Evolution of collectivity in neutron-rich Ru nuclei†

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One of the central features in our understanding of the atomic nucleus is the appearance of magic numbers. Isotopes in their proximity can be described in terms of single-particle interactions with an inert core. Most nuclei, however, lie sufficiently far from magic numbers for collective behaviour to dominate over the single particle structure. In the prolate-oblate transition regions comparable energy minima corresponding to different shapes can lead to shape coexistence and to stable intermediate shapes with different deformations on each axis, so called triaxial nuclei.

An experiment was carried out using at RIBF using a ^{238}U beam with an energy of 345 Mev/u, and an average intensity of $\sim$ 10 pnA and a 555 mg/cm^2 beryllium target. After the target, BigRIPS and ZeroDegree were used for separation and tagging of the nuclei of interest. The secondary beam was implanted into the WAS3ABi silicon detectors. The β-delayed γ-rays were detected with the EURICA[1)] detector array.

The β-delayed γ-ray spectra associated with ^{116}Tc and ^{118}Tc were analysed and interpreted in terms of observables of collectivity[2)]. The energy ratio $R(4/2) = E(4_1^+)/E(2_1^+)$ is one such observable, ranging approximately from the minimum at $R(4/2) = 2$ for spherical nuclei and the maximum $R(4/2) = 3.33$ for rigid rotors. The trends of this ratio as a function of N for Mo, Ru and Pd chains, shown in Fig. 1, indicate that these elements are well deformed in this region. The Pd chain exhibits a relatively stable value around the transitional limit, $R(4/2) = 2.5$, while the Mo chain is closer to the deformed limit and the Ru chain lies in between the former. For the most neutron-rich Ru isotopes the beginning of a shape transition towards sphericity can clearly be seen.

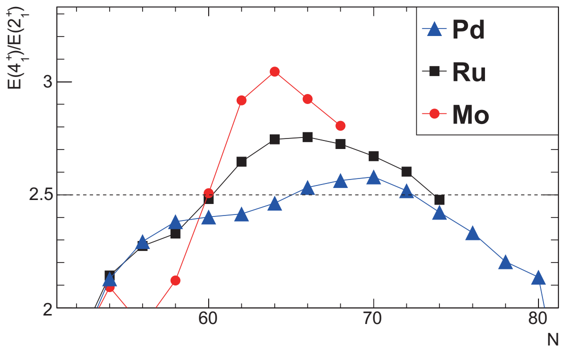

Fig. 1. Experimental $R(4/2)$ ratios. In addition to what was shown in[2)], recent data from[3,4)] have been added to the Pd chain.

Calculations were also carried out for the even-even $^{108-118}$Ru isotopes with the interacting boson model and the algebraic collective model. The conclusions are that the very neutron-rich nuclei still show many features associated with triaxial γ-soft nuclei, represented by the O(6) symmetry, but are approaching a spherical structure, the U(5) symmetry, with increasing neutron number towards the $N = 82$ shell closure.

References
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† Condensed from the article in Phys. Rev. C, **88**, 024301 (2013)

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