# Distinctive features of isomers in transuranic actinides

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As a part of our global survey of nuclear isomers [1] we highlight herewith a few distinctive features of long-lived ($t_{1/2}$≥μs) nuclear isomers presently [2] identified in transuranic nuclides. An early survey [3] of $t_{1/2}$ > 1s isomers in deformed nuclei had concluded that such occurrences are practically non-existent in even-even, rare in odd-A, but quite frequent in odd-odd nuclei. A more detailed examination of odd-odd nuclei of the actinide region [4] had pointed out a few other characteristics detailed below. Herein, we critically examine the current situation against this background. For this purpose, we map in Fig. 1 the available n/p configuration space and use the same in our analysis henceforth. One feature, unique to this region, is that, in view of the fissionability factor, highly excited ($E_x$ ≥1.5MeV), and hence multiparticle (>2qp) configurations yielding high K isomers, cannot be reached.

**Isomers in Odd-A Nuclei**

Looking at the 1qp orbital spins in Fig. 1, we find that no two n or p orbitals with ΔI >3 are next to each other. The only admissible isomer pairs are (7/2, 1/2) with M3 or E3, and $(9/2^-, 5/2^+)_n$ & $(7/2^+, 3/2^-)_p$ with M2 connecting γ transitions and hence rather small $t_{1/2}$. For instance, all odd-A N=151 isotones with Z=96 to 102 have $I^\pi_{gs} = 9/2^-$ and a $K^\pi=5/2^+$ isomer with $t_{1/2}$=(30±15)μs. Lifetimes for ΔI=3 cases are somewhat larger.

**Isomers in Even-Even Nuclei**

Even though 2qp isomers in $^{250}$Fm and $^{254}$No had been identified as early as 1973, inbeam spectroscopic studies over the past 6 years elucidating isomer decay paths have resulted in specific structure as listed in Table.1. These experiments [5-8] have revealed the remarkable similarity of $K^\pi=8^-$ isomers with very similar excitation energies (~1.2MeV) and decay paths to g.s. for all N=150 isotones with Z=94(2)102. Explicitly distinct pp structure (rather than nn as in N=150 isotones) for $K^\pi=8^-$ isomer in $^{254}$No and also identification therein of a high excitation (2.9 MeV) and high K (14 or 16) 4qp isomer (0.2ms) confirms a significant deformed shell gap at N=152.

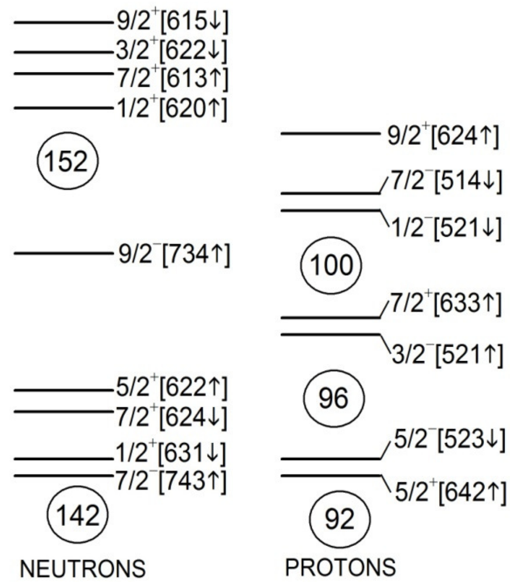


**Fig. 1:** Schematic (not to scale) single particle Nilsson level diagram for actinides.

**Table 1:** Presently identified [5-8] long-lived ($t_{1/2}$ ≥ μs) 2qp isomers in even-even transuranic actinides.

| $^A_ZX$ | $E_x$ (keV) | $t_{1/2}$ | $K^\pi$ (config) |
|---|---|---|---|
| | **N=148 isotones** | | |
| $^{244}_{96}Cm$ | 1042 | 34ms | $6^+$:nn[$5/2^+ \otimes 7/2^+$] |
| $^{248}_{100}Fm$ | 1178 | 10.1ms | $6^+$:nn[$5/2^+ \otimes 7/2^+$] |
| $^{250}_{102}No$ | ? | 43μs | ($6^+$:nn) ? |
| | **N=150 isotones** | | |
| $^{246}_{96}Cm$ | 1180 | ? | $8^-$:nn[$7/2^+ \otimes 9/2^-$] |
| $^{248}_{98}Cf$ | 1261 | ? | $8^-$:nn[$7/2^+ \otimes 9/2^-$] |
| $^{250}_{100}Fm$ | 1198 | 1.9s | $8^-$:nn[$7/2^+ \otimes 9/2^-$] |
| $^{252}_{102}No$ | 1254 | 110ms | $8^-$:nn[$7/2^+ \otimes 9/2^-$] |
| | **N=152 isotones** | | |
| $^{254}_{102}No$ | 1295 | 275ms | $8^-$:pp[$7/2^- \otimes 9/2^+$] |
| | 2917 | 198μs | $16^+$:[pp$8^- \otimes$nn$8^-$] **or** $14^+$:[pp$8^- \otimes$nn$6^-$] |

