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High-spin structure of ^{102}Ru

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Abstract. High-spin states in the nucleus ^{102}Ru have been studied through the $^{96}\text{Zr}(^{13}\text{C}, \alpha 3n)$ reaction using the EUROBALL IV γ -ray spectrometer accompanied by the DIAMANT array for the detection of charged particles. All previously known bands have been extended to higher spins and additional bands have been found. Comparing the experimental Routhians and aligned angular momenta to the predictions of Woods-Saxon TRS calculations, $vh_{11/2}(d_{5/2}, g_{7/2})$ configurations have been assigned to the observed negative-parity bands.

Keywords: rotational bands, configuration assignments

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Recently, several nuclear structure phenomena related to triaxiality have been pointed out in the region of transitional nuclei near $A \sim 100$ just below the tin isotope chain. Their structure is characterized by valence hole-like protons in the $g_{9/2}$ orbital with high Ω below the $Z=50$ gap and valence particle-like neutrons in the $d_{5/2}$, $g_{7/2}$, $h_{11/2}$ orbitals with low Ω above the $N=50$ gap. The different shape driving forces of the low- and high- Ω orbitals may lead to triaxial shapes due to the γ -softness of the core. Indeed, observation of signature inversion in $^{98,100-103}\text{Rh}$ and chiral twin bands in $^{104,105,106}\text{Rh}$ has been reported providing experimental evidence for the existence of stable triaxial shapes in this region. In a more recent work, the rigid or γ -soft character of the triaxiality in ^{102}Ru has been examined in the low-spin regime relevant for chiral symmetry breaking observed in the neighboring odd-odd nuclei [1]. Previously, the evolution from vibrational to rotational structure has been clearly highlighted in the positive parity yrast cascade of ^{102}Ru [2]. The bottom part in one of the previously identified negative-parity bands has been described as a sequence where octupole vibration may appear [3]. The study of the negative-parity bands at higher spin can provide a further interesting insight into the change from vibrational to rotational motion.

The experiment was carried out at the Vivitron accelerator at IReS, Strasbourg. A

^{13}C beam impinged upon a stack of two targets, each of thickness $558 \mu\text{g}/\text{cm}^2$ and enriched to 86% in ^{96}Zr . The emitted γ rays were detected by the EUROBALL IV detector array which consisted of 15 cluster and 26 clover composite Ge detectors. The γ rays were measured in coincidence with charged particles observed by the DIAMANT array consisted of 88 CsI detector elements in order to eliminate the contaminants from the stronger ($^{13}\text{C}, \text{xn}$) reaction channels. The data obtained from the Ge detectors were sorted into a $\gamma\gamma\gamma$ -coincidence cube by requiring the detection of an α -particle and then a standard gating procedure was used to construct the level scheme. A total of 72 transitions were assigned to ^{102}Ru , two thirds of which are observed the first time in the present work. In order to determine the multipolarities of the γ -ray transitions, an analysis of angular-correlation ratios based on the DCO formalism was carried out. The multipolarity assignments were further corroborated by extracting the electromagnetic character of the transitions by measuring the linear polarization of the γ rays. Besides that several new high-spin bands were established, the ground state band has been extended up to $E_x \sim 12$ MeV with $I^\pi=(26^+)$, while the previously published negative-parity bands have been extended up to $E_x \sim 11$ and ~ 9 MeV with $I^\pi=(23^-)$ and (20^-) , respectively.

To further investigate the appearance of octupole vibration in the bottom part of the most intense negative parity band, we plotted the $R_{E-GOS} = E_\gamma(I \rightarrow I-2)/I$ versus I E-GOS trajectory, which is sensitive to a transition between vibrational and rotational states [2]. The behaviour of this curve is in a good agreement with the assumption that at low spins this negative parity band corresponds to a vibration structure [3], while for higher spins it has a rotational character. To explain the structure of the observed bands in higher spin regime, their experimental Routhians and aligned angular momenta were extracted and compared with total routhian surface (TRS) calculations based on the Woods-Saxon cranking formalism. Using this comparison and the deduced $B(M1)/B(E2)$ ratios, $\nu h_{11/2}(g_{7/2}, d_{5/2})$ configurations are suggested for the negative-parity structures.

Further details of the experimental methods and the discussion can be found in Ref. [4].

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