Structural Evolution in ^{125}I, ^{123}I and ^{122}I with Increasing Angular Momentum

Abstract

This thesis investigates the angular momentum induced structural changes in ^{125}I, ^{123}I, and ^{122}I nuclei. Three separate experiments were performed to acquire the requisite data. The high spin states in ^{125}I and ^{123}I were studied using the heavy-ion fusion evaporation reactions ^{82,80}Se(^{48}Ca,p4n)^{125,123}I with the Gammasphere array. The nucleus ^{122}I was investigated using the reaction ^{116}Cd(^{11}B,5n)^{122}I with the Indian National Gamma Array (INGA) spectrometer. A detailed level scheme, for both positive and negative parities, have been established in the study of all the three nuclei. These nuclei undergo a shape transition from moderately deformed states with collective rotation at low spins to non-collective oblate configurations at higher spins. Non-collective oblate states, which are energetically favored with respect to a rotating liquid drop reference, have been identified at spin $I \sim 30\,\hbar$ in all the three nuclei. Cranked Nilsson Strutinsky (CNS) calculations suggest that these states are maximally aligned states, formed by aligning all the valence particles above $^{114}_{50}$Sn$_{64}$ core, along a common axis. In addition, favored non-collective states, where the spin vectors of one or two particles are anti-aligned, have also been identified at $I \sim 20 - 22\,\hbar$.

Several dipole transitions of energies in the range of $1.0 - 1.7$ MeV have been observed feeding the maximally aligned non-collective states in ^{123}I and ^{122}I. CNS calculations indicate that these weak feeding transitions originate from the configurations involving a core-breaking neutron particle-hole excitation from the $g_{7/2}d_{5/2}$ to the $d_{3/2}s_{1/2}$ or $h_{11/2}$ orbitals across the semi-magic $N = 64$ shell gap.

At high-spin, rotational bands extending upto $I \sim 50\,\hbar$ have been observed in ^{125}I and ^{123}I. The properties of these newly identified bands are similar to those of the highly deformed bands recently discovered in the neighboring nuclei, ^{125,126}Xe and ^{124}Ba. Moreover, the band in ^{125}I is found to be 'identical' to one of the bands in ^{126}Xe. This suggests almost similar configuration for the two bands. A comparison of various features of the bands with the results of the CNS calculations suggests that the configuration of these bands involve neutron excitations across the $N = 82$ shell gap into the $h_{9/2}$ and $i_{13/2}$ orbitals, coupled to the proton two-particle-two-hole excitation from the $g_{9/2}$ orbitals across the $Z = 50$ shell closure.

Key words: Nuclear reactions ^{80,82}Se(^{48}Ca,p4n)^{123,125}I, $E = 205{-}207$ MeV; ^{116}Cd(^{11}B,5n)^{122}I, $E = 65$ MeV; Gammasphere array; INGA array; measured γ-γ coincidences; E_γ; I_γ; angular distribution ratios; linear polarization; spin and parity; Cranked Nilsson-Strutinsky Model calculations.