

⁷¹Ga(n,n'γ) 1984Ar09,1977SmZI,1969Ve03

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

1984Ar09: E=reactor fast neutrons; enriched sample; measured γ(θ) for θ=90°, 110°, 135°, and 145°; Hauser-Feshbach analysis.

1977SmZI: E=reactor fast neutrons; measured E_γ, I_γ.

1969Ve03: E=0.4-2.5 MeV neutron beams from the University of Kentucky 5.5-MeV Van de Graaff. Target was natural sample of metallic Ga. Measured E_γ, I_γ, γ(θ), σ(E_n). Deduced levels, J from Hauser-Feshbach analysis.

1985KoZK: E=reactor fast neutrons; measured T_{1/2} DSAM. No details of this measurement are given in 1985KoZK.

⁷¹Ga Levels

| E(level) [†] | J ^π [‡] | T _{1/2} | Comments |
|-----------------------|-------------------------------------|-----------------------------|--|
| 0.0 | 3/2 ⁻ | | |
| 390.02 5 | 1/2 ⁻ | | J=1/2 (1984Ar09), 1/2 (1969Ve03). |
| 487.40 3 | 5/2 ⁻ | | J=5/2 (1969Ve03). |
| 511.45 3 | 3/2 ⁻ | | J=3/2 (1969Ve03). |
| 910.08 4 | 3/2 ⁻ | | J=3/2 (1984Ar09), 1/2 or 3/2 (1969Ve03). |
| 964.56 4 | 5/2 ⁻ | | J=7/2 (1969Ve03). |
| 1107.56 4 | 7/2 ⁻ | | J=7/2 or 9/2 (1969Ve03). |
| 1109.31 20 | 1/2 ⁻ | 0.13 [#] ps +8-4 | J=1/2 (1984Ar09). |
| 1395.12 5 | 7/2 ⁻ | | |
| 1475.94 4 | 5/2 ⁻ | | J=5/2 (1984Ar09). Without listing results of 1476γ(θ) data, 1984Ar09 exclude 7/2. |
| 1493.80 9 | 9/2 ⁺ | | J=9/2 or 7/2 with the requirement that J(1108) and J(1494) must differ by one unit (1969Ve03). |
| 1498.39 5 | 9/2 ⁻ | | J=5/2, 7/2 (1984Ar09). |
| 1631.21 5 | 3/2 ⁻ | 0.15 [#] ps +12-6 | |
| 1699.25 8 | 1/2 ⁺ | | J=1/2 (1984Ar09). |
| 1719.49 5 | 5/2 ⁻ | 0.10 [#] ps +5-2 | J=(5/2) (1984Ar09). |
| 1752.35 5 | 3/2 ⁻ | 0.26 [#] ps +24-10 | J=3/2 (1984Ar09). |
| 1905.37 5 | 5/2 ⁻ | 0.24 [#] ps +11-6 | J=5/2; γ(θ) excludes J=7/2 (1984Ar09). |
| 1941.80 11 | (3/2 ⁻) | | J=(3/2) (1984Ar09). |
| 2063.85 14 | 1/2 ⁻ , 3/2 ⁻ | | |
| 2134.17 5 | 5/2 ⁻ , 7/2 ⁻ | | J=5/2, 7/2 (1984Ar09). |
| 2247.50 8 | 7/2 ⁺ | 0.021 [#] ps +6-5 | J=7/2 (1984Ar09). |
| 2290.73 8 | 1/2 ⁻ | | J=1/2 (1984Ar09). |
| 2450.49 14 | 7/2 ⁺ | | J=7/2 (1984Ar09). |
| 2816.11 12 | 7/2 ⁺ | 0.19 [#] ps +13-6 | |

[†] From a least-squares fit to E_γ data. Several E_γ values are poorly fitted and are omitted in the fitting (very poor fit) or have their uncertainties increased, as noted in the E_γ table.

[‡] From the Adopted Levels. Supporting arguments from this data set which involve J determined from γ(θ) and Hauser-Feshbach analysis of level populations by 1984Ar09 and 1969Ve03 are given in comments.

[#] From DSAM (1985KoZK).

