^{135}Sm ε decay (10.3 s) 1989Vi04

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Alexander A. Rodionov And Yuri L. Khazov	NDS 109, 517 (2008)	22-Jan-2008

Parent: ^{135}Sm: E=0.0; J^π=(3/2$^+$,5/2$^+$); $T_{1/2}$=10.3 s *5*; Q(ε)=7.12×10^3 *17*; %ε+%$β^+$ decay=100.0

^{135}Sm-%ε+%$β^+$ decay: %εp=0.02 *1* (1989Vi04).

1989Vi04: ^{135}Sm produced by ^{92}Mo(^{46}Ti,2pn) E=192 MeV followed by on-line mass separation. Measured Pm x rays, delayed protons, γ rays, γγ coin, (x ray)γ coin, γ($β^+$) coin, p(x ray) coin, pγ coin, isotopic half-life.

1977Bo02: measured $T_{1/2}$ and delayed protons, deduced β strength functions. Isotope identified by x rays and delayed protons.

1989Vi04 proposed population of two isomers of J^π=(3/2,5/2$^+$) and (9/2$^-$,11/2$^-$) from the decay of ^{135}Sm, with the level scheme of ^{135}Pm based mainly on the decay of the high-spin isomer. But a single low-spin activity is suggested by the following arguments:

1. High-spin assignments made by 1989Vi04 to low lying levels populated by ^{135}Sm decay were based, presumably, on the identification of one common γ ray at 286 keV in ^{135}Sm decay and in high-spin studies on ^{135}Pm (1987Be22,1988Wa01). From γγ evidence, 1989Vi04 proposed that 286γ deexcites a level at 341 keV. Three other γ rays at 160, 237 and 341 keV also deexcited this level. In the in-beam γ study (1987Be22,1988Wa01) there is no evidence in the γγ spectra (figure 3 in 1987Be22 and figure 1 in 1988Wa01) for the existence of either the strong 237γ or the weaker (but likely to be seen by 1988Wa01 and 1987Be22) 341γ. It should also be noted that Eγ=285.9 *2* (1989Vi04) in ^{135}Sm decay does not agree with 286.8 *1* (1987Be22) in in-beam study, although 1988Wa01 report 286.2 *2*. The γ-ray energies reported by 1988Wa01 are systematically lower by≈1 keV as compared to those in 1987Be22. Based on the γγ evidence and γ-ray energies, the evaluators suggest that either the placement of 286γ is incorrect in ^{135}Sm decay (1989Vi04) or that it is independent of the 286 γ seen in the in-beam studies.
2. In high-spin studies, the low lying states in ^{135}Sm are proposed as 3/2$^+$ and 7/2$^+$ from band structures and cranked shell-model calculations (1987Mu12,1989MuZR,1996MuZZ). From these studies, there seems no evidence for a long-lived 9/2$^-$ or 11/2$^-$ isomer in ^{135}Sm. A low-lying level 9/2$^-$ level is proposed with $T_{1/2}$=7 ns to 35 ns.
3. 1989Vi04 report a single half-life for delayed protons, γ rays (assigned to ^{135}Sm decay) and x rays, indicating the existence of only one 10.3 s ^{135}Sm activity. The 77 γ displayed a second component, in coin with Pm x rays, with $T_{1/2}$=2.4 s *9*. The origin of this γ ray is not clear. 1989Vi04 speculated that this transition may be associated with the decay of low-spin isomer in ^{135}Sm.

The level scheme has not been normalized for Iγ/100 decays of the parent, since the level scheme is considered incomplete in view of lack of knowledge about β feeding to ^{135}Pm g.s., large Q value of 7200 keV; known level population only up to 1314; and no data for multipolarity of low energy transitions.

log *ft* values were calculated by 1989Vi04 as lower limits, but in the evaluators′ opinion, sufficient data are lacking for such calculations with the available level scheme.

Total decay energy of 3150 keV *250* calculated (by RADLIST code) from level scheme is much lower than the expected value of 7120 keV *170*.

