Study of dipole strength distributions at the ELBE accelerator

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Dipole strength functions up to the neutron-separation energies S_n of the N=50 isotones ^{88}Sr [1], ^{89}Y [2], ^{90}Zr [3], the even-mass Mo isotopes from ^{92}Mo to ^{100}Mo [4,5], the N=82 nuclide ^{139}La [6] and the doubly magic ^{208}Pb [7] have been studied in photon-scattering experiments using the bremsstrahlung facility [8] at the superconducting electron accelerator ELBE of the Forschungszentrum Dresden-Rossendorf.
To estimate the distribution of inelastic transitions from high-lying levels at high level density to low-lying levels, simulations of γ-ray cascades were performed. On the basis of these simulations, intensities of inelastic transitions were subtracted from the experimental intensity distributions that include the resolved peaks as well as a quasicontinuum formed by unresolved transitions, and the intensities of elastic transitions to the ground state were corrected for their branching ratios. The photoabsorption cross sections obtained in this novel way are combined with (γ, n) and (γ, p) data and give detailed information about the dipole strength functions in the energy range from about 4 MeV up to the giant dipole resonance (GDR). In all nuclides enhanced strength compared to Lorentzian-like approximations of the tail of the GDR is found in the energy range from about 5 MeV up to about the respective particle thresholds. Consequences of the enhanced strength for reaction rates of photonuclear reactions are discussed.
Calculations in the framework of the quasiparticle-random-phase approximation (QRPA) underestimate the dipole strength at low energy and show strong fluctuations in the whole energy range up to the giant dipole resonance (GDR). A new approach is presented that calculates the dipole strength for nuclei with shape fluctuations by combining the interacting boson approximation (IBA) with QRPA. Based on the slow shape dynamics and the fast dipole vibrations an Instantaneous Shape Sampling (ISS) is performed that describes the photoabsorption at a fixed shape with QRPA with probabilities given by IBA [9]. The ISS-QRPA improves the description of the experimental photoabsorption cross sections but still requires additional smearing. Predictions of ISS-QRPA for isotopic chains with changing nuclear deformation are presented.
Shell-model calculations including $(2p\text{-}2h)$ excitations performed for the case of ^{208}Pb show that the higher-order excitations are the main mechanism for the fragmentation of the strength and hence for the spreading of the GDR [7].

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