γ(⁷¹Ga)

| E _γ [†] | I _γ [@] | E _i (level) | J _i ^π | E _f | J _f ^π | Comments |
|-----------------------------|-----------------------------|------------------------|-----------------------------|----------------|-----------------------------|---|
| 121.54 8 | 4.8 4 | 511.45 | 3/2 ⁻ | 390.02 | 1/2 ⁻ | I _γ : 4.0 3 (1977SmZI). |
| 142.98 5 | 1.4 1 | 1107.56 | 7/2 ⁻ | 964.56 | 5/2 ⁻ | I _γ : 1.1 2 (1977SmZI). |
| 368.5 | 0.2 | 1475.94 | 5/2 ⁻ | 1107.56 | 7/2 ⁻ | |
| 386.50 16 | 9 | 1493.80 | 9/2 ⁺ | 1107.56 | 7/2 ⁻ | E _γ =368.50 in 1977SmZI seems a misprint, I _γ =14.2 9 (1977SmZI). |
| 389.92 8 | 37 4 | 390.02 | 1/2 ⁻ | 0.0 | 3/2 ⁻ | I _γ : 34 3 (1977SmZI). |

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⁷¹Ga(n,n'γ) 1984Ar09,1977SmZI,1969Ve03 (continued)

γ(⁷¹Ga) (continued)

| E _γ [†] | I _γ [@] | E _i (level) | J _i ^π | E _f | J _f ^π | Mult. ^a | δ ^a | Comments |
|-----------------------------|-----------------------------|------------------------|------------------------------------|----------------|-----------------------------|--------------------|----------------|---|
| 398.58 5 | 1.3 2 | 910.08 | 3/2 ⁻ | 511.45 | 3/2 ⁻ | | | |
| 430.10 [#] 5 | 1.8 2 | 1395.12 | 7/2 ⁻ | 964.56 | 5/2 ⁻ | | | I _γ : 1.8 3 (1977SmZI). |
| 453.12 5 | 8.1 2 | 964.56 | 5/2 ⁻ | 511.45 | 3/2 ⁻ | | | I _γ : 8.1 8 (1977SmZI). |
| 487.41 5 | 100 10 | 487.40 | 5/2 ⁻ | 0.0 | 3/2 ⁻ | D(+Q) | +0.03 4 | A ₂ =-0.08 2; A ₄ =-0.004 4 (1984Ar09) A ₂ =-0.11 5; A ₄ =-0.07 2 (1969Ve03) I _γ : 100 (1977SmZI). I _γ : 63 4 (1977SmZI). |
| 511.60 9 | 60 6 | 511.45 | 3/2 ⁻ | 0.0 | 3/2 ⁻ | | | I _γ : 63 4 (1977SmZI). |
| 546.57 14 | 0.14 ^{&} 2 | 1941.80 | (3/2 ⁻) | 1395.12 | 7/2 ⁻ | | | I _γ : 0.2 (1984Ar09). |
| 565.82 5 | 1.1 1 | 1475.94 | 5/2 ⁻ | 910.08 | 3/2 ⁻ | | | I _γ : 1.1 2 (1977SmZI). |
| 574.17 15 | 1.7 2 | 964.56 | 5/2 ⁻ | 390.02 | 1/2 ⁻ | | | |
| 588.34 ^c 5 | 1.4 1 | 1498.39 | 9/2 ⁻ | 910.08 | 3/2 ⁻ | | | This γ is placed from 2082 level in β ⁻ decay (4.140 h) and in the Adopted Gammas. Placement from 1498, 9/2 ⁻ level to 910, 3/2 ⁻ level in 1984Ar09 is highly unlikely with the currently adopted J ^π values, thus treated as questionable placement by evaluators. |
