## $^{139}$Pm ε decay (4.15 min) 1977De06

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | P. K. Joshi, B. Singh, S. Singh, A. K. Jain | NDS 138, 1 (2016) | 15-Oct-2016 |

Parent: $^{139}$Pm: E=0.0; $J^\pi=(5/2)^+$; $T_{1/2}$=4.15 min *5*; Q(ε)=4514 *26*; %ε+%$β^+$ decay=100.0

$^{139}$Pm-Q(ε): From 2012Wa38.

1977De06: measured: γ's, γγ-coincidences, and γ(t), ce (Si(Li)), βγ-coincidences (E/ΔE telescope, Ge(Li)).

Others: 1973VaYZ, 1971Va22, 1968Bl14.

### $^{139}$Nd Levels

| E(level) | $J^\pi$† | Comments |
|---|---|---|
| 0.0 | $3/2^+$ | %ε+%$β^+$=100 |
| 95.31 *9* | $(1/2)^+$ | |
| 402.77 *11* | $(3/2,5/2)^+$ | |
| 463.10 *12* | $(3/2)^+$ | |
| 675.46 *18* | $(3/2,5/2^+)$ | |
| 756.45 *18* | $(3/2,5/2^+)$ | |
| 815.66 *17* | $(3/2,5/2,7/2^+)$ | |
| 932.89 *19* | $(7/2^-)$ | |
| 981.45 *21* | | |
| 1066.2 *4* | | |
| 1105.0 *3* | | |
| 1282.1 *5* | | |
| 1319.5 *5* | | |
| 2021.43 *17* | | |
| 2107.56 *14* | $(3/2,5/2,7/2)^+$ | |
| 2240.56 *20* | | |
| 2261.27 *20* | | |
| 2289.0 *3* | | |
| 2340.08 *21* | | |
| 2359.30 *24* | | |

† From the Adopted Levels.

### ε,$β^+$ radiations

| E(decay) | E(level) | I$β^+$ # | Iε# | Log *ft* | I(ε+$β^+$)†# | Comments |
|---|---|---|---|---|---|---|
| (2.15×10$^3$ *3*) | 2359.30 | 0.031 *7* | 0.37 *7* | 6.29 *9* | 0.40 *8* | av Eβ=513 *14*; εK=0.780 *6*; εL=0.1115 *9*; εM+=0.03189 *25* |
| (2.17×10$^3$ *3*) | 2340.08 | 0.020 *5* | 0.23 *6* | 6.5 *1* | 0.25 *6* | av Eβ=521 *14*; εK=0.777 *6*; εL=0.1109 *9*; εM+=0.0317 *3* |
| (2.23×10$^3$ *3*) | 2289.0 | 0.011 *3* | 0.11 *3* | 6.9 *1* | 0.12 *3* | av Eβ=544 *14*; εK=0.767 *7*; εL=0.1095 *10*; εM+=0.0313 *3* |
| (2.25×10$^3$ *3*) | 2261.27 | 0.054 *11* | 0.50 *9* | 6.20 *8* | 0.55 *10* | av Eβ=556 *14*; εK=0.761 *7*; εL=0.1086 *10*; εM+=0.0311 *3* |
| (2.27×10$^3$ *3*) | 2240.56 | 0.021 *4* | 0.18 *4* | 6.65 *9* | 0.20 *4* | av Eβ=565 *14*; εK=0.757 *7*; εL=0.1080 *10*; εM+=0.0309 *3* |
| (2.41×10$^3$ *3*) | 2107.56 | 0.32 *6* | 2.0 *3* | 5.66 *8* | 2.3 *4* | av Eβ=624 *14*; εK=0.727 *8*; εL=0.1035 *12*; εM+=0.0296 *4* |
| (2.49×10$^3$ *3*) | 2021.43 | 0.11 *3* | 0.54 *17* | 6.3 *1* | 0.65 *20* | av Eβ=662 *14*; εK=0.706 *8*; εL=0.1004 *12*; εM+=0.0287 *4* |
| (3.19×10$^3$ *3*) | 1319.5 | 0.039 *8* | 0.057 *12* | 7.5 *1* | 0.096 *20* | av Eβ=978 *14*; εK=0.503 *9*; εL=0.0711 *13*; εM+=0.0203 *4* |
| (3.23×10$^3$ *3*) | 1282.1 | 0.042 *21* | 0.06 *3* | 7.4 *2* | 0.10 *5* | av Eβ=995 *15*; εK=0.492 *9*; εL=0.0695 *13*; |

