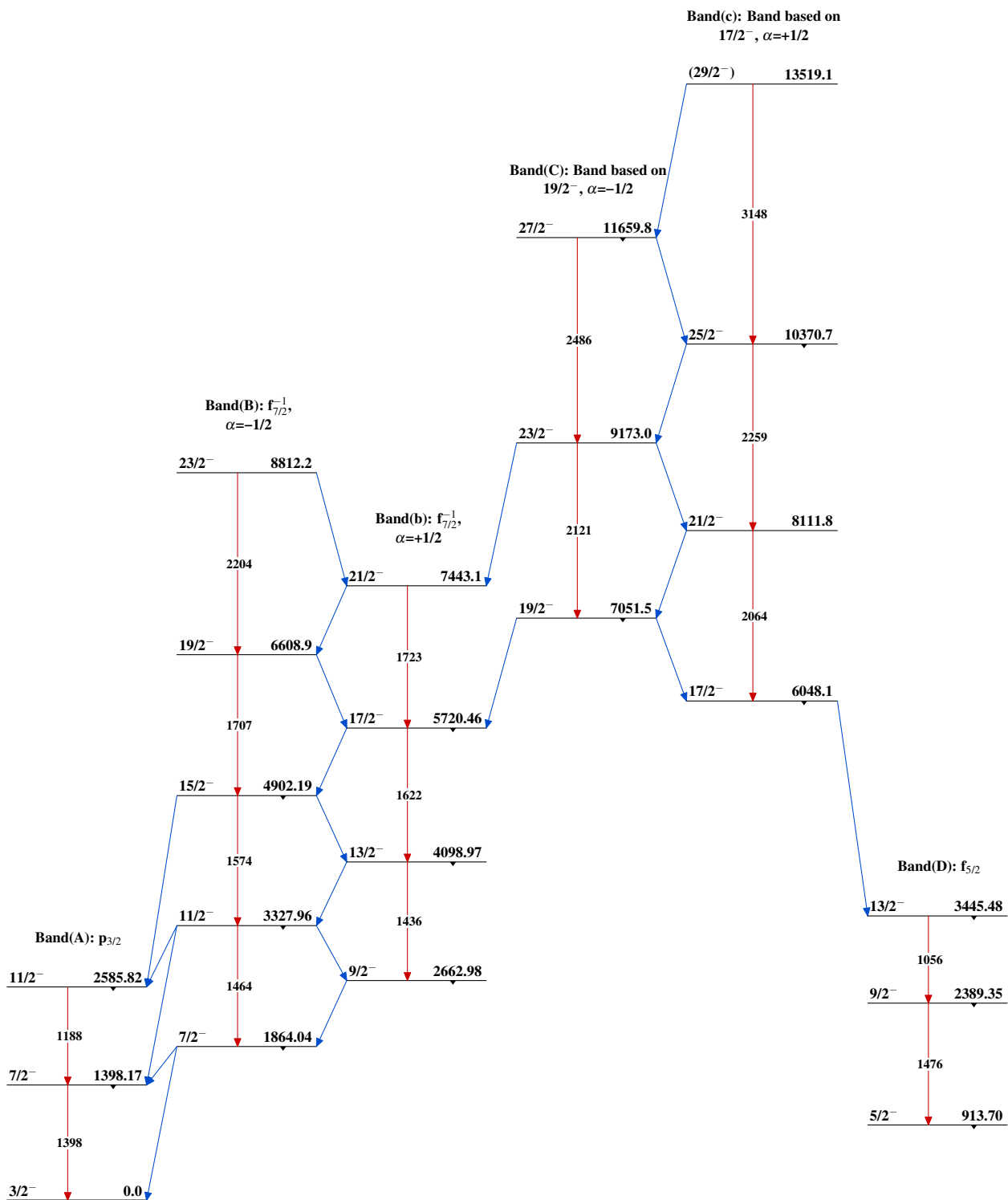


⁴⁰Ca(²⁸Si,2αpγ) **2002An20,2000An32**