| 596.21 5 | 7 1 | 1107.56 | 7/2 ⁻ | 511.45 | 3/2 ⁻ | | | I _γ : 1.4 2 (1977SmZI). I _γ : 10.6 8 (1977SmZI). |
| ^x 612.63 9 | 0.14 ^{&} 2 | | | | | | | |
| 620.18 5 | 14.0 10 | 1107.56 | 7/2 ⁻ | 487.40 | 5/2 ⁻ | (M1+E2) | +1.2 2 | A ₂ =+0.44 3; A ₄ =+0.04 4 (1984Ar09) A ₂ =+0.41 11 (1969Ve03) I _γ : 15.7 9 (1977SmZI). |
| 635.70 10 | 0.2 | 2134.17 | 5/2 ⁻ ,7/2 ⁻ | 1498.39 | 9/2 ⁻ | | | |
| ^x 644.13 10 | 0.29 ^{&} 3 | | | | | | | |
| 666.74 6 | 1.1 1 | 1631.21 | 3/2 ⁻ | 964.56 | 5/2 ⁻ | | | I _γ : 1.1 2 (1977SmZI). |
| ^x 684.02 6 | 0.76 ^{&} 7 | | | | | | | |
| 721.05 11 | 0.29 ^{&} 3 | 1631.21 | 3/2 ⁻ | 910.08 | 3/2 ⁻ | | | I _γ : 0.3 (1984Ar09). |
| 753.72 5 | 2.2 ^{&} 2 | 2247.50 | 7/2 ⁺ | 1493.80 | 9/2 ⁺ | | | |
| 771.18 [‡] 6 | 1.0 1 | 2247.50 | 7/2 ⁺ | 1475.94 | 5/2 ⁻ | | | E _γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=771.55. I _γ : 0.24 2 (1977SmZI) is discrepant. |
| 788.06 [‡] 6 | 1.1 1 | 1752.35 | 3/2 ⁻ | 964.56 | 5/2 ⁻ | | | E _γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=787.78. I _γ : 0.82 9 (1977SmZI). |
| 797.82 7 | 0.19 ^{&} 3 | 1905.37 | 5/2 ⁻ | 1107.56 | 7/2 ⁻ | | | I _γ : 0.2 from 1984Ar09. |
| 883.69 6 | 0.7 1 | 1395.12 | 7/2 ⁻ | 511.45 | 3/2 ⁻ | | | I _γ : 0.71 8 (1977SmZI). |
| 907.6 2 | 2.0 4 | 1395.12 | 7/2 ⁻ | 487.40 | 5/2 ⁻ | | | I _γ : 5.7 6 (1977SmZI) is discrepant. |
| 910.3 2 | 27 3 | 910.08 | 3/2 ⁻ | 0.0 | 3/2 ⁻ | | | I _γ : 23 2 (1977SmZI). |
| ^x 922.64 19 | 0.11 ^{&} 2 | | | | | | | |
| 940.70 7 | 0.6 1 | 1905.37 | 5/2 ⁻ | 964.56 | 5/2 ⁻ | | | I _γ : 0.65 6 (1977SmZI). |
| 959 | 0.6 3 | 2450.49 | 7/2 ⁺ | 1493.80 | 9/2 ⁺ | | | |
| 964.6 | 1.6 3 | 1475.94 | 5/2 ⁻ | 511.45 | 3/2 ⁻ | | | |
| 964.62 6 | 24.4 20 | 964.56 | 5/2 ⁻ | 0.0 | 3/2 ⁻ | (M1+E2) | +1.3 3 | A ₂ =+0.23 3; A ₄ =+0.002 2 (1984Ar09) A ₂ =+0.19 2 (1969Ve03) I _γ : 26 3 (1977SmZI). |
| 976.95 ^{b#} 6 | 2.1 ^b 2 | 1941.80 | (3/2 ⁻) | 964.56 | 5/2 ⁻ | | | I _γ : 2.1 3 (1977SmZI). |
| 976.95 ^{b#} 6 | 2.1 ^b 2 | 2450.49 | 7/2 ⁺ | 1475.94 | 5/2 ⁻ | | | |
| 988.57 6 | 4.1 4 | 1475.94 | 5/2 ⁻ | 487.40 | 5/2 ⁻ | D+Q | +0.10 5 | A ₂ =+0.14 2; A ₄ =-0.04 2 (1984Ar09) |