^{135}Pm Levels

E(level)†	J^π	$T_{1/2}$	Comments
0.0+x	(3/2$^+$,5/2$^+$)	49 s *3*	J^π: it is assumed by the evaluators that the ε decay of ^{135}Sm populates a low spin isomer in ^{135}Pm as opposed to an 11/2$^-$ state suggested by 1989Vi04. See comments above for the level table.
55.4+x *1*	(+)		J^π: 1989Vi04 proposed 11/2$^-$, but see comment for 0.0+y level in 'Adopted Levels'. From systematics, 1993BrZU suggested 5/2$^+$.
104.6+x *1*			J^π: 1989Vi04 proposed (9/2$^-$ to 13/2$^-$), but see comment for 0.0+y level in 'Adopted Levels'. From systematics, 1993BrZU suggested 5/2$^+$.
181.7+x *1*			J^π: 1989Vi04 proposed (13/2$^-$), but see comment for 0.0+y level in 'Adopted Levels'. From systematics, 1993BrZU suggested 7/2$^+$.
341.2+x *1*			J^π: 1989Vi04 proposed 15/2$^-$, but see comment for 0.0+y level in 'Adopted Levels'.
418.3+x *1*			
531.6+x *2*			
609.9+x *2*			J^π: 1989Vi04 proposed (15/2), but see comment for 0.0+y level in 'Adopted Levels'.
725.3+x *2*			
754.7+x *2*			

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^{135}Pm Levels (continued)

E(level)[†]
1313.8+x *6*
5.5×10^{3}[‡] *15*

[†] From least-squares fit to Eγ's.
[‡] Levels in the range 4000-7000 (1989Vi04) fed (Iβ≈0.02%) by ^{135}Sm β decay which deexcite by delayed protons.

γ(^{135}Pm)

Iγ normalization: Based on the existing level scheme of 1989Vi04 give Iγ normalization=0.11, assuming Iβ(to g.s.)<7% (1989Vi04).

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α[†]	Comments
49.1 *2*	10 *3*	104.6+x		55.4+x	(+)			
55.4 *2*	65 *20*	55.4+x	(+)	0.0+x	(3/2+,5/2+)	(M1,E2)	15 *7*	α(K)=5.7 *15*; α(L)=7 *6*; α(M)=1.6 *14*; α(N+..)=0.4 *4* α(N)=0.4 *3*; α(O)=0.04 *4*; α(P)=0.00034 *14* Mult.: E1 with α=1.3 is ruled out from intensity balance argument at 55.4+x level. M2 and higher multipolarities requiring a longer (μs or higher) lifetime for the 55.4+x level are less likely since 55.4γ is seen in γγ coincidences (1989Vi04) Thus choice of (M1,E2) seems most probable.
77.2[‡] *2*	32[‡] *10*	181.7+x		104.6+x				Iγ(doublet)=33 *10*.
77.2[‡] *2*	≈1[‡]	418.3+x		341.2+x				
104.6 *2*	46 *10*	104.6+x		0.0+x	(3/2+,5/2+)			
115.5 *3*	8 *2*	725.3+x		609.9+x				
[x]123.8 *3*	6 *2*							
126.3 *2*	88 *10*	181.7+x		55.4+x	(+)			
159.5 *4*	3 *1*	341.2+x		181.7+x				
181.7 *2*	22 *5*	181.7+x		0.0+x	(3/2+,5/2+)			
190.3 *2*	100 *10*	531.6+x		341.2+x				
236.6[‡] *3*	≈45[‡]	341.2+x		104.6+x				Iγ(doublet)=90 *30*.
236.6[‡] *3*	≈45[‡]	418.3+x		181.7+x				
285.9 *2*	87 *10*	341.2+x		55.4+x	(+)			
313.4 *4*	10 *3*	418.3+x		104.6+x				
341.3 *2*	≈7	341.2+x		0.0+x	(3/2+,5/2+)			
350.0 *2*	20 *5*	531.6+x		181.7+x				
363.0 *2*	84 *10*	418.3+x		55.4+x	(+)			
418.2 *2*	26 *5*	418.3+x		0.0+x	(3/2+,5/2+)			
428.2 *2*	70 *10*	609.9+x		181.7+x				
543.5 *2*	26 *5*	725.3+x		181.7+x				
573.0 *2*	30 *8*	754.7+x		181.7+x				
754.7 *2*	40 *10*	754.7+x		0.0+x	(3/2+,5/2+)			
1132.1 *5*	22 *5*	1313.8+x		181.7+x				

[†] 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.
[‡] Multiply placed with intensity suitably divided.
[x] γ ray not placed in level scheme.

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Decay Scheme

Intensities: Relative I_γ
@ Multiply placed: intensity suitably divided

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