Giant and pigmy dipole resonances in neutron-rich nuclei far from the stability: their excitation via Coulomb and nuclear fields

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One of the more interesting aspect in the study of the structure of nuclear systems far from the stability is the evolution of the properties of the nuclear collective modes, in primis the giant resonances. Interest has been first focussed on the Giant Dipole Resonance (GDR): our microscopic RPA calculations shows that, in spite of the pure isovector character of the mode, the presence of a neutron skin in the density leads to a non-vanishing isoscalar transition density. As a result the GDR will be also excited by the nuclear field induced by isoscalar probes, as α particles. The corresponding excitation probabilities will be a direct measure of the extension of the neutron skin.

Microscopic RPA calculations, based on both non-relativistic and relativistic mean-field, also display the occurrence of new dipole strength at lower excitation energy, in agreement with pioneer experimental findings. This strength (usually named as Pigmy Dipole Resonance, PDR), should not be confused with the threshold stength arising from the halo structure in weakly-bound nuclei and is instead normally associated with the soft collective mode in which the valence neutrons of the skin oscillate against the (proton+neutron) core. Different calculations have led to controversial conclusions about the collectivity and the precise nature of these states. We have compared our calculated RPA isoscalar and isovector transition densities with the predictions of the macroscopic soft dipole mode (cf. Fig.1). We have then calculated, folding these microscopic densities, Coulomb and nuclear formfactors for the excitation of these modes in heavy-ion induced reactions. We show how the use of different projectiles, altering the relative role of isoscalar and isovector nuclear components, can provide unique information on the real nature of these states.

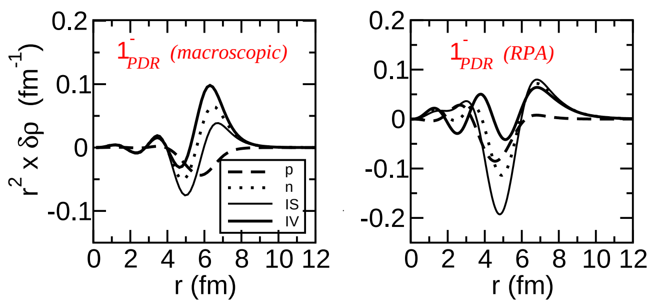

FIG. 1: Comparison of isoscalar and isovector transition densities for the Pigmy Resonance. The results of the microscopic RPA are compared with those associated with the macroscopic soft mode.

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