# Study of the dissipation in the fission process

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**Frame :**

Among the different nuclear reactions, the fission is without any doubt one of the most difficult to describe, reflecting the diversity of dynamic aspects of the many body problem. During this dynamic process, the nucleus is found in states of extreme deformations resulting in the formation of two fragments. The sensitivity of fission properties with respect to the studied nucleus or the initial conditions attest to the richness of the phenomenon in which different structure aspects manifest, such as the shell effects or the superfluidity.

**Goal :**

In this context, the studies carried out at CEA are concentrated so far on the fission of actinides in the adiabatic hypothesis: at each stage of the collective motion, the nucleus is considered in its minimum state energy. Only collective degrees of freedom (typically deformation variables) are then used. Nevertheless the mechanisms of nucleon pair breaking have been experimentally observed [1-3] and the energy dissipated in the individual excitations (or intrinsic) of these nucleons is estimated to be in the range of 15-20 MeV at scission. This PhD thesis is concerned with taking account of the excited low energy states of the nucleus to describe the low energy fission, up to a few MeV above the barrier fission.

**Way** : For this objective, the Schrödinger Collective Intrinsic Model (SCIM) has been recently developed [4] by generalizing the coordinate method Generator (GCM) commonly used to describe fission. In the SCIM, 2 quasi-particles excitations are taken into account and the Schrödinger-like equation of the model is governed by a Hamiltonian including the couplings between the different chosen collective and intrinsic degrees of freedom. At first, the different terms of this collective-intrinsic Hamiltonian between excited states will be derived and calculated numerically. One will have to determine the importance of the different terms of the Hamiltonian and to understand the nature of the dominant couplings between quantum states of the nucleus.

Besides, in GCM, the wave function of the nucleus propagates on a potential energy surface which corresponds to the state of minimal energy of the nucleus for a fixed deformation. The second part of the PhD thesis will be devoted to the numerical implementation of the SCIM: the wave function of the fissioning nucleus will spread here on the different potential energy surfaces generated by the intrinsic excitations and the state of energy minimum thanks to the different previously studied couplings.

The application of the SCIM will then be carried out on one or more actinide (s). The estimation of the energy dissipated in the intrinsic excitations will allow a much better estimate of the distribution of the available energy in the total kinetic energy of fission, the emission of fast neutrons or photons. These applications can be done thanks to the exceptional computational resources of the CEA/DAM. Theoretical extensions of the SCIM will also be envisaged.

This thesis will be part of a collaboration between the CEA/DAM, the Australian National University(Canberra, Australia), the Universidad Autonoma de Madrid (Spain) and the Lawrence Berkely National Laboratory (Berkeley, USA).

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[4] R. Bernard et al, Phys. Rev. C 84, 044308 (2011).