Summary of the doctoral thesis "Study of Spontaneous Fission of Actinide and SuperHeavy Elements" by Jose Marin Blanco

The thesis is devoted to a theoretical description of the nuclear fission phenomenon. Apart from an extended review of theoretical models used by the author, it contains essential estimates of fundamental parameters that decide the occurrence of fission. The macroscopic, microscopic nuclear energy model is used to predict the ground and isomeric state energies, fission barrier heights, and fission paths leading to fission.

The Lublin-Strasbourg drop was used to evaluate the macroscopic part of the energy, and the microscopic energy correction was obtained using the Strutinsky shell correction method and the BCS formalism. The Yukawa-folded mean-field potential was used to describe the singleparticle structure of nuclei. An extended calculation of the potential energy surfaces (PES) in the up-to-date 4D Fourier shape parametrization is performed for 261 even-even nuclei with the proton numbers from Z=90 to 120, taking into account the deformation parameters describing the elongation of a nucleus, left-right mass asymmetry, neck shape and the nonaxiality. The calculation is made in two steps. The first one evaluated the PES for actinide nuclei using a universal expression for the pairing strength, which describes the average properties of nuclei from different mass regions.
Using the equilibrium deformations of nuclei obtained in this calculation, we have refitted the pairing strength to the experimental mass difference of the actinide nuclei. This new local fit of the pairing strength used in the second-step calculations allows for a more precise description of the properties of the heavy and super-heavy nuclei.

The PES analysis results are presented in several tables and are used for the spontaneous fission lifetimes. The fission barrier's penetration probability was estimated in the multidimensional WKB approximation using the irrotational-flow estimate of the inertia tensor. The most probable paths for fission in the 4D space are found within a variational calculation based on the Fourier expansion of the fission path. Obtained in such a way estimates of the spontaneous fission half-lives and the barrier heights are close to existing experimental data, which is a good sign for the predictive power of our model. Such calculations are essential to estimate and predict the stability of unknown isotopes, including the region of super-heavy.