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Unique Information on Proton-Neutron Structure of Nuclear States from Combined Electromagnetic and Hadronic Scattering Experiments

A consequence of the formulation of the proton-neutron version of the Interacting Boson Model [1] is the occurrence of low-energy mixed-symmetry states with boson couplings that are partially non-symmetric with respect to proton and neutron boson labels. This results in enhanced M1 gamma-ray transitions to lower-lying fully symmetric states that dominate the low-energy M1 strength function in heavy nuclei. The existence of mixed-symmetry states have later-on been verified experimentally. Their properties are uniquely sensitive to the effective proton-neutron interaction in the valence shell. Electromagnetic probes such as photon scattering, electron scattering, or projectile-Coulomb excitation on light targets have proven themselves as powerful methods for the identification and quantitative investigation of the fundamental building block of quadrupole-collective mixed-symmetry structures of heavy nuclei, the one-phonon mixed-symmetry 2+1,ms state. A complete set of data on the 2+1,ms state has been obtained [2-4] on stable even-even isotopes of the A=130 mass region on the basis of absolute M1 transition rates. For the case of ¹³²Te the method of projectile-Coulomb excitation has produced first solid evidence for a mixed-symmetry state of a radioactive nuclide [5], too. Information on the dominant single-particle components involved in the formation of quadrupole-collective one-phonon states of vibrational nuclei has recently been obtained [6] from a comparison of inelastic electron-scattering and proton-scattering cross sections. Quantum interferences in charge- or matter-transition densities enable one to determine whether a proton boson or a neutron boson couples antisymmetrically within the mixed-symmetry wave function [6]. New data [7] on that phenomenon will be presented and discussed. The topic represents a strong physics case for a continued collaboration between TU Darmstadt and iThemba Labs.

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