

^{156}Sm β^- decay [1966Ha26,1968An09](#)

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 2537 (2012)	1-Mar-2012

Parent: ^{156}Sm : $E=0$; $J^\pi=0^+$; $T_{1/2}=9.4$ h 2; $Q(\beta^-)=722$ 8; $\% \beta^-$ decay=100.0

^{156}Sm - $T_{1/2}$: [Additional information 1](#).

^{156}Sm - $Q(\beta^-)$: [Additional information 2](#).

[Additional information 3](#).

^{156}Sm has been produced as a product of n-induced fission of ^{235}U , U and ^{239}Pu , α -induced fission of ^{238}U and the (d, α) reaction on ^{158}Gd .

The decay-scheme data are primarily those of [1966Ha26](#). The excited-state half-lives are those reported by [1968An09](#). Others: [1963Gu04](#); [1969Gr32](#).

Experimental methods:

[1966Ha26](#): ^{156}Sm from n-induced fission of ^{239}Pu , followed by chemical separation. γ 's measured using proportional counters, Ge and NaI(Tl) detectors. ce and β^- measured in a 6-gap orange-type magnetic spectrometer. β^- also measured in an anthracene crystal. measured $E\gamma, I\gamma, \gamma\gamma, ce, ce\gamma, \beta\gamma$ and $ce\beta$. Deduced ce(K), multiplicities for several transitions.

[1968An09](#): ^{156}Sm from U fission products, followed by chemical separation. Measured level half-lives using plastic and NaI(Tl) detectors.

The 0^+ g.s. of ^{156}Eu and the nature of the $0^+ \rightarrow 0^+$ β^- transitions connecting the ^{156}Eu g.s. with the ground states of ^{156}Sm and ^{156}Gd have been discussed by [1965Wi08](#).

 ^{156}Eu Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	Comments
0. @	0^+	15.19 d 8	$T_{1/2}$: From the adopted values. Additional information 4 .
22.6 @ 1	1^+		
47.8? @ 3	2^+		
87.58 & 18	1^-	12.0 ns 3	
125.68 & 20	(2^-)		
267 ^b 1	1^-		E(level): Level placed by the evaluator to accommodate the 219 γ reported by 1966Ha26 , but not placed by them (see the comment on the 219 γ).
291.4 ^a 3	1^+	≤ 0.2 ns	

[†] From least-squares fit to γ energies.

[‡] J^π and band assignments are from ^{156}Eu Adopted Levels, and are similar to those proposed by [1966Ha26](#).

[#] From [1968An09](#) for excited states.

@ Band(A): $K^\pi=0^+$, g.s. band. configuration= $\pi 5/2[413]-\nu 5/2[642]$.

& Band(B): $K^\pi=1^-$ band. configuration= $\pi 5/2[413]-\nu 3/2[521]$.

^a Band(C): $K^\pi=1^+$ bandhead. configuration= $\pi 7/2[523]-\nu 5/2[523]$. [1966Ha26](#) assign the configuration $\pi 7/2[523]-\nu 5/2[523]$ to this state. [1991Ba06](#), in order to account for the relatively low $\log ft$ value of the β^- transition to this level, assume that this latter configuration is present only as an admixture.

^b Band(D): $K^\pi=0^-$ bandhead. configuration= $\pi 5/2[532]-\nu 5/2[642]$.

¹⁵⁶Sm β⁻ decay **1966Ha26,1968An09 (continued)**

β⁻ radiations

E(β⁻) are from 1966Ha26. Other: 1963Gu04.

I(β⁻) are from γ intensity balances, with Iβ⁻(125) set to 0; 1966Ha26 give similar values. Calculation gives 6% 2 feeding to the 125 level, but, for 0⁺ to 2⁻, one expects (1973Ra10) log f^t ≥ 8.5 or Iβ⁻ ≤ 0.1%.

E(decay)	E(level)	Iβ ^{-†}	Log ft	Comments
415 25 (455 8)	291.4 267	44 8 0.5 4	5.32 9 7.3 4	av Eβ=127.7 27 av Eβ=136.0 28 Log ft: Calculated by the evaluator using the reported I _γ value for the 219 γ and the adopted properties of the γ's deexciting this level.
700 30 (722 8)	22.6 0.	48 15 <0.02	6.00 14 >9.4	av Eβ=223.4 30 av Eβ=232 3 A Fermi β transition (see, e.g., 1965Wi08, 1966Ha26). Iβ ⁻ : For a 0 ⁺ to 0 ⁺ beta transition, systematics (1973Ra10) suggest log ft > 9.5 in this mass region; this gives Iβ < 0.015%.

† Absolute intensity per 100 decays.

