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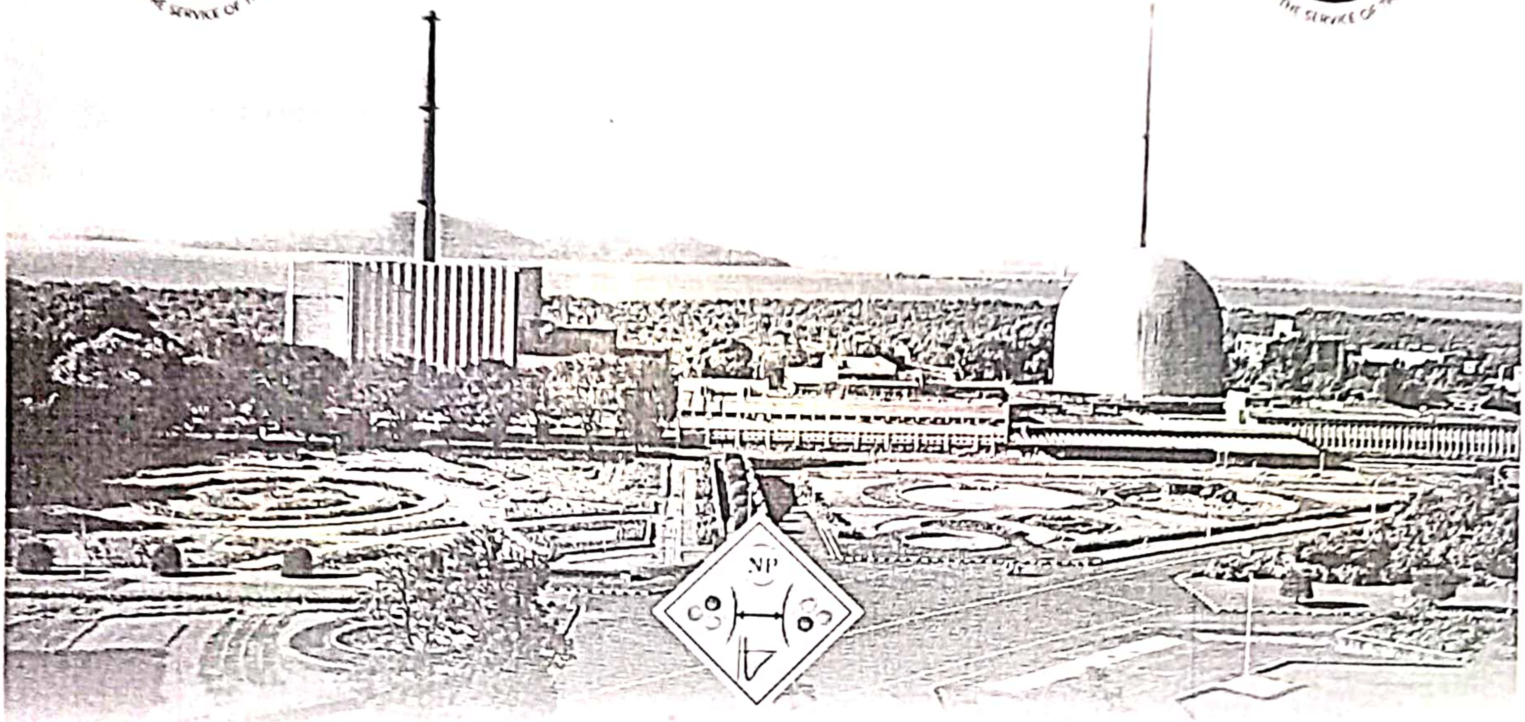