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⁷¹Ga(n,n'γ) 1984Ar09,1977SmZI,1969Ve03 (continued)

γ(⁷¹Ga) (continued)

| E _γ [†] | I _γ [@] | E _i (level) | J _i ^π | E _f | J _f ^π | Mult. ^a | δ ^a | Comments |
|-----------------------------|-----------------------------|------------------------|------------------------------------|----------------|-----------------------------|--------------------|----------------|---|
| 1010.92 6 | 7.4 7 | 1498.39 | 9/2 ⁻ | 487.40 | 5/2 ⁻ | | | |
| 1026.69 6 | 1.1 1 | 2134.17 | 5/2 ⁻ ,7/2 ⁻ | 1107.56 | 7/2 ⁻ | | | I _γ : 1.1 2 (1977SmZI). |
| ^x 1034.54 9 | 0.19& 2 | | | | | | | |
| ^x 1083.41 9 | 1.5& 2 | | | | | | | |
| 1107.6 2 | 0.5 | 1107.56 | 7/2 ⁻ | 0.0 | 3/2 ⁻ | | | A ₂ =+0.08 1 (1969Ve03) I _γ : 3.2 3 (1977SmZI) is discrepant. I _γ : 3.8 4 (1977SmZI) is discrepant. |
| 1109.3 2 | 7.0 7 | 1109.31 | 1/2 ⁻ | 0.0 | 3/2 ⁻ | | | |
| 1119.69 6 | 2.2 2 | 1631.21 | 3/2 ⁻ | 511.45 | 3/2 ⁻ | | | |
| 1139.95 8 | 0.7 1 | 2247.50 | 7/2 ⁺ | 1107.56 | 7/2 ⁻ | | | I _γ : branching is too high by a factor of ≈5 as compared to β ⁻ decay data, value not used in Adopted Gammas. In the opinion of the evaluators, either the intensity of this γ ray in 1984Ar09 is incorrect or there is an alternate placement of 1139.95γ. Other: 0.73 7 (1977SmZI). |
| 1169.34‡ 7 | 1.0 1 | 2134.17 | 5/2 ⁻ ,7/2 ⁻ | 964.56 | 5/2 ⁻ | | | E _γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1169.59. I _γ : 1.1 2 (1977SmZI). I _γ : 0.81 9 (1977SmZI). |
| 1188.2 2 | 1.3 2 | 1699.25 | 1/2 ⁺ | 511.45 | 3/2 ⁻ | | | Placed from a 1702.9 level in 1977SmZI. |
| ^x 1191.4 2 | 0.81& 9 | | | | | | | I _γ : 1.1 2 (1977SmZI). I _γ : 0.68 8 (1977SmZI). |
| 1208.06 7 | 0.7 1 | 1719.49 | 5/2 ⁻ | 511.45 | 3/2 ⁻ | | | |
| 1232.09 7 | 1.1 1 | 1719.49 | 5/2 ⁻ | 487.40 | 5/2 ⁻ | | | |
| 1240.83‡ 6 | 1.2 1 | 1631.21 | 3/2 ⁻ | 390.02 | 1/2 ⁻ | | | E _γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1241.18. I _γ : branching is too high by a factor of ≈30 as compared to β ⁻ decay data, value not used in Adopted Gammas. In the opinion of the evaluators, either the intensity of this γ ray in 1984Ar09 is incorrect or there is an alternate placement of 1240.83γ. Other: 1.2 2 (1977SmZI). |
| ^x 1249.2 2 | 0.14& 2 | | | | | | | |
| 1264.89 6 | 2.6 3 | 1752.35 | 3/2 ⁻ | 487.40 | 5/2 ⁻ | | | |
| ^x 1280.6 2 | 0.29& 4 | | | | | | | |
| ^x 1309.00 10 | 0.76& 8 | | | | | | | |
| 1322.30 9 | 0.40 5 | 2816.11 | 7/2 ⁺ | 1493.80 | 9/2 ⁺ | | | I _γ : 0.40 4 (1977SmZI). |
| ^x 1348.67 11 | 0.29& 4 | | | | | | | |
| 1362.29 7 | 0.9 1 | 1752.35 | 3/2 ⁻ | 390.02 | 1/2 ⁻ | (M1+E2) | +1.5 5 | I _γ : 0.92 8 (1977SmZI). |
| 1380.64 7 | 1.1 1 | 2290.73 | 1/2 ⁻ | 910.08 | 3/2 ⁻ | | | I _γ : 1.1 2 (1977SmZI). |
| 1395.05 7 | 5.8 6 | 1395.12 | 7/2 ⁻ | 0.0 | 3/2 ⁻ | Q | | A ₂ =+0.25 2; A ₄ =-0.04 2 (1984Ar09) I _γ : 5.3 5 (1977SmZI). |
| 1418.07 7 | 2.0 2 | 1905.37 | 5/2 ⁻ | 487.40 | 5/2 ⁻ | | | |
| 1454.52 15 | 0.11& 2 | 1941.80 | (3/2 ⁻) | 487.40 | 5/2 ⁻ | | | I _γ : 0.1 (1984Ar09). |
| 1475.90 7 | 3.1 3 | 1475.94 | 5/2 ⁻ | 0.0 | 3/2 ⁻ | | | I _γ : 2.8 2 (1977SmZI). 1984Ar09 state that γ(θ) is not consistent with 7/2 to 3/2, pure quadrupole transition, but the authors do not list any data for angular distributions. |

