DIPOLE RESPONSE OF NUCLEI WITHIN THE CONFIGURATION INTERACTION APPROACH

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Abstract:
The gamma strength functions are fundamental properties of atomic nuclei as they govern the formation and decay of excited nuclei. They are also inputs for calculations of radiative neutron capture cross-sections which play a central role in astrophysics models of nucleosynthesis and stellar evolution. The astrophysics simulations require the knowledge of nuclear structure ingredients for about 5000 nuclids therefore they rely on theoretical predictions of nuclear structure observables, including the gamma strength functions.
While all electromagnetic multipoles can contribute to the strength function, usually the electric dipole (E1) transitions dominate. Above the particle threshold, the E1 strength function is governed by the isovector giant dipole resonance (GDR) but at lower energies the situation is more complex : in nuclei with neutron excess one observes an enhancement of the strength called pygmy dipole resonance (PDR) interpreted as an excitation of the neutron skin over the N=Z core. As the pygmy mode is located near particle threshold, its impact on astrophysical reactions rates and resulting abundounces of the rprocess have been studied [1].
The Brink-Axel hypothesis states in its primary primary version that the cross section of the GDR is independent on the structure of the state on which it is built. As in the stellar environements one deals with with finite temperatures, the validity of Brink-Axel hypothesis for excited states becomes crucial. In recent works [2, 3] the E1 photoabsorption and photoemission strength functions were studied for the first time within the Configuration Interaction (CI) approach. In particular, the Brink-Axel hypothesis was studied in the PDR region in Ne isotopes showing deviations with sizeable consequences on calculated neutron-capture rates. Most interestingly, a redistribution of the PDR strength on excited states was noted : this completely new phenomenon requires further insight and understanding of the nature of PDR strength in light and heavier nuclei. To this end, CI calculations of dipole response will be performed in several nuclei followed by a detailed examination of evolution of sum rules, widths, strength distributions and microscopic structure of low-energy states with varying excitation energies.

[1] S. Goriely, E. Khan, M. Samyn, Nucl. Phys. A739, 331 (2004).
[2] K. Sieja, Phys. Rev. Lett. 119, 052502 (2017).
[3] K. Sieja, submitted (2022).