Fission chance distribution of ^{212}Po

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In an earlier contribution [1] we have investigated the sensitivity of fission excitation function and pre-fission neutron multiplicity data to the different potential energy surface frequently used in literature. Statistical model calculations were carried out with three different options for the potential energy surface: a. liquid drop mass (M_{LD}) and liquid drop fission barrier (B_{LD}), b. experimental mass (M_{exp} = M_{LD} + Δ_n) along with a damping of the shell correction at the ground state (Δ_n) with excitation energy and shell corrected fission barrier ($B_{LD} - \Delta_n$), c. experimental mass and liquid drop fission barrier. The statistical model calculation with option 'a' reproduced both the experimental fission probabilities and the prefission neutron multiplicity (ν_{pre}) data [2–4]. The calculation with option 'b' reproduced the experimental fission probabilities. However, it failed to reproduce the experimental ν_{pre} data. The calculation with option 'c' over predicted both the experimental fission probabilities and ν_{pre} data.

It was observed in Ref. [5] that both the heavy-ion and light-ion induced fission excitation function for the compound nucleus ^{210}Po could be simultaneously explained using the option 'b' only. It was concluded that the experimental ν_{pre} data may have contribution from non-statistical processes and the experimental ν_{pre} data should not be used in statistical model to determine the fission barrier.

In the present contribution, we report the extraction of fission chance distribution and pre-fission neutron multiplicity in fission of ^{212}Po at E* = 59 MeV from the experimental fission excitation function for ^{3,4}He + ^{206,207,208}Pb systems [6]. The results have also been compared with the statistical model predictions with different options for the potential energy surface.

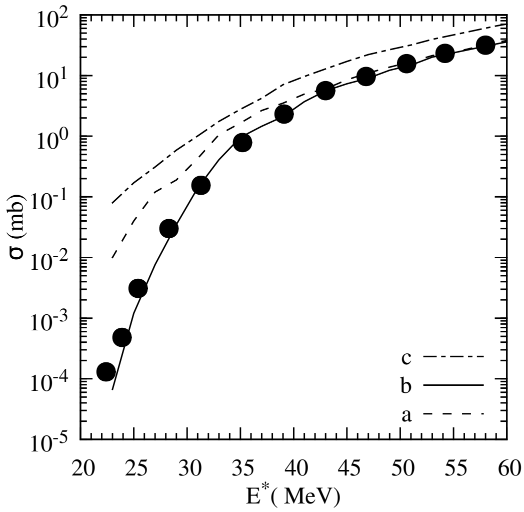

FIG. 1: Experimental fission excitation function for ^{4}He+^{208}Pb is compared with the statistical model predictions with different options for the potential energy surface (see text).

The fission probabilities as a function of chance are obtained form the observed cumulative fission probabilities P_{obs} of neighbouring isotopes with mass A at an excitation energy E_0 and A-1 at E_1 = E_0 - S_n - 2T as [8]

$$P(A, E_0) = \frac{P_{obs}(A, E_0) - P_{obs}(A-1, E_1)}{1 - P_{obs}(A-1, E_1)}, \quad (1)$$

where, S_n and T are the neutron separation energy and temperature, respectively. The average number of neutron emitted before fission (ν_{pre}) have been obtained by taking the first

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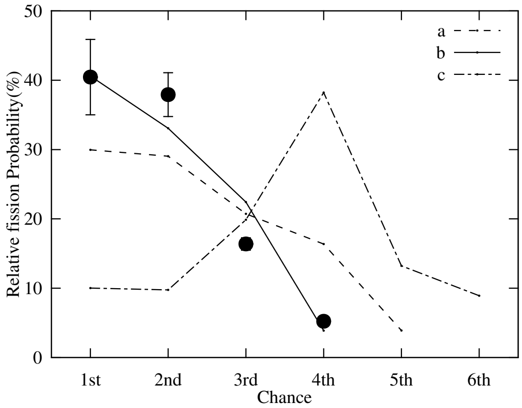

FIG. 2: Extracted relative fission probabilities as function of chance from the experimental fission excitation function are compared with the statistical model predictions with different option for potential energy surface (see text).

moment of the chance distribution.

The statistical model calculations have been carried out using the statistical model code PACE [7]. The ratio of the level density parameter at the saddle deformation to that at the equilibrium deformation ($\tilde{a_f}/\tilde{a_n}$) is taken as 1.026. The macroscopic fission barriers have been scaled by a factor 1.10 for all the option. Other details of the calculations can be found in Ref. [1, 5].

The fission excitation function, fission chance distribution and the pre-fission neutron multiplicities are compared with the statistical model predictions in Fig. 1, 2 and 3, respectively. It is observed that only the statistical model calculation with realistic potential energy surface (option 'b') reproduces the fission excitation function along with the deduced chance distribution and ν_{pre} value. Pre-fission neutron multiplicity deduced from the neutron energy spectra in coincidence with fission [2] are larger as compared to those deduced from the chance distribution, indicating the presence of non-statistical contribution in the deduce ν_{pre} from the measured neutron energy spectra. Option 'b', which is more realistic and accurate, should be used in the analysis for more accurate understanding of the fission process.

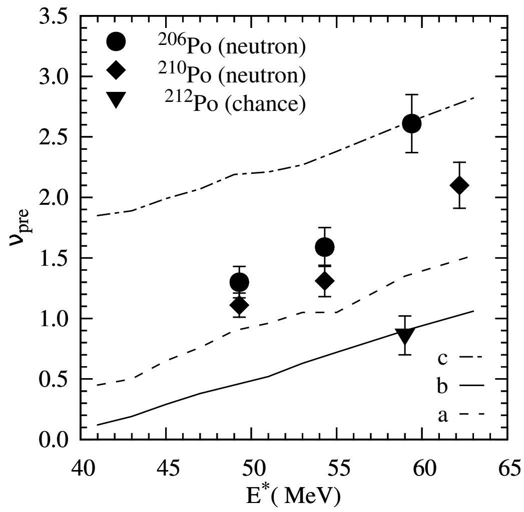

FIG. 3: Pre-fission neutron multiplicity for ^{212}Po from the fission chance distribution is compared with statistical model predictions with different options for the potential energy surface. For comparison, ν_{pre} extracted from the neutron energy spectra in coincidence with fission for ^{206,210}Po [2] is also shown.

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