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Photon strength functions and nuclear level densities at the ELI-NP/IFIN-HH facilities

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The γ-ray beam under construction at the ELI-NP facility is projected to provide users with high-energy, high-intensity and narrow bandwidth photon beams for nuclear structure studies. Two major topics that can be studied at such a facility, with the almost complete selectivity of electromagnetic probes, are high-precision measurements of nuclear $J^P = 1^-$ level densities and the electric dipole photon strength functions. In parallel to the ongoing construction of the ELI-NP photon beams, an experimental program of complementary measurements of photon strength functions and nuclear level densities with charged particle probes has started at the 9~MV Tandem facilities at IFIN-HH using large-volume scintillator detectors from ELI-NP [1]. This is an important preparatory step for the ELI-NP photon beams, in addition to being a complementary technique where photon probes and hadronic probes can be used together to extract as model-independent data as possible on these quantities.

In a first experiment in 2023, we measured photon-ray strength functions and nuclear level densities of ^{112,114}Sn for the first time at the 9~MV Tandem accelerator facilities at IFIN-HH using the Oslo method [2]. Comparisons with the quasiparticle-phonon model results show the importance of complex configurations to the low-energy dipole response in the pygmy dipole resonance energy region. The experimental data are further included in the cross-section and reaction rate calculations for the (n,γ) reaction, showing a significant increase in reaction rates at high temperatures. In a second $(\mathrm{p},\mathrm{p}'\gamma)$ scattering experiment in 2024, we have extracted the nuclear level density of ^{128}Te [3]. Here, the decay data were normalised using photonuclear data, resulting in nuclear level densities without intrinsic model dependencies from the constant temperature or Fermi gas models, showing the potential of complementary experiments with photon beams and charged particle beams for the future ELI-NP facility. In a third experiment, scheduled for June 2025, we intend to measure the nuclear level densities and photon strength functions of ^{140}Ce using the same methods. This measurement will continue comparing the nuclear level densities obtained in photonuclear reactions with those determined from proton-beam data.

[1] S. Aogaki, et al. Nucl. Instrum. Methods Phys. Res. A 1056 (2023) 168628
[2] P.-A. Söderström, et al. Phys. Rev. C, in print
[3] P.-A. Söderström, et al. Phys. Scripta, in print

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