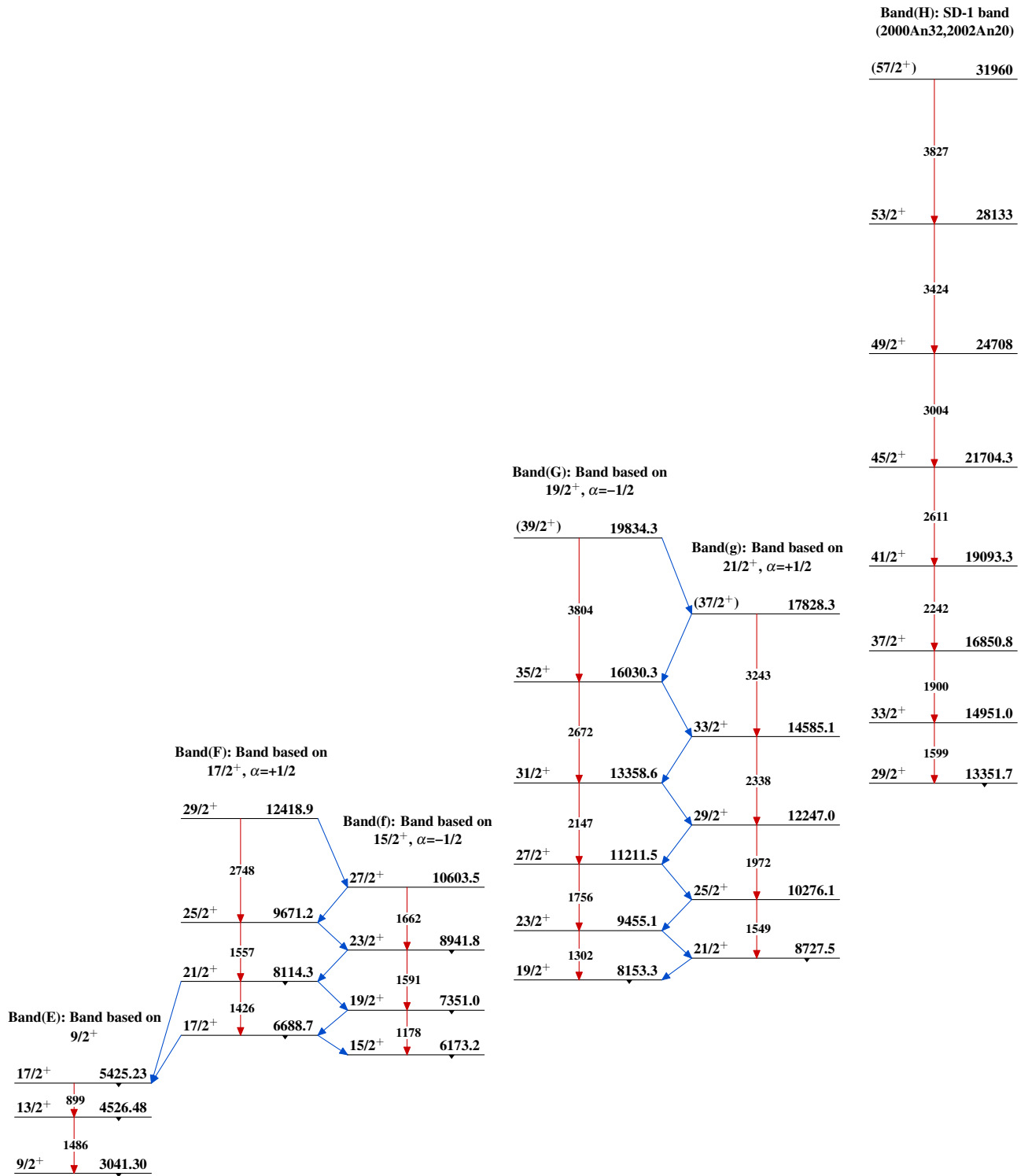
Level Scheme (continued)

