Microscopic prediction of gamma-ray strength function

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Abstract:
Recent advances in theory of nuclear structure open the way to the use of microscopic models of nuclei for evaluated data in reactor physics. In this framework, nuclei are considered as a collection of nucleons in strong interaction and their properties are coherently described via the use of so-called A body methods. They represent therefore a tool of choice to describe within a single framework (and without readjustment) phenomena that are very different in nature (spectroscopy, reaction, fission) over the whole nuclear chart. They are expected to improve the predictive power of theoretical models and allow a better extrapolation to systems or observables that are difficult to access experimentally.
In this talk, predictions of gamma-ray strength functions based on microscopic models will be presented. Gamma-ray strength functions constitute a key ingredient of Hauser-Feshbach's statistical model for the determination of the neutron capture (emission) cross section given that this physical process is in direct competition with the emission of a photon. Traditionally, the Quasi Random Phase Approximation (QRPA) (that explores harmonic vibrations around the ground state) is considered to be the tool of choice for systematic microscopic calculations over the nuclear chart. We will list the advantages and limitations of QRPA and see how these drawbacks (that are usually corrected a posteriori with ad hoc external parameters) can affect the input used for nuclear cross-sections.
This will motivate the introduction of a theory going beyond standard QRPA, i.e. the Projected Generator Coordinate Method (PGCM), that has been employed for many years in the nuclear structure community to describe the low-lying spectroscopy of nuclei, but rarely for strength functions. We will illustrate how the PGCM overcomes most of QRPA's limitations on the basis of monopole and dipole strength functions in selected sd-shell nuclei.
This preliminary study, performed within the PAN@CEA collaboration, paves the way for the systematic generalization of these tools to all nuclei in the coming years.