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Collectivity in light neutron-rich nuclei

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The observation of either enhanced or reduced transition strengths (collectivity) can signal unexpected changes in nuclear structure. In light neutron-rich nuclei both phenomena have been reported and both have led to unexpected results and new insights.

An example of the former is found in the "island of inversion". First observed through an increased binding in 31Na, the N=20 isotones 30Ne, 32Mg, and 31Na are now known to exhibit large quadrupole transition strengths, B(E2)'s, consistent with large quadrupole (charge) ground-state deformations. This is despite N=20 being a pronounced spherical shell gap for stable nuclei (e.g. 40Ca). The onset of collectivity (deformed ground-states) for n-rich N=20 isotones is currently understood as a weakening of the N=20 shell gap due to the neutron-proton interaction.

An example of the latter (reduced collectivity) has been reported in carbon and boron isotopes where reduced B(E2) values have been interpreted as a "decoupling" of neutrons and protons. While the definition of decoupling may turn out to be subjective, the evolution of B(E2) values in neutron-rich carbon isotopes has received a great deal of attention recently, both experimental and theoretical. The B(E2) trend towards the drip-line is sensitive to, for example, the isospin dependence of effective charges, changes in shell gaps and possible differences in proton and neutron deformations.

We will present data on both phenomena.

• Data from experiments carried out at the NSCL to study the transition from "spherical"to "deformed"ground-states in Na and Ne nuclei will be discussed. The focus will be on the 2-proton knockout from 32Mg to 30Ne, both are considered to have deformed (intruder) ground states. 2-p knockout (from ⊠d5/2) has a distinctive spin dependence and we use thus to identify the 4+ state for the first time. Also for the first time we have used the fully mixed MSCM wavefunctions to calculate 2-p knockout cross-sections. The measured (quenched) 2p knockout cross-section, when compared to theory, may suggest a significant difference in the neutron intruder content between 32Mg and 30Ne, contrary to current shell models.

• Data will be presented from a new lifetime measurement for the first-excited 2+ state in 16C. The experiment was carried out at the LBNL 88-Inch Cyclotron using the Recoil Distance Method and 9Be(9Be,2p) fusion-evaporation reaction. The mean lifetime was found to be 11.7(20) ps corresponding to a B(E2) of 4.15(73) e2fm4, consistent with other even-even closed shell nuclei and neighboring systematic, and provides an important benchmark for theory.

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