Interplay of shapes through non-collective excitations in neutron deficient $A \sim 120$ in perspective of ^{122}Te

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The nuclei in $A \sim 120$ region is known to be γ-soft. They are characterized by a few number of nucleons outside the shell-closure, which are sufficient to induce deformation in the system. Thus, the mass region is in itself a rich laboratory to study various structural effects associated with interplay of collective and non-collective excitations [1, 2]. The alignment of individual angular momenta along the rotational axis can generate a limited total angular momentum, thus terminating a given configuration [3–5]. Here the symmetry axis coincides with the rotational axis thereby forbidding collective rotation about the symmetry axis and only single-particle excitations can prevail. In these nuclei, alignments of protons in low-$\Omega h_{11/2}$ orbitals favor prolate shape while the aligned neutrons in medium- to high-$\Omega h_{11/2}$ orbitals may drive the nucleus towards non-collective oblate shape [2].

The pairing independent and pure terminating states are helpful in probing the nature of nuclear potential and come up with an efficient interaction to demonstrate the observed phenomenon [6]. Recently, maximally aligned and anti-aligned states were observed in ^{120}Te, ^{122,123,125}I [5, 7–9].

The β-stable nucleus ^{122}Te is a member of this transitional mass region. Present work concentrates on low-medium spin region in ^{122}Te and the results are discussed in the framework of theoretical models.

Excited states of ^{122}Te were populated using the reaction ^{116}Cd(^{11}B, p4n)^{122}Te with beam energy of 65 MeV and current 1.5 nA which was provided by 14UD pelletron accelerator at TIFR, Mumbai. A self supporting target with a thickness of 15mg/cm^2 was used for the reaction. In-beam γ-rays were detected using Indian National Gamma Array (INGA)[10, 11] and a total of 3.1×10^9 events with clover fold ≥ 2 were recorded using Pixie-16 modules of XIA LLC [10, 12] in a beamtime of three days. Calibrated and gain matched data were sorted into $\gamma - \gamma$ matrices and $\gamma - \gamma - \gamma$ cubes using data sorting routine "MARCOS" developed at TIFR [13]. The software package RADWARE was used in the offline data analysis [14].

In the present work, we confirm the transitions observed in previous works [15–17] and could extend the level scheme further to spin $I \sim 23\hbar$. The level scheme of ^{122}Te highlights irregular structures with appearance of several decay branches above $I^\pi = 14^+$ state.

The observed energy states relative to a rotating rigid rotor shows three prominent minima at spins 16^+, 22^+ and $21\hbar$. The 16^+ state has been interpreted as maximally aligned state with a configuration of $\pi[(g^2_{7/2})]_{6^+} \otimes \nu[h^2_{11/2}]_{10^+}$ [3–5, 17, 18] in lighter Te isotopes. TRS calculations for Te isotopes with A$\geq$118 predict 22^+ state as a favored oblate state of $\pi[(g^2_{7/2})]_{6^+} \otimes \nu[h^4_{11/2}]_{16^+}$ configuration [17].

Observation of negative parity states at low energy is a common feature in even-even Te isotopes [3, 4]. Literature survey shows that these states are based on odd number of protons or neutrons in $h_{11/2}$ orbital [3–5]. TRS predicts existence of 19^- and 22^- in ^{122}Te based upon odd number of proton or neutron quasiparticles in the $h_{11/2}$ orbital.

These observations motivated us to carry out shell model [22] as well as pairing independent cranked Nilsson Strutinsky calculations [23] to probe into the excitation modes in ^{122}Te (details of calculations will be presented during seminar). The calculated results are

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in well agreement with those of observed phenomenon thus highlighting the significance of maximally aligned states.

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