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⁷¹Ga(n,n'γ) 1984Ar09,1977SmZI,1969Ve03 (continued)

γ(⁷¹Ga) (continued)

| E _γ [†] | I _γ [@] | E _i (level) | J _i ^π | E _f | J _f ^π | Mult. ^a | δ ^a | Comments |
|-----------------------------|-----------------------------|------------------------|------------------------------------|----------------|-----------------------------|--------------------|----------------|---|
| 1485.86 14 | 0.19& 2 | 2450.49 | 7/2 ⁺ | 964.56 | 5/2 ⁻ | | | E _γ ,I _γ : not reported in 1984Ar09. |
| ^x 1503.27 7 | 2.9& 3 | | | | | | | |
| ^x 1537.04 8 | 0.84& 9 | | | | | | | |
| 1552.3 2 | 0.1 | 2063.85 | 1/2 ⁻ ,3/2 ⁻ | 511.45 | 3/2 ⁻ | | | I _γ : 0.33 4 (1977SmZI) is discrepant. |
| ^x 1594.9 2 | 0.43& 4 | | | | | | | |
| 1631.42‡ 10 | 0.5 1 | 1631.21 | 3/2 ⁻ | 0.0 | 3/2 ⁻ | | | E _γ : uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1631.19. I _γ : 0.46 5 (1977SmZI). I _γ : 0.87 8 (1977SmZI). |
| 1646.69 8 | 0.9 1 | 2134.17 | 5/2 ⁻ ,7/2 ⁻ | 487.40 | 5/2 ⁻ | | | |
| ^x 1665.2 3 | 0.24& 4 | | | | | | | |
| ^x 1691.4 3 | 0.11& 2 | | | | | | | Placed from a 2601.6 level in 1977SmZI. |
| 1699.16 8 | 1.8 2 | 1699.25 | 1/2 ⁺ | 0.0 | 3/2 ⁻ | | | I _γ : 1.27 8 (1977SmZI). |
| 1719.38 9 | 1.1 1 | 1719.49 | 5/2 ⁻ | 0.0 | 3/2 ⁻ | (M1+E2) | +1.4 5 | I _γ : 1.1 2 (1977SmZI). |
| ^x 1739.8 3 | 0.24& 3 | | | | | | | |
| ^x 1778.87 10 | 0.62& 5 | | | | | | | |
| 1904.83‡ 9 | 2.2 4 | 1905.37 | 5/2 ⁻ | 0.0 | 3/2 ⁻ | (M1+E2) | +0.8 3 | E _γ : uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=1905.34. I _γ : 2.2 9 (1977SmZI). |
| ^x 1923.60 17 | 0.14& 2 | | | | | | | |
| ^x 1933.4 2 | 0.19& 3 | | | | | | | |
| ^x 2041.7 2 | 0.49& 6 | | | | | | | |
| ^x 2049.3 3 | 0.49& 6 | | | | | | | |
| 2063.9 2 | 0.5 1 | 2063.85 | 1/2 ⁻ ,3/2 ⁻ | 0.0 | 3/2 ⁻ | | | I _γ : 0.43 5 (1977SmZI). |
| ^x 2105.26 11 | 1.25& 9 | | | | | | | |
| 2134.19 13 | 0.6 1 | 2134.17 | 5/2 ⁻ ,7/2 ⁻ | 0.0 | 3/2 ⁻ | | | I _γ : 0.65 6 (1977SmZI). |
| ^x 2169.66 13 | 0.65& 6 | | | | | | | |

† From 1977SmZI where uncertainties are given; otherwise, data are from 1984Ar09. The placement of the γ rays follows 1984Ar09 and differs from 1977SmZI in some cases; no ΔEγ is given in 1984Ar09.

‡ Poor fit; uncertainty multiplied by a factor in the fitting as noted under comments.

Very poor fit; γ omitted in the fitting.

@ Relative intensities at θ=90° from 1984Ar09, unless otherwise noted. Values in 1977SmZI from the same lab as 1984Ar09 are assumed to be superseded by those in 1984Ar09 where available and are given under comments, unless otherwise noted.

& From 1977SmZI.

^a From γ(θ) in 1984Ar09. A₂ and A₄ coefficients are listed by 1984Ar09 only for five γ rays but not for 1719γ, 1362γ and 1905γ. Sign convention not specified but probably Krane-Steffen.

^b Multiply placed with undivided intensity.