γ(¹⁵⁶Eu)

I_γ normalization, I(γ+ce) normalization: Chosen to give 100% I(γ+ce) feeding to the ¹⁵⁶Eu g.s. From a 4π βγ coincidence measurement, 1963Gu04 give absolute I_γ values. From these latter data, one would deduce I_γ normalization ≈ 1.4. Coincidence results are shown in the drawing (1966Ha26).

E _γ [†]	I _γ ^{‡#c}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. @&	α ^b	I _(γ+ce) ^c	Comments
22.6 1	2.6 5	22.6	1 ⁺	0.	0 ⁺	M1	22.4 5	61 12	ce(L)/(γ+ce)=0.751 10; ce(M)/(γ+ce)=0.162 4; ce(N+)/(γ+ce)=0.0436 12 ce(N)/(γ+ce)=0.0372 10; ce(O)/(γ+ce)=0.00587 16; ce(P)/(γ+ce)=0.000575 16 I _γ : From Ice and α(L). From a proportional-counter measurement, 1966Ha26 report I _γ =7 4. I _(γ+ce) : From experimental γ and ce intensities (1966Ha26).
25.3 3		47.8?	2 ⁺	22.6	1 ⁺	(M1) ^a	16.0 7	4.5 19	ce(L)/(γ+ce)=0.739 19; ce(M)/(γ+ce)=0.160 8; ce(N+)/(γ+ce)=0.0429 23 ce(N)/(γ+ce)=0.0365 19; ce(O)/(γ+ce)=0.0058 3; ce(P)/(γ+ce)=0.00057 3 I _(γ+ce) : From electron intensity. Intensity balance gives 2.4 9.
38.1 1	<3	125.68	(2 ⁻)	87.58	1 ⁻	M1	4.77 8		α(L)=3.74 6; α(M)=0.809 13; α(N+..)=0.217 4 α(N)=0.185 3; α(O)=0.0293 5; α(P)=0.00287 5 I _γ : From I _γ (38)/I _γ (103) in ¹⁵³ Eu(3n,γ) data, I _γ =3.9.
65.0 5	2.3	87.58	1 ⁻	22.6	1 ⁺	E1	0.899 23		α(K)=0.747 19; α(L)=0.120 4; α(M)=0.0258 7; α(N+..)=0.00667 18

Continued on next page (footnotes at end of table)

¹⁵⁶Sm β⁻ decay **1966Ha26,1968An09** (continued)

γ(¹⁵⁶Eu) (continued)

<u>E_γ[†]</u>	<u>I_γ^{‡#c}</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult. @&</u>	<u>a^b</u>	<u>Comments</u>
87.6 2	24 7	87.58	1 ⁻	0.	0 ⁺	E1	0.406 7	α(N)=0.00577 15; α(O)=0.000845 22; α(P)=5.87×10 ⁻⁵ 14 α(K)=0.340 6; α(L)=0.0516 8; α(M)=0.01111 18; α(N+..)=0.00290 5
103 2	1.8	125.68	(2 ⁻)	22.6	1 ⁺	E1 ^a	0.262 15	α(N)=0.00250 4; α(O)=0.000372 6; α(P)=2.78×10 ⁻⁵ 5 α(K)=0.220 13; α(L)=0.0327 19; α(M)=0.0070 5; α(N+..)=0.00184 11 α(N)=0.00159 10; α(O)=0.000238 14; α(P)=1.85×10 ⁻⁵ 10
165.8 5	13 2	291.4	1 ⁺	125.68	(2 ⁻)	E1	0.0723 12	α(K)=0.0613 10; α(L)=0.00869 15; α(M)=0.00187 3; α(N+..)=0.000493 8 α(N)=0.000423 7; α(O)=6.48×10 ⁻⁵ 11; α(P)=5.47×10 ⁻⁶ 9
204.0 5	21 2	291.4	1 ⁺	87.58	1 ⁻	E1	0.0416 7	α(K)=0.0353 6; α(L)=0.00494 8; α(M)=0.001062 17; α(N+..)=0.000281 5 α(N)=0.000241 4; α(O)=3.71×10 ⁻⁵ 6; α(P)=3.23×10 ⁻⁶ 5
219 1	0.5 3	267	1 ⁻	47.8?	2 ⁺			γ observed, but not placed, by 1966Ha26. Following 1991Ba06, the evaluator has associated it with the 219.27 γ seen in ¹⁵³ Eu(3n,γ) and has shown it as feeding the well-established 47.8, 2 ⁺ level.
244.0 8	2.1 8	291.4	1 ⁺	47.8?	2 ⁺	[M1,E2]	0.132 21	α(K)=0.106 24; α(L)=0.0203 21; α(M)=0.0045 6; α(N+..)=0.00118 13 α(N)=0.00102 12; α(O)=0.000154 11; α(P)=1.1×10 ⁻⁵ 4
268.5 8	2.4 8	291.4	1 ⁺	22.6	1 ⁺	[M1,E2]	0.100 18	α(K)=0.081 19; α(L)=0.0148 8; α(M)=0.00327 25; α(N+..)=0.00086 5 α(N)=0.00074 5; α(O)=0.000113 3; α(P)=8.E-6 3
291.0 8	2.8 10	291.4	1 ⁺	0.	0 ⁺	[M1]	0.0954 15	α(K)=0.0809 13; α(L)=0.01133 18; α(M)=0.00244 4; α(N+..)=0.000657 11 α(N)=0.000560 9; α(O)=8.89×10 ⁻⁵ 14; α(P)=8.87×10 ⁻⁶ 14

