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Beta-decay study of the shape coexistence in ^{98}Zr

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Shape evolution in atomic nuclei has been a major area of research in nuclear physics. While throughout the nuclear chart the evolution of a spherical ground-state shape into a deformed one is usually a gradual process, in the Zr isotopic chain an abrupt shape transition is observed at N=60. Recent state-of-the-art Monte Carlo Shell Model (MCSM) calculations have successfully reproduced this dramatic onset of deformation in ^{100}Zr and predict that the same deformed configuration may coexist at higher excitation energies in lighter Zr isotopes [1, 2]. Of particular interest is ^{98}Zr, which is a transitional nucleus lying on the interface between both spherical and deformed nuclear phases. Based on the above, extensive experimental and theoretical research efforts have been made to study the shape coexistence phenomena in this isotope [3,4,5,6]. Although these studies provide an overall understanding of ^{98}Zr's nuclear structure, uncertainties remain in interpreting its higher-lying bands. Specifically, two recent studies utilizing MCSM [3] and Interacting Boson Model with configuration mixing (IBM-CM) [4] calculations have presented conflicting interpretations. The MCSM predicts multiple shape coexistence with deformed band structures, whereas the IBM-CM favours a multiphonon-like structures with configuration mixing.

To address these uncertainties, a β-decay experiment was conducted at TRIUMF-ISAC facility utilizing the 8π spectrometer with auxiliary β-particle detectors. The high-quality and high-statistics data obtained enabled the determination of branching ratios for weak transitions, which are crucial for assigning band structures. In particular, the key 155-keV $2^+_2 \to 0^+_3$ transition was observed, and its branching ratio measured, permitting the B(E2) value to be determined. Additionally, γ-γ angular correlation measurements enabled the determination of both spin assignments and mixing ratios. As a result, the 0^+, 2^+, and $I = 1$ nature for multiple newly observed and previously known but not firmly assigned states has been established. The new results revealed the collective character of certain key transitions, supporting the multiple shape coexistence interpretation provided by the MCSM framework. These results will be presented and discussed in relation to both MCSM and IBM-CM calculations.

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