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Studying the pygmy dipole resonance in Sn isotopes with the Oslo method

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The electric dipole response of neutron-rich nuclei below the neutron threshold often reveals the presence of the pygmy dipole resonance (PDR). As this feature is commonly interpreted in relation to the neutron excess and oscillations of the neutron skin, a multifaceted experimental and theoretical study of this feature may have a significant impact on studying both the nuclear structure properties in general and heavy element nucleosynthesis via astrophysical s-, i-, and r-processes.

This work presents a systematic study of the dipole γ-ray strength functions (GSF) below the neutron threshold in eleven Sn isotopes ($^{111-113}$Sn,$^{116-122}$Sn and ^{124}Sn) with a primary goal of investigating the evolution of the pygmy dipole strength with increasing neutron number in the Sn isotopic chain. The experimental GSFs have been extracted from the particle$-\gamma$ coincidence data by applying the Oslo method [1], primarily used for a simultaneous extraction of statistical properties of nuclei, such as the GSF and the nuclear level density. The shapes of the strengths in some of the studied nuclei have been additionally constrained with the novel shape method applied to the coincidence data [2]. The previously published strengths in $^{116-119,121,122}$Sn [3] have been re-analyzed in order to provide a model-consistent analysis throughout the isotopic chain.

All experimental strengths were compared to the GSFs extracted from relativistic Coulomb excitation in forward-angle inelastic proton scattering below the neutron separation energy [4], where they were found to be in excellent agreement at least down to ≈ 6 MeV. The Oslo method strengths below and the Coulomb excitation data above the neutron threshold provide an exhaustive picture of the dipole nuclear response, covering the giant dipole resonance, the PDR, and the low-lying $M1$ strength. The evolution of parameters characterising the PDR as well as the fraction of the corresponding classical Thomas-Reiche-Kuhn (TRK) sum rule with increasing neutron number will be presented together with the study on the effect of the pygmy dipole strength on the radiative neutron capture cross-sections in these nuclei. The low-lying dipole strength appears to be almost constant ($2-3\%$ of the TRK sum rule) throughout the chain of the studied isotopes, in contradiction to the majority of theoretical approaches. Despite this, the presence of an enhancement in the strength close to the neutron threshold has a noticeable effect on the astrophysical i process in this mass region.

[1] A. C. Larsen *et al.*, Phys. Rev. C **83** (2011) 034315.
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[3] H. K. Toft *et al.*, Phys. Rev. C **83** (2011) 044320.
[4] S. Bassauer *et al.*, Phys. Rev. C **102** (2020) 034327.

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