Systematics of 4-D Langevin Calculations.

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Detailed systematics of fission fragment mass and total kinetic energy (TKE) resulting from four-dimensional (4-D) Langevin calculations are compared with known experimental data and systematics. We will see the contributions of TKE from both symmetric and asymmetric fragments towards the patterns and anomalies seen in both systematics. The mass systematics in question refers to Flynn fission fragment mass systematics. Meanwhile, the TKE systematics we meant here is Viola systematics.

Keywords: Langevin equation, Total kinetic energy, Nuclear Fission

1. Introduction

In the 3-D Langevin calculations with microscopic transport coefficients [1], we are able to see the manifestation of the various fission modes particularly with regards to ^{258}Fm which produces an anomalous TKE estimates far higher than what are expected from Viola systematics [4]. In the current work, the Langevin equation had previously been extended by an extra dimension [5] revealing to us some dynamics that have previously alluded us. As a results, we have now obtained a better understanding regarding the transition from double peak to single peak single fission fragment yield for the actinides from Uranium up to Fermium.

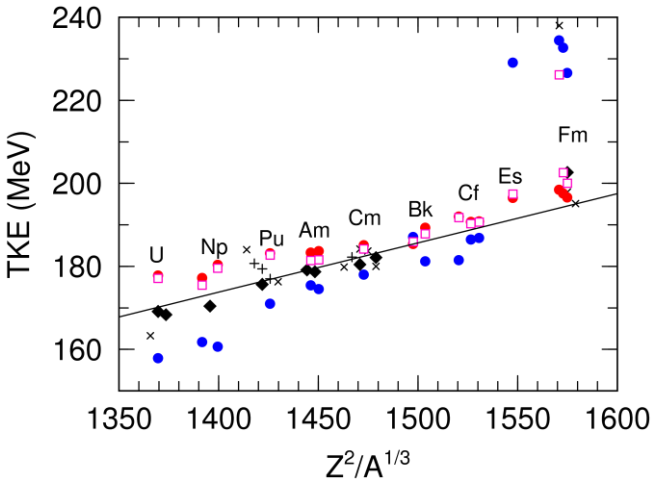

Fig. 1 Calculated TKE systematics for the average (square pink), symmetric (blue) and asymmetric (red) components of the fission fragment mass. Comparison are made with experimental data from Hoffman [2,3] in 'x' and '+' and JENDL's average TKE (diamond). The line is from the systematics by Viola [4].

2. Preliminary Result

Our preliminary result are best summarized in Fig. 1 where we compare the TKE of various fissioning system against the Coulomb repulsion it experienced in the fission process. From Uranium to Fermium with the exception of ^{258}Fm, we noticed that the TKE are dominated by the contributions from asymmetric contributions. Additionally, we see that the TKE from symmetric components increases more rapidly as it approach Californium and increases suddenly for ^{254}Es even though the contributions from asymmetric fragments are more dominant. This clearly indicates that as the double magic configuration of ^{258}Fm are approached, the strength of the symmetric repulsion increases as had been previously speculated.

References

[1] M. D. Usang, C. Ishizuka, F. A. Ivanyuk, and S. Chiba, Phys. Rev. C **96**, 064617 (2017).
[2] D. C. Hoffman and M. R. Lane, Radiochim. Acta **70**, 135-146 (1995).
[3] D. C. Hoffman, T. M. Hamilton and M. R. Lane, *Nuclear Decay Modes* (CRC, Boca Raton, FL, 1996), pp. 393-432.
[4] V. E. Viola, K. Kwiatkowski and M. Walker, Phys. Rev. C **31**, 1550 (1985).
[5] C. Ishizuka, M. D. Usang, F. A. Ivanyuk, J. Maruhn, K. Nishio and S. Chiba, Phys. Rev. C **96**, 064616 (2017).