The 29th International Nuclear Physics Conference (INPC 2025)

INPC 2025
May 25-30, 2025
DCC, Daejeon, Korea

Contribution ID: **208**

Type: **Contributed Oral Presentation**

Pygmy Dipole Resonance and its evolution in the Sn mass region studied with the Oslo method

Thursday, 29 May 2025 17:35 (15 minutes)

The pygmy dipole resonance (PDR) is typically associated with an enhancement in the low-lying electric dipole response of stable and unstable heavy nuclei, appearing on top of the tail of the giant dipole resonance (GDR). Despite the ongoing debates regarding its origin, its emergence is commonly linked to the presence of the neutron excess and might potentially affect the neutron-capture rates and, thus, abundances of elements produced in heavy-element nucleosynthesis [1]. A systematic investigation of the evolution of the PDR and the low-lying electric dipole strength in general in different isotopic chains with different theoretical approaches and experimental methods is therefore of interest for both general nuclear structure studies and astrophysical simulations.

This work presents a consistent systematic study of the low-lying electric dipole strength and the potential PDR in Pd, Cd, In, and Sn isotopes with the primary goal of investigating its evolution with increasing neutron number, comparing it with available theoretical approaches, and revealing a possible impact of this feature on the astrophysical radiative neutron-capture processes. The analysis involves a simultaneous extraction of the nuclear level densities and the dipole γ-ray strength functions (GSF) of the studied nuclei using the Oslo method [2]. Combining these data with available (γ, n) cross sections and the electric and magnetic dipole strengths from relativistic Coulomb excitation in forward-angle inelastic proton scattering [3] allows us to extract the low-lying $E1$ component from the total dipole strength. It appears to exhaust $\approx 1-3\%$ of the classical Thomas-Reiche-Kuhn (TRK) sum rule, being either nearly constant throughout the whole chain of isotopes or mildly increasing with neutron number. This is in contradiction with the majority of theoretical approaches, such as, e.g., relativistic quasiparticle random-phase and time-blocking approximations, which predict a steady increase in the PDR strength with neutron number. Moreover, a presumably isovector component of the PDR was extracted for $^{118-122,124}$Sn.

The GSFs and nuclear level densities of the studied nuclei were further used as inputs to constrain the cross sections and Maxwellian-averaged cross sections of (n, γ) reactions on Cd and Sn isotopes using the reaction code TALYS [4]. The obtained results agree well with other available experimental data and the recommended values from the libraries. Despite a relatively small exhausted fraction of the TRK sum rule, the low-lying electric dipole strength makes a noticeable impact on the radiative neutron-capture cross sections in the studied isotopes, contributing up to 20% of the estimated total cross sections. Moreover, the presence of a PDR-like enhancement in the GSFs of ^{122,1124}Sn was found to affect the production of Sb in the astrophysical i process, providing new constraints on the uncertainties of the resulting chemical abundances from multi-zone low-metallicity Asymptotic Giant Branch stellar models.

[1] S. Goriely *et al.*, Phys. Lett. B **436** (1998) 10-18.
[2] A. C. Larsen *et al.*, Phys. Rev. C **83** (2011) 034315.
[3] S. Bassauer *et al.*, Phys. Rev. C **102** (2020) 034327.
[4] A. Koning *et al.*, Eur. Phys. J. **59** (2023) 131.

Primary author: MARKOVA, Maria (University of Oslo)

Co-author: Prof. LARSEN, Ann-Cecilie (University of Oslo)

Presenter: MARKOVA, Maria (University of Oslo)

Session Classification: Parallel Session

Track Classification: Nuclear Structure