Contribution ID: **31** Type: **not specified**

Nuclear Mixed-Symmetry States as Probes for the Proton-Neutron Effective Valence-Shell Interaction

Monday 12 February 2007 14:40 (30 minutes)

Considerable efforts are currently being made to improve our understanding of the structural evolution of heavy nuclei, in particular, those with neutron excess. This evolution as a function of nucleon number is dictated by the dynamics of the valence shell. Since quantitative theoretical predictions from first principles are not yet possible, experimental constraints and input on key quantities, such as the proton-neutron quadrupole-quadrupole interaction, are highly desirable. The proton-neutron interaction in the nuclear valence shell dominates the formation of collective structures at low excitation energy, e.g., nuclear quadrupole deformation. The properties of proton-neutron non-symmetric excitation modes of the valence shell, so-called mixed-symmetry states (MSSs), are particularly sensitive to certain parts of the effective valence-shell interaction. MSSs of stable nuclei have, therefore, been studied for over 20 years with electron-, photon-, and neutron-scattering reactions. We have recently demonstrated [1,2] a technique for investigating MSSs based in Coulomb excitation reactions in inverse kinematics, a method applicable to neutron-rich radioactive ion beams. MSSs in vibrational nuclei such as 96Ru and 138Ce near N=50 and 82 neutron shell closures have been studied with this method. We will give an overview over these results and we will address the potential research on MSSs with modern RIBs.

[1] N. Pietralla et al., Phys. Rev. C 64, 031301(R) (2001).
[2] G. Rainovski et al., Phys. Rev. Lett. 96, 122501 (2006).

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Session Classification: Opening Session