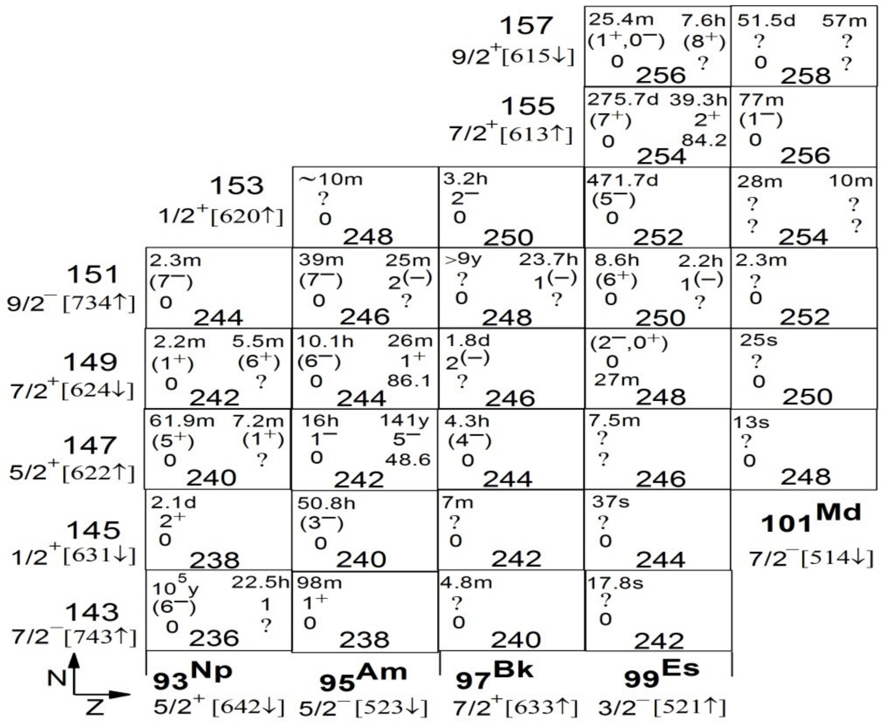


**Fig. 2:** N-Z plot of long-lived ($t_{1/2}$>s) of presently identified [2-4] isomers in transuranic odd-odd nuclides. Entries in each box are $t_{1/2}$, $J^\pi$ and $E_x$ (keV) for g.s. and isomer wherever known.

**Isomers in Odd-Odd Nuclei**

The updated information, as available in June 1912 version of NNDC data bases [2], in respect of the ground (lowest) and isomeric states of Z=93(2)101 odd-odd nuclides is summarized in Fig. 2. Certain distinctive features unique to this region are evidenced here. For instance, excepting $^{242}$Am, in no other case IT (γ) connects the isomer to g.s.. Only in 2 other cases, namely $^{244}$Am and $^{254}$Es ΔE (isomer-g.s.) is known. In all the other known isomer pairs, energy ordering of the two isomers, and hence the g.s., remains undefined. Out of the 12 known isomer pairs, $J^\pi$ is unambiguously assigned for both members only in $^{242}$Am. Further, from Fig.1 & 2, it is seen that, excepting N=145 &153 isotones (with $\Omega_n$ = ½$^+$) long lived isomers with ΔI ≥ 5 (based on GM coupling rule) are predicted for almost all other odd-odd nuclei. Sood *et.al.* [4] developed a formalism to address questions of energy ordering and $J^\pi$ assignment and successfully applied the same in a few cases, as detailed in ref. [4]. Sood *et.al.* [10] had applied this formalism to predict occurrence of $K^\pi$=7$^-$ and $K^\pi$=0$^-$ isomer pair in $^{250}$Md. Similar analysis for other odd-odd nuclei is being undertaken and results thereof will be presented.

## References


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