Continued on next page (footnotes at end of table)

## $^{139}$Pm ε decay (4.15 min) 1977De06 (continued)

### ε,β+ radiations (continued)

| E(decay) | E(level) | Iβ+ # | Iε# | Log *ft* | I(ε+β+)†# | Comments |
|---|---|---|---|---|---|---|
| | | | | | | εM+=0.0199 *4* |
| (3.41×10$^3$ *3*) | 1105.0 | 0.057 *14* | 0.063 *16* | 7.47 *11* | 0.12 *3* | av Eβ=1076 *15*; εK=0.443 *9*; εL=0.0624 *12*; εM+=0.0178 *4* |
| (3.45×10$^3$ *3*) | 1066.2 | 0.13 *2* | 0.13 *3* | 7.15 *9* | 0.26 *5* | av Eβ=1094 *15*; εK=0.432 *9*; εL=0.0610 *12*; εM+=0.0174 *4* |
| (3.53×10$^3$ *3*) | 981.45 | 0.40 *8* | 0.37 *7* | 6.72 *9* | 0.77 *15* | av Eβ=1133 *15*; εK=0.410 *8*; εL=0.0578 *12*; εM+=0.0165 *4* |
| (3.58×10$^3$ *3*) | 932.89 | 0.04 *3* | 0.04 *2* | 7.7 *3* | 0.08 *5* | av Eβ=1155 *15*; εK=0.398 *8*; εL=0.0561 *12*; εM+=0.0160 *4* |
| (3.70×10$^3$ *3*) | 815.66 | 0.51 *10* | 0.40 *7* | 6.74 *9* | 0.91 *17* | av Eβ=1209 *15*; εK=0.369 *8*; εL=0.0520 *11*; εM+=0.0148 *3* |
| (3.76×10$^3$ *3*) | 756.45 | 1.1 *2* | 0.80 *17* | 6.4 *1* | 1.9 *4* | av Eβ=1236 *15*; εK=0.356 *8*; εL=0.0501 *11*; εM+=0.0143 *3* |
| (3.84×10$^3$ *3*) | 675.46 | 0.41 *8* | 0.28 *5* | 6.93 *9* | 0.69 *13* | av Eβ=1273 *15*; εK=0.338 *7*; εL=0.0475 *10*; εM+=0.0136 *3* |
| (4.05×10$^3$ *3*) | 463.10 | 4.5 *8* | 2.4 *4* | 6.04 *8* | 6.9 *12* | av Eβ=1371 *15*; εK=0.294 *6*; εL=0.0414 *9*; εM+=0.01181 *24*<br>E(ε)=4040 *120* from measured Eβ+ (1977De06). |
| (4.11×10$^3$ *3*) | 402.77 | 8.7 *14* | 4.3 *7* | 5.79 *8* | 13.0 *21* | av Eβ=1399 *15*; εK=0.283 *6*; εL=0.0398 *8*; εM+=0.01136 *23*<br>E(ε)=4010 *100* from measured Eβ+ (1977De06). |
| (4.42×10$^3$ @ *3*) | 95.31 | <0.13 | <0.07 | >7.8 | <0.2 | av Eβ=1542 *15*; εK=0.233 *5*; εL=0.0327 *7*; εM+=0.00932 *19*<br>I(ε+β+): γ-transition intensity balance gives −0.2 *4* consistent with expected no β feeding, as expected for ΔJ=2, Δπ=no. |
| (4.51×10$^3$ ‡ *3*) | 0.0 | 53 *4* | 18 *1* | 5.25 *4* | 71 *5* | av Eβ=1587 *15*; εK=0.219 *5*; εL=0.0307 *6*; εM+=0.00877 *18*<br>E(ε)=4542 *40* from measured Eβ+. |

† Uncertainties dominated by uncertainty in direct g.s. feeding.
‡ $E_{\beta\pm}$=3520 keV *40* from 1983Al06 (Ge(HP),Ge(Li)). Other $E_{\beta\pm}$=3450 keV *50* (1995Ve08; Ge(HP)).
# Absolute intensity per 100 decays.
@ Existence of this branch is questionable.

