Abstract

Over the past few decades, γ-ray spectroscopy has emerged as one of the leading experimental probes into the structure of the atomic nucleus across different regions of the nuclear chart. One of these regions is the transitional region, which lies between the spherical Sn isotopes and the deformed La and Ce isotopes and is notable for exhibiting shape changes and coexisting shapes. This thesis uses γ-ray spectroscopy to study the structure of three such isotopes in this region: ^{126}Te, ^{125}Te, and ^{123}Te. In the present work, excited states of ^{125,126}Te were produced in a fusion evaporation reaction $^{124}\mathrm{Sn}(\alpha, 3n/2n)^{125,126}\mathrm{Te}$. The resulting γ-γ coincidences were recorded using the Indian National Gamma Array. The high-spin states of ^{123}Te were populated via the reaction $^{80}\mathrm{Se}(^{48}\mathrm{Ca}, \alpha 3n)^{123}\mathrm{Te}$ and the de-exciting γ rays were detected using the GAMMASPHERE.

The level scheme for ^{126}Te has been enriched with the addition of 65 new transitions and five newly identified structures. Spin-parity assignments were made for the observed states. The experimental results were interpreted in the framework of the nuclear shell model using the large-scale shell model code ANTOINE and subsequently configurations were suggested for the various spin states.

The level scheme of ^{125}Te established in the present work has been considerably expanded with the placement of 92 new transitions. Three positive- and three negative-parity structures exhibiting a rotation-like nature have been identified. The particle rotor model has been employed to explain the behavior of the low-spin states in this nucleus, and configurations were assigned to these structures based on particle rotor model calculations. Experimental results indicated a multiquasiparticle nature for the higher-spin states.

The high-spin states of ^{123}Te have been explored in the present work. Much of the previously known level scheme has been verified, and spin-parity assignments have been made accordingly. A notable result obtained from this work is the presence of a collective band above a tentative spin 43/2. The observation of a rotational-like band at such high spins suggests that this band is of a highly deformed nature, based on a $\pi(g_{9/2})^{-2}$ configuration. Cranked Nilsson-Strutinsky

calculations were performed to assign configurations to the different structures.

Preliminary shell model calculations of the odd-mass ^{125,123}Te isotopes were carried out using ANTOINE. The effectiveness of the *Z50.bonna* interaction in explaining the experimental results was studied.

Keywords: Nuclear reactions ^{124}Sn$(\alpha, 3n/2n)^{125,126}$Te, E = 31, 35 MeV; ^{80}Se$(^{48}$Ca$, \alpha 3n)^{123}$Te, E = 205 MeV; INGA; GAMMASPHERE array; $\gamma - \gamma$ coincidences; RADWARE package; DCO; IPDCO; spin and parity; shell model code ANTOINE; Particle Rotor Model; Cranked Nilsson Strutinsky calculations