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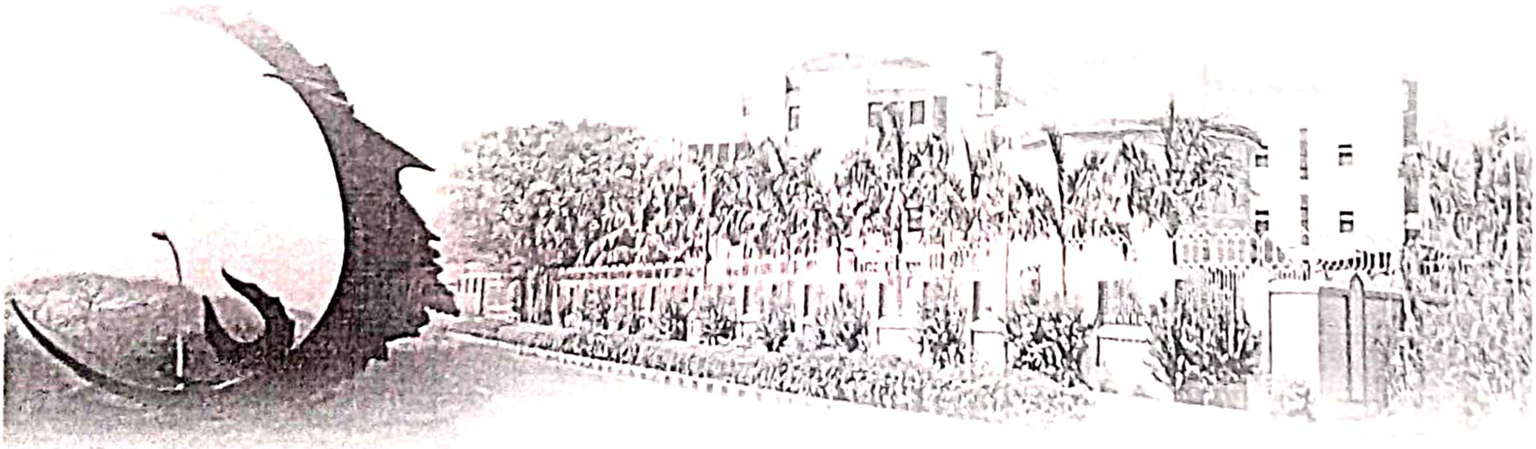

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Preformation probability of α in SHE with Z = 118 to 125

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Introduction

Superheavy elements (SHE) usually refer to transactinide elements with atomic number greater than or equal to 101. For unstable superheavy nuclei, α-decay is an important decay mode. Alpha emission was studied by applying quantum tunneling process by Gamow and liquid drop model is used for fission studies. Unified nuclear potential was developed by Krappe *et al* [1] which is the generalization of liquid drop model. In Yukawa-plus-exponential potential, range of folding function denoted as "a" represents the diffuseness of surface and plays a important role in calculation of half-lives. Poenaru *et al* [3] assumed preformation probability of alpha/cluster as the probability of penetration corresponding to the over-lapping potential in order to equalize the fission and cluster models. The preformation probability of alpha particle for superheavy nuclei synthesized and yet to be synthesized, with Z = 118 to 125 are determined and related shell structure is analyzed in the present work.

Coulomb-plus-Yukawa-plus-exponential potential [1] is used for the post-touching region. A third-order-polynomial [2] is used for the pre-touching part, as given below:

$$V(r) = \frac{Z_1 Z_2 e^2}{r} + V_n - Q, \quad r \geq r_t \qquad (1)$$

with Q value being taken as origin. Cubic barrier is given as,

$$V(r) = -E_v + [V_{r_t} + E_v] \left\{ s_1 \left[\frac{r - r_i}{r_t - r_i}\right]^2 - s_2 \left[\frac{r - r_i}{r_t - r_i}\right]^3 \right\}, \quad r_i \leq r \leq r_t \qquad (2)$$

where r_i is the distance between the centres of mass of two portions of a sphere cut by a plane in two pieces with volume asymmetry of the decay. P_0 indicates pre-formation probability which is the penetrability for over-lapping region [3] which is calculated using WKB method.

$$P_0 = \exp\left[-\frac{2}{\hbar}\int_{r_a}^{r_t} \{2\mu V(r)\}^{1/2} dr\right] \qquad (3)$$