## $^{139}$Pm ε decay (4.15 min) 1977De06 (continued)

### γ($^{139}$Nd)

Iγ normalization: from Iγ(403γ)=14.5% *23*; weighted average based on Iγ($^{139}$Nd 405γ; 4.15-min component)/Iγ(403γ)=0.080 *6* and Iγ($^{139}$Nd 1074γ; 4.15-min component)/Iγ(403γ)=0.026 *3*, Iγ($^{139}$Nd 405γ)=7.0% *10* and Iγ($^{139}$Nd 1074γ)=2.5% *5*, and $T_{1/2}$($^{139}$Pm)=4.15 min *5* and $T_{1/2}$($^{139}$Nd g.s.)=29.7 min *5*.
α(K)exp: normalized to α(K)(420γ $^{140}$Nd; E3)=0.044.

| $E_\gamma$ | $I_\gamma$[‡] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult.[†] | δ[†] | α[#] | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 95.3 *1* | 12.3 *8* | 95.31 | $(1/2)^+$ | 0.0 | $3/2^+$ | M1(+E2) | <0.18 | 1.64 *3* | α(K)exp=1.3 *3*; K/L=8.2 *18*<br>α(K)=1.382 *20*; α(L)=0.204 *13*; α(M)=0.044 *3*<br>α(N)=0.0097 *6*; α(O)=0.00146 *8*; α(P)=8.91×10$^{-5}$ *14* |
| 272.7 *4* | 0.81 *20* | 675.46 | $(3/2,5/2^+)$ | 402.77 | $(3/2,5/2)^+$ | | | | |
| 307.4 *2* | 2.4 *3* | 402.77 | $(3/2,5/2)^+$ | 95.31 | $(1/2)^+$ | [E2] | | 0.056 *8* | α(K)=0.047 *8*; α(L)=0.00764 *25*; α(M)=0.00165 *8*<br>α(N)=0.000365 *14*; α(O)=5.34×10$^{-5}$ *8*; α(P)=2.8×10$^{-6}$ *7* |
| 367.8 *2* | 24.3 *15* | 463.10 | $(3/2)^+$ | 95.31 | $(1/2)^+$ | M1 | | 0.0401 | α(K)exp=0.040 *6*<br>α(K)=0.0342 *5*; α(L)=0.00462 *7*; α(M)=0.000978 *14*<br>α(N)=0.000219 *3*; α(O)=3.34×10$^{-5}$ *5*; α(P)=2.19×10$^{-6}$ *3* |
| 402.8 *2* | 100 | 402.77 | $(3/2,5/2)^+$ | 0.0 | $3/2^+$ | M1+E2 | 1.0 *5* | 0.027 *3* | α(K)exp=0.022 *3*<br>α(K)=0.022 *3*; α(L)=0.00339 *17*; α(M)=0.00072 *3*<br>α(N)=0.000161 *8*; α(O)=2.39×10$^{-5}$ *15*; α(P)=1.4×10$^{-6}$ *2* |
