Contingency of Alpha decay in $^{287\text{-}306}120$ isotopes of SHE

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Introduction

In Recent years the synthesis and identification of super heavy nuclei has a particular attention in the field of nuclear physics. Many theoretical calculations have been done to study the properties of even-Z Super heavy elements (SHE). Durate et al. [1] applied the effective liquid drop model to predict the alpha decay, cluster emission and cold fission half-life values of nuclei on the region of Super heavy elements, defined by $155 \leq N \leq 220$ and $110 \leq Z \leq 135$. In the case of super heavy elements spontaneous fission and alpha decay are the main decay modes. Super heavy nuclei which have relatively small alpha decay half times compared to spontaneous fission half lives will survive fission and thus can be detected in the laboratory through α-decay. The present paper aims to predict possibility of alpha decay in the element Z = 120 isotopes using CYE model and the spontaneous fission half lives are computed using the phenomenological formula proposed by Ren et al. [2].

Cubic plus Yukawa plus Exponential (CYE) model

In this work, to study the decay properties we have used a realistic model [3], called as CYE model we use a cubic potential in the pre-scission region connected by Coulomb plus Yukawa plus Exponential potential in the post scission region. The alpha particle pre exists within the nucleus at a certain distance from the nucleus, the potential encountered by the alpha particle is purely coulomb. This potential as a function of r which is the centre of mass distance of the two fragments for the post scission region is given by

$$V(r) = \frac{Z_d Z_e e^2}{r^2} + V_n(r) - Q, \qquad r \geq r_t$$

The half –life time of the system is calculated using the equation

$$T = \frac{1.423 \times 10^{-21}(1+\exp K)}{E_v}$$

Results and Discussions

Alpha decay half lives in the range $287 \leq A \leq 311$ with Z = 120 have been calculated using CYE model. The decay energy needed for the calculation is taken from Ref. [4]. Figure 1 represents the plot connecting the calculated alpha decay and spontaneous fission half lives against mass number of isotopes with Z = 120. The computed half life times for all the isotopes are compared with the values of Moller and Nix [4] and the results are in close agreement with it.

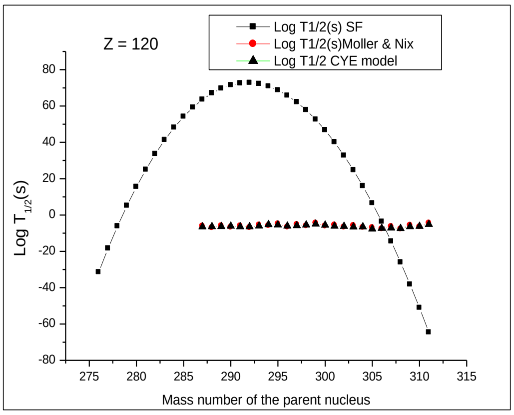

Fig.1 The comparison between spontaneous and calculated alpha decay half life times for the isotopes $^{287\text{-}306}120$

The isotopes situated within the inverted parabola have spontaneous fission half lives greater than that of alpha decay half lives, so these isotopes will survive fission and can be identified via alpha decay. For example, in $^{298}120$ present $\log_{10} T_{1/2}$ (s) = 3.3μs, reference value is 11μs [5] and in $^{299}120$, $\log_{10} T_{1/2}$= 10μs, reference value is 15μs [5]. Some of these isotopes that are already synthesized and our computed alpha decay half lives are in close agreement.

Therefore, the comparison between computed alpha decay half lives and the present spontaneous fission semi empirical formula predictions of isotopes with Z = 120 are studied. From our calculations, we insist that the isotopes of 120 with A ≥ 287 and A ≤ 306, i.e. isotopes in the range $^{287\text{-}306}120$ will survive fission and the alpha decay is restricted within this range. Therefore, we presume that our study will give motivation to future experiments involving the synthesis of SHE.

References

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