

Frontiers in Gamma Ray Spectroscopy

FIG18



Contribution ID : 35

Nuclear Radius Parameter-An Indicator of Nuclear Shell Closure

Content :

This paper presents behavior of nuclear radius parameter (r_0) of alpha-daughter nuclei with parent neutron and proton numbers. Preston's spin-independent equations [1] of alpha-decay radioactivity were used to calculate the nuclear radius parameter (r_0) of 184 even-even nuclides from up-to-date experimental alpha-decay data.

Variation of r_0 parameters with parent neutron number for different nuclides demonstrates that r_0 parameters exhibit a minimum at $N=126$ (a major shell closure) and increase thereafter, decreasing again toward the next minor shell closure [2]. Additionally, there is a shallow minimum at $N=152$, which indicates a minor shell closure, consistent with the recent mapping of $N=152$ shell effects [2].

On the basis of present study, we suggest that the isotonic chains with $N=104$, 106 and 112 exhibit a minima at $Z=82$, which indicates the role of $Z=82$ proton shell closure, consistent with the shell model predictions of Wauters et al.[3]. However, the shell effects at $Z=82$ disappear for the isotonic chains with $N=102$, 108 and 110 as suggested by Buck et al. [4,5] and Brown [6]. Thus, further calculations are required to address the issue pertaining to $Z=82$ proton shell closure.

We have also investigated the behavior of deformed actinides from Th to Cf. These nuclei are found to exhibit interesting behavior near $N=126$. The Th, U and Pu isotopes display two minima, which keep shifting by two neutrons to the right. These minima lie at $N=134$ and 140 for Th, at $N=136$ and 142 for U, at $N=138$ and 144, for Pu, and at $N=146$ for Fm isotopes. Thereafter, Pu and Cm have a minimum at $N=150$, and Fm and Cf at $N=152$. It is, therefore, clear that the much talked about $N=152$ minimum [2] is also a transient minimum. This behavior of "shifting minima" for these heavy nuclides is interesting and, as yet, has not been discussed in the literature. The evaluated r_0 parameters in our work can further be used to deduce r_0 parameters of odd-A and odd-odd nuclides, and hence to extract alpha-decay hindrance factors for elucidating important nuclear structure information of such nuclei.

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Session classification : --not yet classified--

Track classification : --not yet classified--

Type : Poster