| 412.5 *10* | 1.0 *5* | 815.66 | $(3/2,5/2,7/2^+)$ | 402.77 | $(3/2,5/2)^+$ | | | | |
| 463.1 *2* | 28.1 *18* | 463.10 | $(3/2)^+$ | 0.0 | $3/2^+$ | M1+E2 | >0.045 | 0.018 *4* | α(K)exp=0.013 *5*<br>α(K)=0.015 *4*; α(L)=0.0023 *3*; α(M)=0.00049 *6*<br>α(N)=0.000108 *13*; α(O)=1.62×10$^{-5}$ *22*; α(P)=1.0×10$^{-6}$ *3* |
| 530.1 *2* | 2.4 *2* | 932.89 | $(7/2^-)$ | 402.77 | $(3/2,5/2)^+$ | D | | | Mult.: from Adopted Gammas. |
| 579.0 *6* | 0.39 *10* | 981.45 | | 402.77 | $(3/2,5/2)^+$ | | | | |
| 580.1 *3* | 2.9 *3* | 675.46 | $(3/2,5/2^+)$ | 95.31 | $(1/2)^+$ | | | | |
| 603.1 *4* | 1.0 *1* | 1066.2 | | 463.10 | $(3/2)^+$ | | | | |
| [x]631.8 *4* | 0.80 *9* | | | | | | | | |
| 661.3 *4* | 2.8 *3* | 756.45 | $(3/2,5/2^+)$ | 95.31 | $(1/2)^+$ | | | | |
| 663.4 *6* | 0.81 *16* | 1066.2 | | 402.77 | $(3/2,5/2)^+$ | | | | |
| 675.5 *3* | 1.3 *1* | 675.46 | $(3/2,5/2^+)$ | 0.0 | $3/2^+$ | | | | |
| 702.0 *10* | 0.57 *15* | 1105.0 | | 402.77 | $(3/2,5/2)^+$ | | | | |
| [x]721.0 *10* | 0.38 *10* | | | | | | | | |
| 756.5 *3* | 13.7 *11* | 756.45 | $(3/2,5/2^+)$ | 0.0 | $3/2^+$ | | | | |
| 815.8 *2* | 7.8 *2* | 815.66 | $(3/2,5/2,7/2^+)$ | 0.0 | $3/2^+$ | | | | |
| 822.0[@] *10* | 0.40 *20* | 1282.1 | | 463.10 | $(3/2)^+$ | | | | |
| 856.4 *4* | 0.66 *9* | 1319.5 | | 463.10 | $(3/2)^+$ | | | | |
| 879.3 *4* | 0.38 *6* | 1282.1 | | 402.77 | $(3/2,5/2)^+$ | | | | |
| 981.6 *4* | 7.3 *5* | 981.45 | | 0.0 | $3/2^+$ | | | | |
| [x]1079.9 *4* | 1.0 *2* | | | | | | | | |
| 1105.0 *3* | 0.28 *6* | 1105.0 | | 0.0 | $3/2^+$ | | | | |