Results and discussion

Preformation probability values of alpha particle for different isotopes of superheavy elements Z = 118 to 125 are calculated using Eq. (3) for the use of surface diffuseness a = 0.8 fm [4]. The influence of the interaction potential is noticed at the touching point. Calculated values of $\log_{10}P_0$ of alpha particle are shown in figure 1 plotted against parent neutron number (N) for different isotopes of superheavy nuclei. In Fig. 1(a) $\log_{10}P_0$ of 28 isotopes of parent nucleus Z = 118 are presented. It is found to have minimum values at N = 162, 164, 178, 182 and 189. The maximum value of $\log_{10}P_0$ is found for N = 186, which confirms N = 184 as predicted magic number. Two neutrons outside the closed shell forms an alpha particle with two protons, hence at N =

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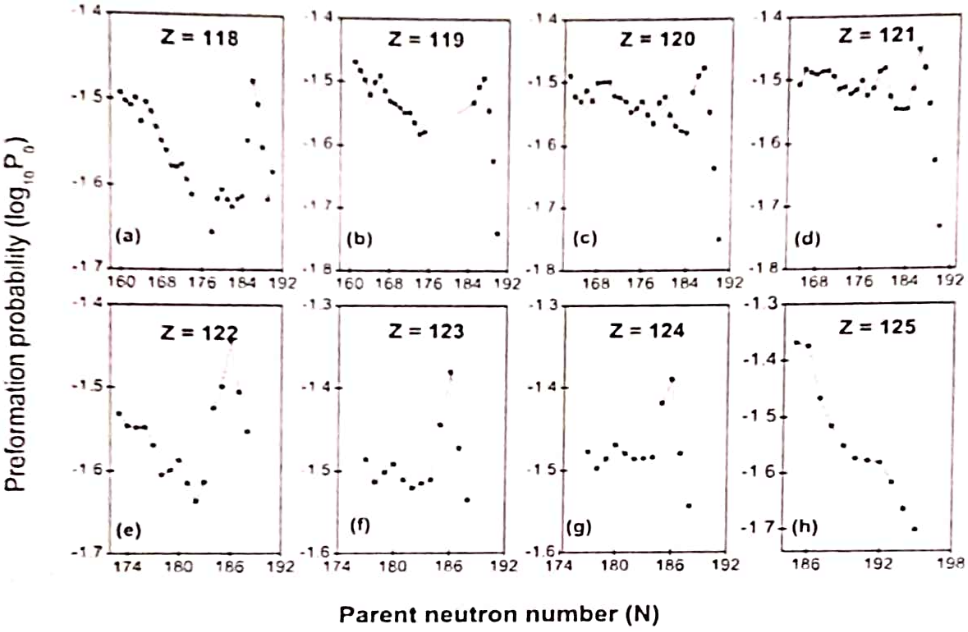

FIG. 1: Decimal logarithmic values of preformation probability plotted against parent neutron number for the isotopes of superheavy nuclei with Z = 118 to 125 using surface diffuseness a = 0.8 fm

184 shell closure is ensured. Similarly, Fig. 1(b) $\log_{10}P_0$ of 21 isotopes of parent nucleus, Z = 119 are presented. It is found to have sharp dip at N = 161 and a sharp rise at N = 165, confirming the magicity at N = 164. The maximum value of $\log_{10}P_0$ is found for N = 187. For the 28 isotopes of Z = 120, $\log_{10}P_0$ values are plotted in panel (c). There is dip noted at N = 165, 167, 174, 178 and 184. After N = 184, value increases till N reaches 187. After N = 187, a steep decrease noted for N = 188, 189, 190. However N = 181 seems to be magic number since there a dip among the other isotopes. Further among 16 isotopes of Z = 122, minimum value of $\log_{10}P_0$ is noted at N = 182 and a maximum is noted at N = 186, confirming magic neutron number at N = 184. In Fig. 1 (f) to (h), $\log_{10}P_0$ values of isotopes of Z = 123, 124, 125 are drawn respectively for 12, 12 and 11 isotopes. In all the three cases, maximum value of $\log_{10}P_0$ is found at N = 186. This confirms the role of shell- structure. When parent neutron number further increases, the value of $\log_{10}P_0$ decreases in all the three cases. In conclusion, the effect of shell structure in preformation probability for the isotopes of superheavy nuclei with Z = 118 to 125 using surface diffuseness a = 0.8 fm, is analyzed and role of the surface diffuseness parameter a will be presented in detail.

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