Microscopic calculation of spontaneous fission lifetime

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Abstract: The spontaneous fission lifetime has been studied within nuclear density functional theory by minimizing the collective action integral for fission. The collective potential and inertia tensor are obtained self-consistently using the Skyrme energy density functional and density-dependent pairing interaction. The resulting spontaneous fission lifetimes are compared with the static result obtained with the minimum-energy pathway. First, we investigate the dependence of fission pathways on assumptions underlying collective inertia. A two-dimensional calculation for ^{264}Fm is performed for this purpose on the quadrupole collective space of elongation and triaxiality. We show that the dynamic fission pathway becomes strongly triaxial with the nonperturbative mass parameters and it approaches the static fission valley. Then, we proceed further to investigate the role of nuclear pairing in determining the spontaneous fission half-life. To this end, the two-dimensional model is extended to three dimensions by incorporating pairing correlation on the same footing as the collective shape coordinates. We show that the pairing strongly influences the fission path for ^{240}Pu even though the effect is not very significant for ^{264}Fm. Finally, the spontaneous fission half-life is calculated of ^{240}Pu by including the mass-asymmetry degree of freedom in addition to elongation, triaxiality and pairing correlation. A good agreement with the experimental half-life is achieved.