The observation of evolution of different nuclear shapes across N,Z 28 shell closure

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Evolution of different nuclear shapes are primarily due to change in occupation of nucleons in different active nucleonic orbitals. Nuclei with N,Z 28 are close to doubly magic, self conjugate ^{56}Ni which has a soft core as compared to other doubly magic ^{48}Ca [1]. Their configuration space comprised of $1f_{7/2}$, $2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$ and $1g_{9/2}$ orbitals. The first shell gap which is created due to the presence of spin−orbit coupling term in the nuclear Hamiltonian is 28 shell gap, which is created due to lowering of $1f_{7/2}$ orbital from upper fp space. Due to this, the particle-hole excitation across this shell gap may be possible at relatively lower excitation energies. On the other hand, $1f_{7/2}$ and $1g_{9/2}$ single-particle orbitals have large shape driving effect which can bring collectivity in the system. Also, the coupling of $2p_{3/2}$ and $1g_{9/2}$ orbitals ($\triangle$j=3 and $\triangle$l =3) can bring octupole correlation in the system. Therefore, possibilities of different nuclear shapes in this part of nuclear chart is very high. Even-even ^{56}Fe (Z=26, N=30) is known to have shape coexistence of prolate and oblate shapes at lower excitation [2]. Now it will be interesting to see how the shape evolves with change in occupation of nucleons from ^{56}Fe. With this idea in mind, an gamma ray spectroscopy experiment was performed at VECC, Kolkata using 34 MeV α beam from K-130 cyclotron on ^{55}Mn target to populate nuclei with 1 neutron particle (^{57}Fe), 1 neutron particle and 1 proton hole (^{54}Mn) as well as 1 proton hole (^{55}Mn) coupled to ^{56}Fe core. The deexcited γ rays were detected using 11 CS clover detectors and 1 LEPS detector placed at 3 different angles (3 including LEPS at 40°, 6 at 90°and 3 at 125°). The PIXIE-16 digitizer based data acquisition system and IUCPIX package, developed by UGC-DAE CSR Kolkata [3], was used to record and process the data. The $\gamma\gamma$ symmetric and asymmetric matrices and $\gamma\gamma\gamma$ cube were constructed to establish the level scheme and to assign spin and parity of the levels. The lifetimes of a few states were also measured using DSAM technique. The evolution of different nuclear shapes including deformed (axial and triaxial) and spherical at different excitation energies have been observed for these 3 nuclei which is caused due to the affect of odd particles on shape coexistent core. The octupole correlation has also been observed. Detailed results will be presented in the conference.

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