Evolution of collectivity and mirror symmetry along $N = Z$

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Unlike any other physical system the nucleus represents a unique dual quantum many-body system. Its constituents, the protons and neutrons, are assumed to be identical, except for their electric charge. They can be seen as two representations of the nucleon, with isospin components $t_z = \pm 1/2$ for neutrons and protons, respectively. Under the assumption of charge independence of the strong interaction, hence invariance under rotation in the isospin space, the properties of mirror nuclei should be identical.

Mirror symmetry is typically studied through energy differences between excited states of mirror nuclei or isospin triplets. Measurements of $B(\mathrm{E2}; 0^+_{\mathrm{gs}} \rightarrow 2^+_1)$ values for $T = 1$ isospin triplets allow to extract information on the proton and neutron matrix elements and to test isospin symmetry.[1)] The proton and neutron multipole matrix elements can be written in isospin representation

$$M_{\mathrm{n/p}} = \frac{1}{2}\left(M_0(T_z) \pm M_1(T_z)\right) \qquad (1)$$

where $M_0(T_z)$ is the isoscalar and $M_1(T_z)$ the isovector multipole matrix element. Assuming isospin conservation the proton matrix elements of isobars are a linear function of T_z only, *i.e.* $M_0(T_z) = M_0$ and $M_1(T_z) = M_1 \cdot T_z$, with constant $M_{0/1}$ for all T_z. The linearity provides a direct test of the isospin purity of the states. So far this has been tested for light nuclei, mostly in the *sd* shell, the heaviest case where the $B(\mathrm{E2}; 0^+_{\mathrm{gs}} \rightarrow 2^+_1)$ values of all three members are measured is the $A = 46$ system.[2)]

In order to test this relation in heavier nuclei we have studied the Coulomb excitation of $A = 62$ nuclei. All three nuclei were studied under identical experimental conditions to reduce the statistical and theoretical uncertainties. The ^{62}Zn, ^{62}Ga, and ^{62}Ge beams were produced by the fragmentation of a 345 AMeV primary ^{78}Kr beam provided by the SRC. Unique particle identification in BigRIPS and the ZeroDegree Spectrometer was achieved by means of ΔE-$B\rho$-TOF measurements. Secondary Be and Au targets were used to determine the $B(\mathrm{E2}; 0^+_{\mathrm{gs}} \rightarrow 2^+_1)$ values. The particle identification plots for the ^{62}Zn beam impinging on the Be target is shown in Fig. 1.

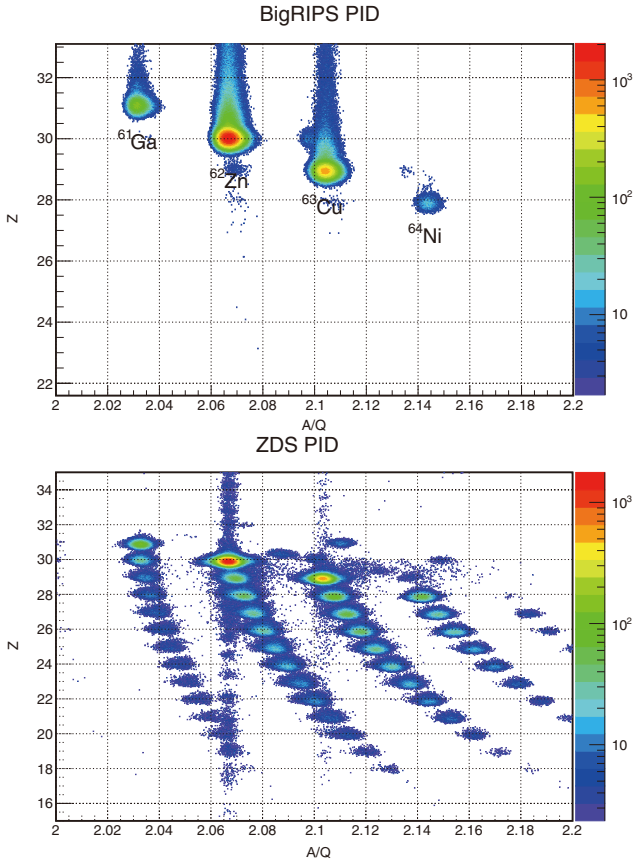

Fig. 1. Particle identification plots for the ^{62}Zn beam impinging on the Be target.

The beams impinged on secondary targets located at the F8 focus. γ rays from excited states were detected in the DALI2+ array. Sufficient statistics for all three members of the $A = 62$ multiplet were collected to determine the linearity of the proton multipole matrix elements with a precision of about 5%. Additionally new states were observed in nuclei beyond the $N = Z$ line. The results will shed new light on the evolution of collectivity along the $N = Z$ line and provide one of the most stringent tests of isospin symmetry.

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