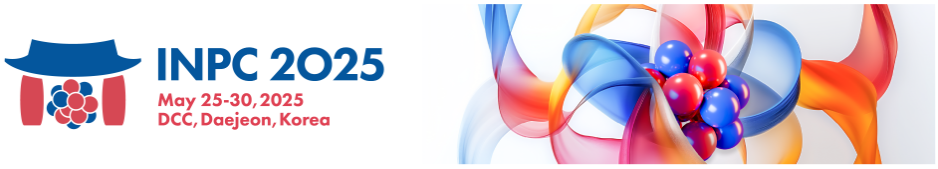


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# Lifetime Measurements in N=Z 88Ru at FRIB

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Crucial questions remain unanswered in the heaviest accessible region of $N = Z$ nuclei, where both the neutron and proton Fermi levels are located well inside the $g_{\frac{9}{2}}$ region. The details of how collectivity varies for $N = Z$ nuclei between $^{56}$Ni and $^{100}$Sn, and the location, and extent, of the maximum collectivity presents a demanding test of our best nuclear-structure models - see e.g. [1]. The reduced transition probability $B(E2 : 2_1^+ \rightarrow 0_1^+)$ remains one of the most sensitive probes of quadrupole collectivity and can provide an indication of nuclear deformation. To date the heaviest $N = Z$ systems, for which $B(E2 : 2_1^+ \rightarrow 0_1^+)$ have been measured, are $^{78}$Y (odd-odd) and $^{80}$Zr (even-even) [2]. The results demonstrate the presence of rapidly changing nuclear collectivity with the addition of nucleons beyond mass 70. An issue of much contemporary significance in this region is whether $N = Z$ nuclei are likely to show clear evidence for isoscalar ($T = 0, J > 0$) np-pairing correlations [3]. A measurement of the $B(E2 : 2_1^+ \rightarrow 0_1^+)$ can potentially shed light on these issues. For example, calculations [4] suggest that $T = 0$ np pairing plays an important role in both the evolution of the moments of inertia in the $N = Z$ nucleus $^{88}$Ru and the absolute value of the predicted $B(E2 : 2_1^+ \rightarrow 0_1^+)$. Indeed, the structure of the $^{88}$Ru yrast band exhibits a delayed rotational alignment [5] which has been interpreted in terms of the presence of such isoscalar np pairing. In this contribution, new results from FRIB on the lifetime of the $2^+$ state in $^{88}$Ru will be presented - the heaviest $N = Z$ nucleus for which such a measurement has been possible. We will also report on progress towards the lifetime measurement of the $T = 1$ $2^+$ state in odd-odd $N = Z$ $^{86}$Tc.

The experiment was performed in April 2023 at FRIB. A 250 MeV/u $^{124}$Xe beam was used to produce fragmentation beams of $^{88}$Tc and $^{89}$Ru, separated using the new ARIS spectrometer at FRIB. Final fragments were identified using the S800 spectrometer, with $\gamma$ rays recorded using GRETINA. The TRIPLEX plunger device was utilised in order to determine the lifetimes, and hence $B(E2 : 2_1^+ \rightarrow 0_1^+)$ values, for the $N = Z$ nuclei $^{88}$Ru and odd-odd $^{86}$Tc. The first results for the measured $B(E2 : 2_1^+ \rightarrow 0_1^+)$ for $^{88}$Ru will be presented and compared with state-of-the-art shell-model and DFT calculations. For the shell model, two new approaches are available and have been applied to the new results for $^{88}$Ru. The first is the new Discrete Nonorthognal shell-model approach [6], which applies mean-field and beyond-mean-field techniques, and the second is the large-scale shell model (LSSM) using a new interaction, ZBM3 [7], operating in the $f_{5/2}, p, g_{9/2}, d_{5/2}, s_{1/2}$ space. The new results for $^{88}$Ru present the first opportunity for $N = Z$ results to be evaluated in such a model space.

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