Effects of microscopic transport coefficients on fission observables calculated by Langevin equations

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We have developed new Langevin-model codes to calculate fission observables as a contract with MEXT. Developed are 1) a Langevin code which can take account of microscopic transport coefficients (the mass and friction tensors) calculated by linear response theory, and 2) a 4-dimensional Langevin code in which deformations of 2 fission fragments are treated to be independent. Calculated results by them will be presented placing emphasis on those with microscopic transport coefficients and their effects on fission observables.

Keywords: Nuclear fission, Langevin equation, microscopic transport coefficients, 4-dimensional Langevin code

1. Introduction

We have a 4-year contract with MEXT to improve accuracy of delayed-neutron nuclear data, based on both experimental and theoretical activities. Here, we present our results on description of nuclear fission by Langevin equations.

2. Computational Method and Results

The nuclear shape during fission is described in terms of two-center shell model, where 3 or 4 collective coordinates are used. In the 4D case, deformations of the 2 fragments are chosen independently besides elongation and mass-asymmetry degree-of-freedoms. The potential energy surface and transport coefficients are calculated at selected grid points of nuclear shape according to Ref. [1].

We have calculated fission observables such as mass distribution and prescission kinetic energy (PKE) of fragments. Figure below shows how average PKE depends on the temperature (T_{tr}) at which the microscopic transport coefficients are calculated. When T_{tr} is small, so is the friction, and then the PKE becomes large. This mean that fission fragments acquire much kinetic energy during descent from the saddle to scission when T_{tr} is small, and opposite is true for large T_{tr}. Therefore, the fission dynamics is affected clearly by the microscopic effects on the transport coefficients.

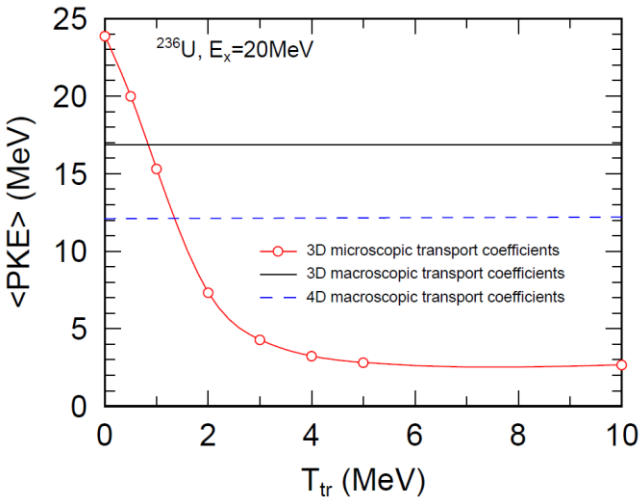

Figure: Dependence of the prescission kinetic energy on temperature T_{tr} at which microscopic transport coefficients are calculated.

3. Conclusion

Effects of microscopic transport coefficients are explored by a new Langevin-model code.

References

[1] F.V. Ivaniuk et al., J. Nucl. Sci. Tech., DOI: 10.1080/00223131.2015.1070111.