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




^x γ ray not placed in level scheme.

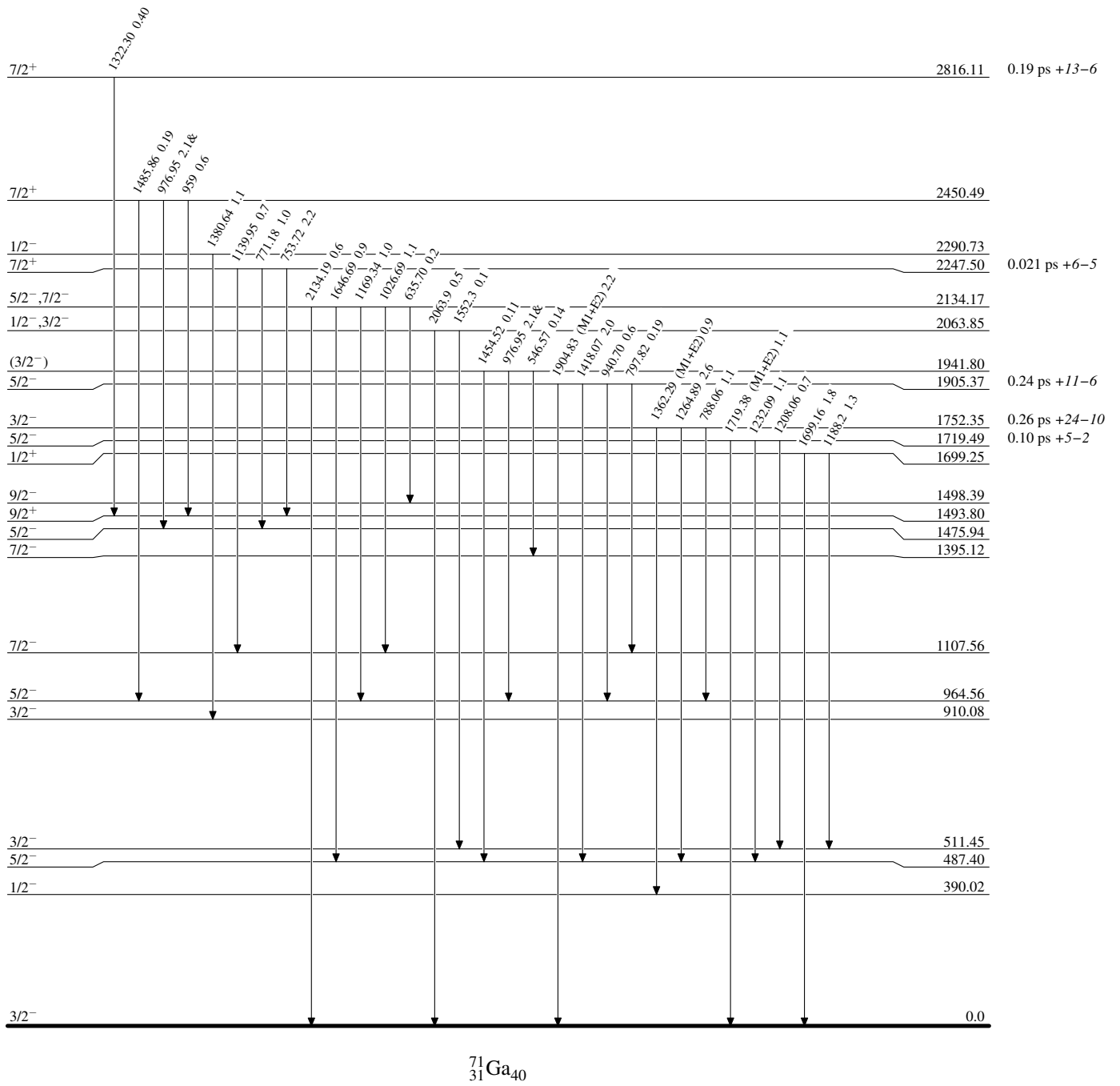
${}^{71}\text{Ga}(n,n'\gamma)$ 1984Ar09,1977SmZI,1969Ve03

Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

 $I_\gamma < 2\% \times I_\gamma^{\max}$
 $I_\gamma < 10\% \times I_\gamma^{\max}$
 $I_\gamma > 10\% \times I_\gamma^{\max}$



$^{71}\text{Ga}(n,n'\gamma)$ 1984Ar09,1977SmZI,1969Ve03

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)

