Measurements of octupole collectivity in ^{90,91}Zr*

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The collective excitation mode and its coupling with the single-particle excitation mode in atomic nuclei remain a fundamental issue in modern nuclear structure physics [1]. At low excitation energy, the rotational and vibrational spectra of even-even nuclei provide the simplest examples of collective modes, with quadrupole and octupole excitations comprising the latter one. Due to the almost spherical ground state of nuclei near the shell closures, quadrupole collectivity is seen to be less compared to the cylindrically symmetric deformed nuclei. In contrast, octupole excitations in these spherical nuclei have been observed by measuring enhanced electric-octupole transition strengths, B(E3) values [2] associated with octupole phonon states. Additionally, the coupling between a valence nucleon and an octupole phonon can induce octupole collectivity in the neighboring odd-A nuclei having one particle outside the even-even core by acquiring a permanent octupole deformation [3]. In this context, zirconium isotopes around $A = 90$ region having semimagic $Z = 40$, draw attention for the assessment of the evolution of octupole collectivity across the isotopic chain.

To explore such features, a series of new measurements have been performed on ^{90,91}Zr through different interaction mechanisms using hybrid setup of the Indian National Gamma Array (INGA) and various ancillary detectors at Tata Institute of Fundamental Research, India [4, 5]. Observation of the 3^-_1 state in ^{90}Zr has been confirmed through the relevant γ-decays having coincidence detection of scattered projectiles in an annular double-sided Si-detector [6]. The $B(\mathrm{E3}; 3^-_1 \rightarrow 0^+_{\mathrm{g.s.}})$ strength in ^{90}Zr has been extracted for the first time via Coulomb excitation technique by analyzing the yields of the γ-transitions and other spectroscopic data using the semi-classical least squares search code GOSIA [7]. In a separate heavy-ion fusion-evaporation experiment incorporating multi-fold γ-coincidence conditions in clover HPGe and $LaBr_3$(Ce) detectors, lifetime of the $11/2^-_1$ state in ^{91}Zr has been measured employing electronic fast- timing technique that leads to a significantly enhanced $B(\mathrm{E3}; 11/2^-_1 \rightarrow 5/2^+_{\mathrm{g.s.}})$ value [8]. The extracted B(E3) strengths have been compared with the random phase approximation calculations and Skyrme interactions. The above results will be discussed in consideration of recently published findings [9].

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