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Pygmy resonances in the mirror

The origin of low-energy E1 strength remains an open issue even in the case of stable nuclei. An important question is whether a collective resonance develops (often called pygmy resonance) and accordingly what mechanisms could generate or hinder it. The answer holds particular relevance for predictions about shell structure, the softness of the symmetry energy, phonon coupling, and broad resonances in the continuum.

The majority of related studies, both theoretical and experimental, have focused on neutron-rich nuclei. Here I focus on analyses and predictions for N = 20 isotones [1], which include the stable and symmetric 40Ca and the magic drip-line nucleus 48Ni, and how they compare with their mirror Ca isotopes [2]. The mirror nucleus of the very exotic 48Ni, namely 48Ca, is stable and has been thoroughly studied. The comparisons help one address the role of shell effects and the continuum in determining the strength distribution – see also a related study of Ni isotopes [3]. The models used for this work include pairing (QRPA) or the continuum (CRPA).

Indeed, larger amounts of E1 strength in the asymmetric N = 20 isotones are predicted than the amounts of strength predicted or detected in equally asymmetric Z = 20 mirror nuclei, pointing unambiguously to the importance of structural effects, as opposed to global parameters like absolute asymmetry, in determining the E1 spectrum at low energy. An exotic collective excitation is found most likely in 46Fe but perhaps also in 44Cr and 48Ni. I will show that a correct, converged treatment of threshold transitions (as in CRPA), and therefore of extended wave-functions, is important for the description of proton pygmy states since the proton emission threshold is extremely low. Ongoing investigations focus on the role of the effective mass in the modeling [4].

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[2] P.Papakonstantinou at al., Phys. Lett. B 709 (2012) 270.

[3] P.Papakonstantinou, et al.,Phys. Rev. C 92 (2015) 034311.

[4] H.Gil, P.Papakonstantinou et al., in preparation.

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