[†] From 1966Ha26 and based on γ and ce data. Others: 1963Gr04, 1965Wi08 (same authors as 1966Ha26), and 1969Gr32. For more precise values, see the ¹⁵³Eu(3n,γ) data.

[‡] From 1966Ha26, from evaluator's combination of results from Ge and NaI detectors and proportional counters. Others: 1963Gu04, 1969Gr32.

I(K x ray)=10 3 (1966Ha26).

@ From ¹⁵⁶Eu Adopted γ radiations and based on the ce data following this decay (1966Ha26) and the ¹⁵³Eu(3n,γ) reaction.

& Normalization of the ce spectrum and the γ-ray spectrum to deduce conversion coefficients for the γ transitions was done using the theoretical value, α(K)=0.062, for the 165.8, E1 G. The α(K)exp value for this γ was measured relative to that of the 123, E2 γ in ¹⁵⁴Eu decay, for which the theoretical value, α(K)=0.65, was used (1966Ha26).

^a Value from the ¹⁵³Eu(3n,γ) reaction. It is included to help obtain an intensity balance in the level scheme.

^b Computed from the more precise Eγ values in the ¹⁵⁶Eu Adopted γ radiations data set.

^c For absolute intensity per 100 decays, multiply by 1.01 16.

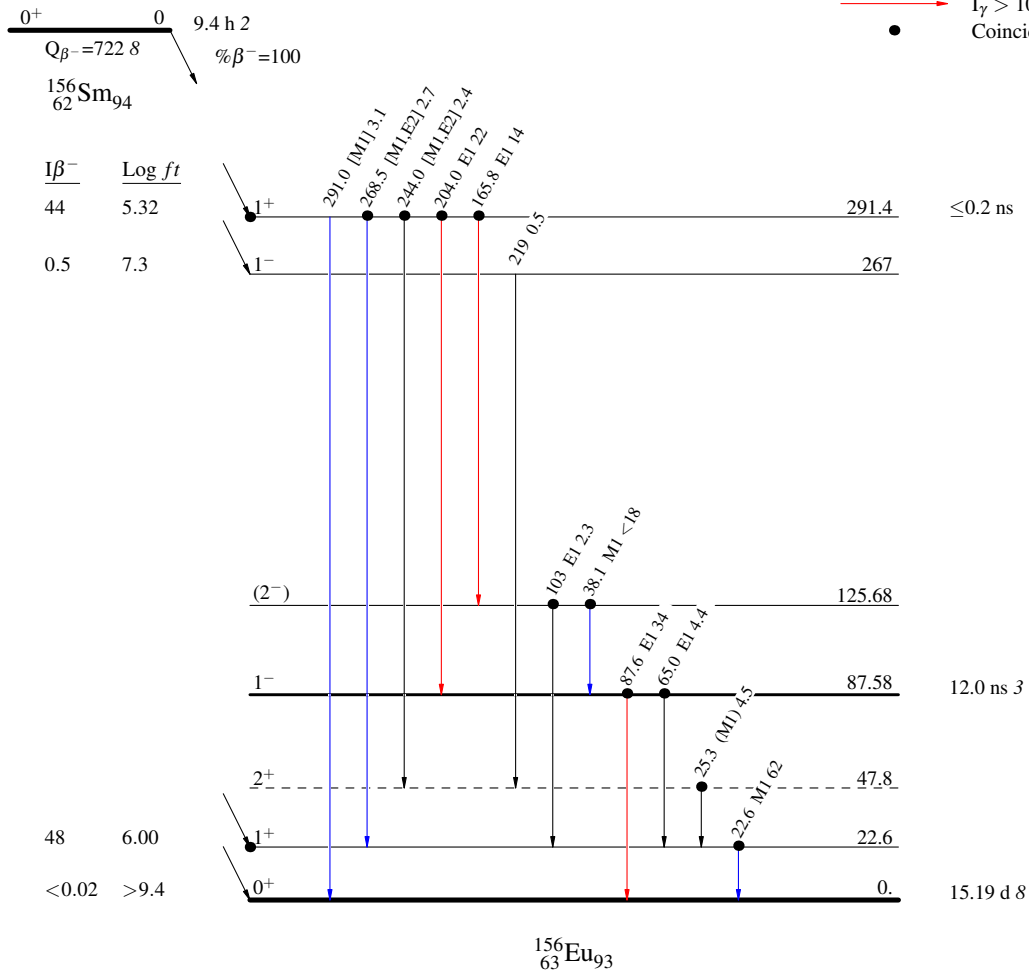
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Decay Scheme