$^{139}_{60}Nd_{79}$-3

## $^{139}$Pm ε decay (4.15 min) 1977De06 (continued)

### γ($^{139}$Nd) (continued)

| $E_\gamma$ | $I_\gamma$‡ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | $E_\gamma$ | $I_\gamma$‡ | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1126.1 *3* | 2.0 *2* | 2107.56 | (3/2,5/2,7/2)$^+$ | 981.45 | | 1644.5 *3* | 2.1 *2* | 2107.56 | (3/2,5/2,7/2)$^+$ | 463.10 | (3/2)$^+$ |
| 1174.7 *3* | 1.2 *1* | 2107.56 | (3/2,5/2,7/2)$^+$ | 932.89 | (7/2$^-$) | 1664.6 *3* | 0.26 *4* | 2340.08 | | 675.46 | (3/2,5/2$^+$) |
| x1193.3 *3* | 1.4 *2* | | | | | 1704.6 *3* | 4.9 *5* | 2107.56 | (3/2,5/2,7/2)$^+$ | 402.77 | (3/2,5/2)$^+$ |
| 1205.7 *4* | 0.37 *8* | 2021.43 | | 815.66 | (3/2,5/2,7/2$^+$) | 1798.4 *4* | 0.60 *8* | 2261.27 | | 463.10 | (3/2)$^+$ |
| 1265.1 *3* | 0.61 *9* | 2021.43 | | 756.45 | (3/2,5/2$^+$) | 1825.9 *3* | 0.31 *5* | 2289.0 | | 463.10 | (3/2)$^+$ |
| 1292.5 *4* | 1.9 *2* | 2107.56 | (3/2,5/2,7/2)$^+$ | 815.66 | (3/2,5/2,7/2$^+$) | x1849.5 *5* | 0.29 *5* | | | | |
| x1299.7 *3* | 0.54 *6* | | | | | 1858.5 *3* | 1.7 *2* | 2261.27 | | 402.77 | (3/2,5/2)$^+$ |
| 1351.1 *3* | 1.43 *13* | 2107.56 | (3/2,5/2,7/2)$^+$ | 756.45 | (3/2,5/2$^+$) | 1876.8 *3* | 1.1 *2* | 2340.08 | | 463.10 | (3/2)$^+$ |
| 1358.8 *3* | 0.36 *12* | 2340.08 | | 981.45 | | 1886.2 *5* | 0.29 *5* | 2289.0 | | 402.77 | (3/2,5/2)$^+$ |
| 1426.3 *4* | 0.64 *15* | 2359.30 | | 932.89 | (7/2$^-$) | 1956.7 *6* | 0.99 *20* | 2359.30 | | 402.77 | (3/2,5/2)$^+$ |
| 1473.0 *10* | 0.26 *9* | 2289.0 | | 815.66 | (3/2,5/2,7/2$^+$) | 2021.3 *3* | 1.2 *1* | 2021.43 | | 0.0 | 3/2$^+$ |
| 1484.1 *1* | 1.40 *11* | 2240.56 | | 756.45 | (3/2,5/2$^+$) | 2107.3 *3* | 2.5 *3* | 2107.56 | (3/2,5/2,7/2)$^+$ | 0.0 | 3/2$^+$ |
| 1558.2 *5* | 0.89 *14* | 2021.43 | | 463.10 | (3/2)$^+$ | 2261.1 *3* | 1.5 *2* | 2261.27 | | 0.0 | 3/2$^+$ |
| x1602.9 *3* | 2.9 *3* | | | | | x2351.0 *4* | 0.25 *5* | | | | |
| 1618.7 *3* | 1.4 *11* | 2021.43 | | 402.77 | (3/2,5/2)$^+$ | 2359.3 *3* | 1.1 *1* | 2359.30 | | 0.0 | 3/2$^+$ |

† From $\alpha_K$(exp) and K/L. δ′s deduced by evaluators. Multipolarities in brackets were assigned in order to obtain the normalization and $I_{\varepsilon+\beta+}$′s. Same assignments are in the Adopted Gammas.

‡ For absolute intensity per 100 decays, multiply by 0.145 *23*.

# 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.

@ Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.