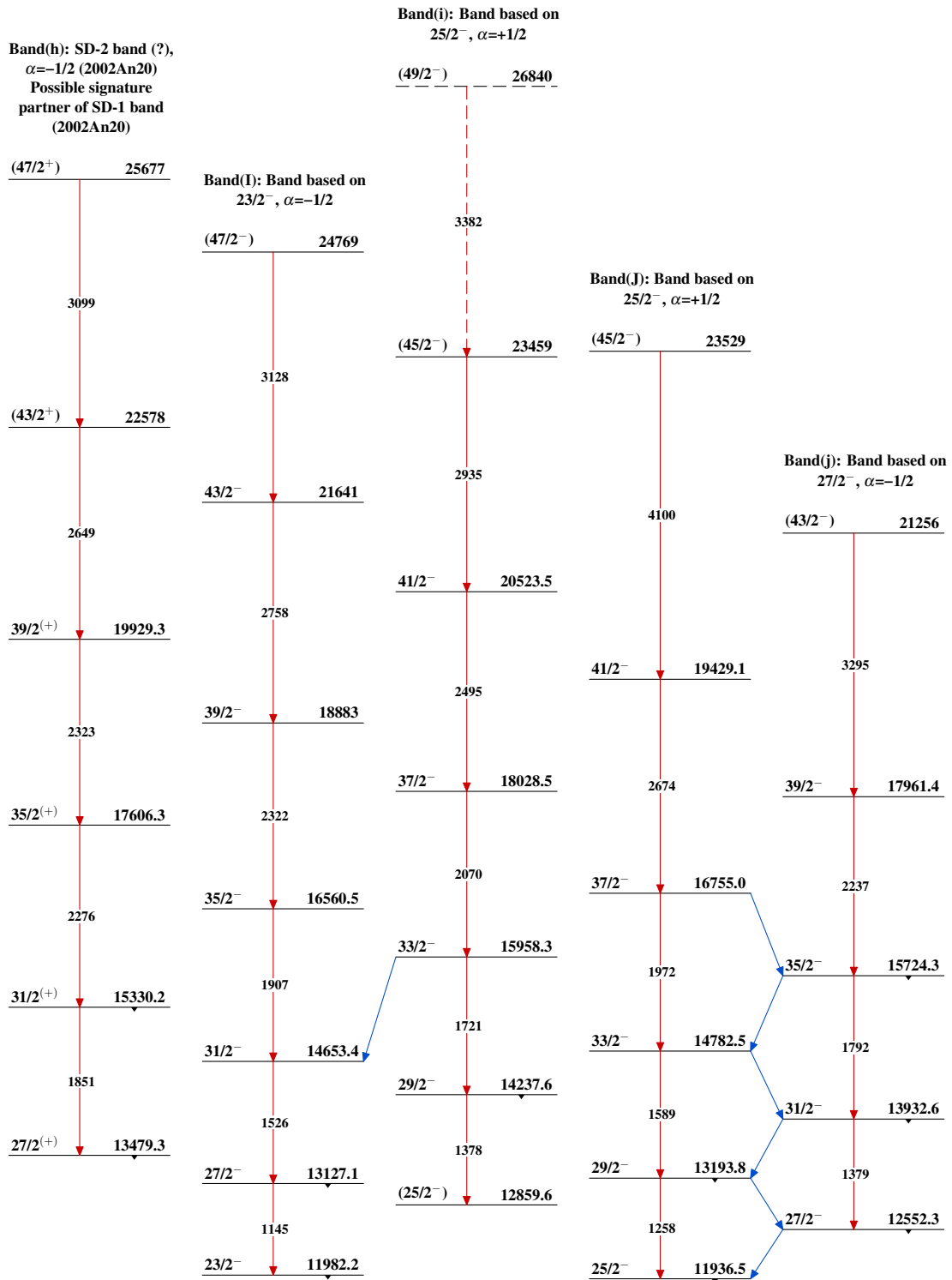
Intensities: Relative I_γ
 @ Multiply placed: intensity suitably divided



$^{40}\text{Ca}(^{28}\text{Si}, 2\alpha\gamma)$ 2002An20, 2000An32 $^{59}_{29}\text{Cu}_{30}$

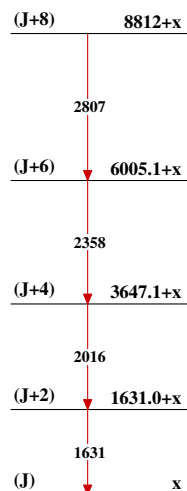
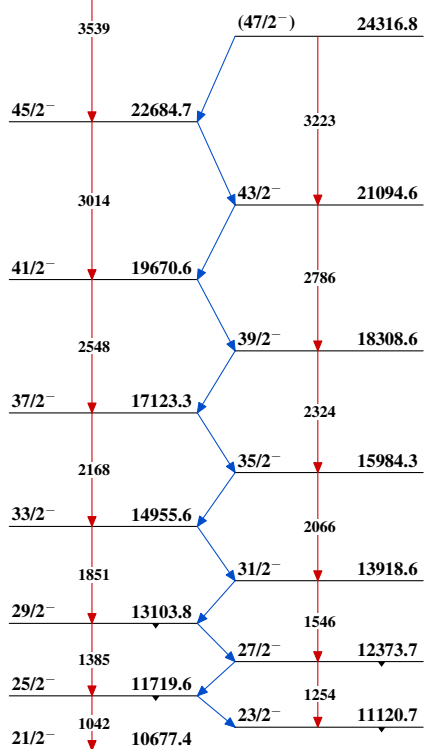
⁴⁰Ca(²⁸Si,2αpγ) 2002An20,2000An32 (continued)



$^{40}\text{Ca}(^{28}\text{Si}, 2\alpha p \gamma)$ 2002An20, 2000An32 (continued) $^{59}_{29}\text{Cu}_{30}$

$^{40}\text{Ca}(^{28}\text{Si}, 2\alpha\gamma)$ 2002An20,2000An32 (continued)

Band(L): Band structure

Band(K): Band based on
 $21/2^-$, $\alpha=+1/2$ (49/2⁻) 26224Band(k): Band based on
 $23/2^-$, $\alpha=-1/2$  $^{59}_{29}\text{Cu}_{30}$