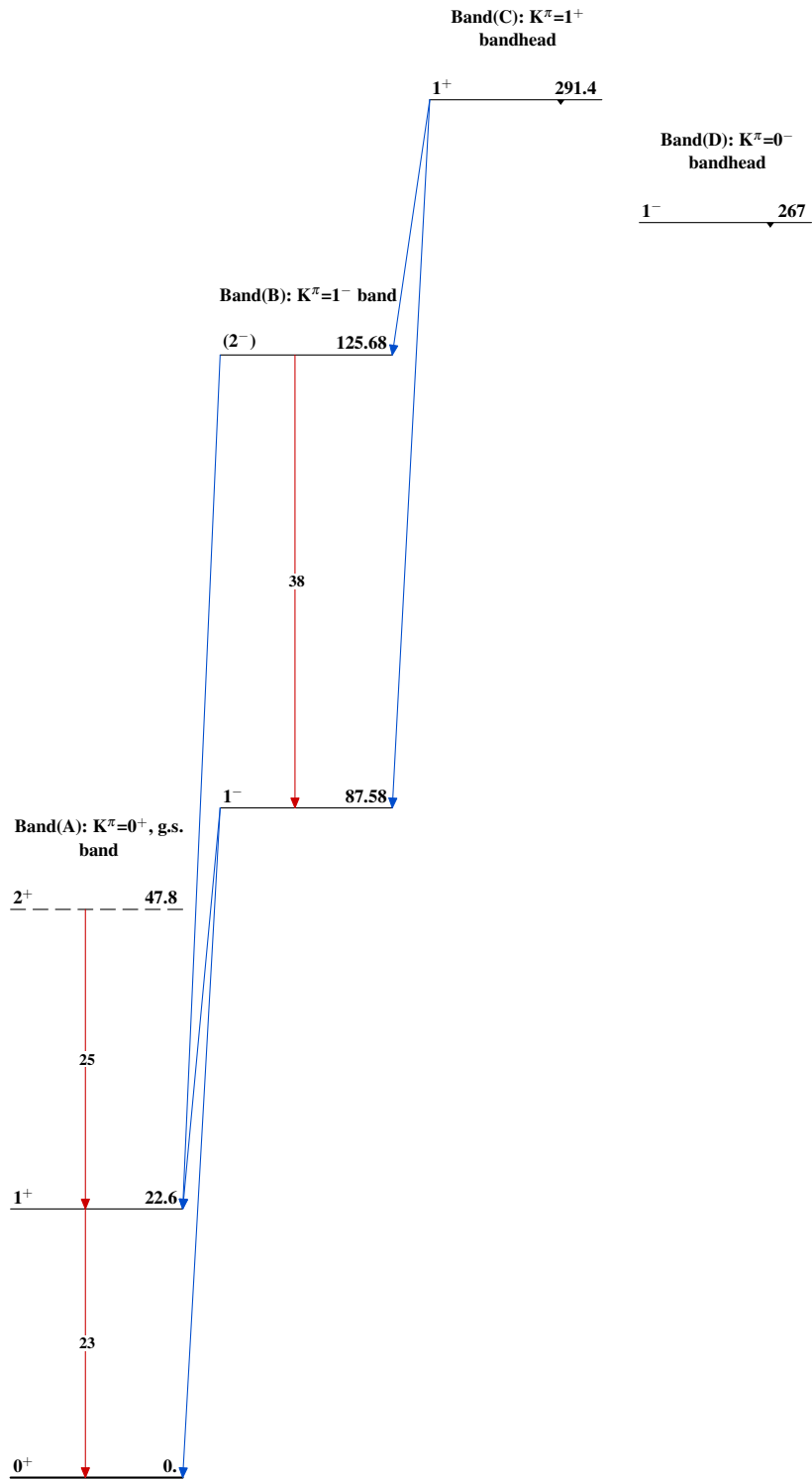
Intensities: $I_{(\gamma+ce)}$ per 100 decays through this branch

Legend

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



$^{156}\text{Sm} \beta^-$ decay 1966Ha26,1968An09



$^{156}_{63}\text{Eu}_{93}$