$^{139}_{60}Nd_{79}$-4

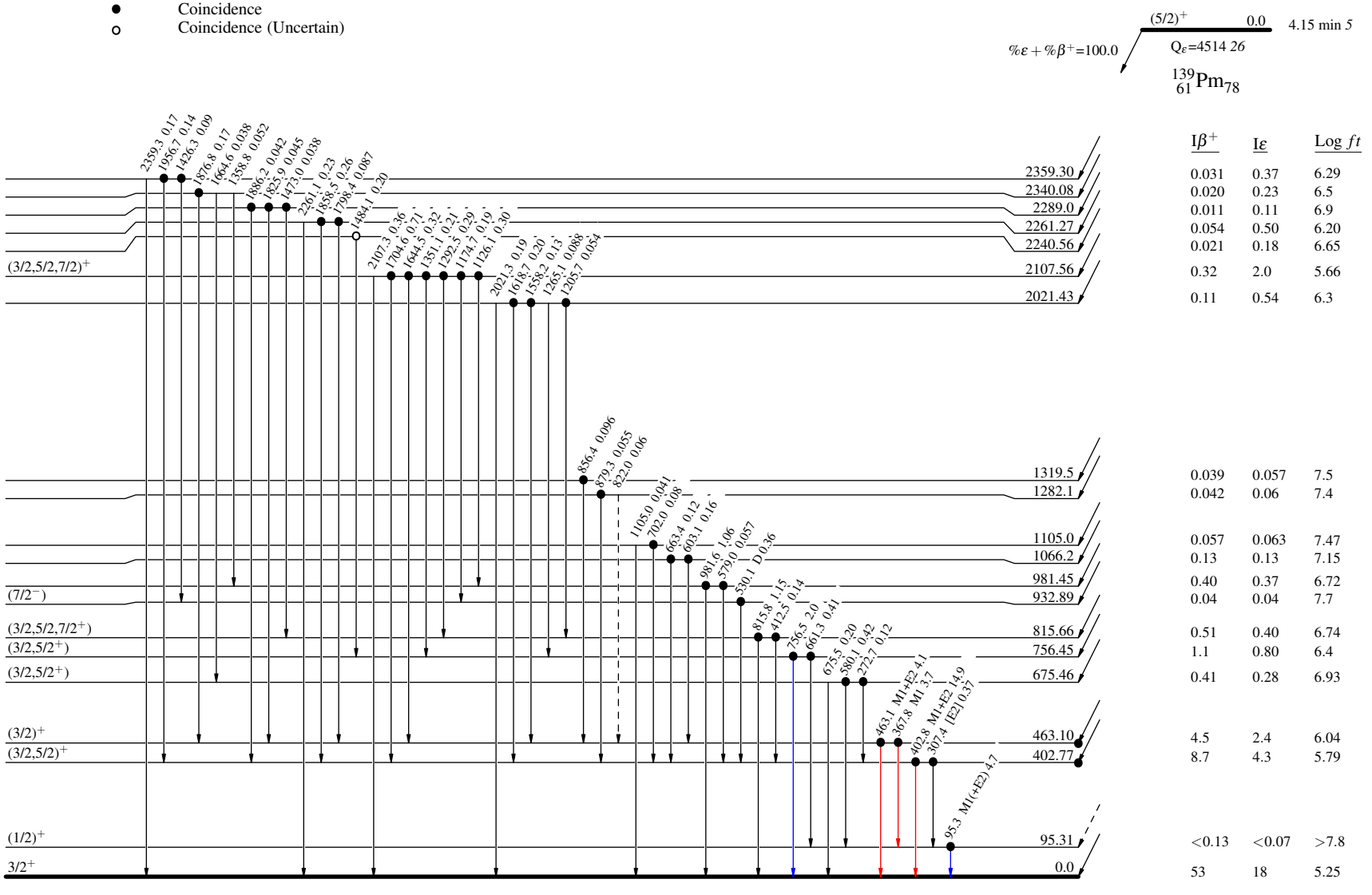
## $^{139}$Pm ε decay (4.15 min) 1977De06

### Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

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)
- Coincidence
- Coincidence (Uncertain)




| | Iβ+ | Iε | Log *ft* |
|---|---|---|---|
| 2359.30 | 0.031 | 0.37 | 6.29 |
| 2340.08 | 0.020 | 0.23 | 6.5 |
| 2289.0 | 0.011 | 0.11 | 6.9 |
| 2261.27 | 0.054 | 0.50 | 6.20 |
| 2240.56 | 0.021 | 0.18 | 6.65 |
| 2107.56 | 0.32 | 2.0 | 5.66 |
| 2021.43 | 0.11 | 0.54 | 6.3 |
| 1319.5 | 0.039 | 0.057 | 7.5 |
| 1282.1 | 0.042 | 0.06 | 7.4 |
| 1105.0 | 0.057 | 0.063 | 7.47 |
| 1066.2 | 0.13 | 0.13 | 7.15 |
| 981.45 | 0.40 | 0.37 | 6.72 |
| 932.89 | 0.04 | 0.04 | 7.7 |
| 815.66 | 0.51 | 0.40 | 6.74 |
| 756.45 | 1.1 | 0.80 | 6.4 |
| 675.46 | 0.41 | 0.28 | 6.93 |
| 463.10 | 4.5 | 2.4 | 6.04 |
| 402.77 | 8.7 | 4.3 | 5.79 |
| 95.31 | <0.13 | <0.07 | >7.8 |
| 0.0 | 53 | 18 | 5.25 |

$^{139}_{60}Nd_{79}$





$^{139}_{60}Nd_{79}$-5