Exploring the isoscalar - isovector symmetries in ^{94}Ru, ^{95}Rh, ^{94}Pd and ^{96}Pd nuclei by means of lifetime measurements

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Two body interaction between like and unlike nucleons plays an important role in explaining various nuclear structure properties. The isovector interaction between like nucleons give rise to the seniority scheme, where seniority, ν, is defined as the minimum number of unpaired particles in a single j shell for a given configuration |j^n,I>. It is a conserved quantum number for a system with n identical particles, each with angular momentum j, interacting through a pairing force **[1]**. The isoscalar coupling on the other hand arises from the occupancy of unlike nucleons in close lying orbits. In this regard, the nuclei such as ^{94}Ru$_{50,}$ ^{95}Rh$_{50}$ and ^{96}Pd$_{50}$ **[2]** were studied in the present experiment to explore the nature of seniority symmetry in the $g_{9/2}$ subshell for protons and the ^{94}Pd$_{48}$ nucleus was studied to search for the competition between isoscalar and isovector couplings among the nucleons residing at the $g_{9/2}$ subshell **[3]**.

The nuclei of interest were produced in the projectile fragmentation of a 850 MeV/nucleon ^{124}Xe beam impinging on a 4 g/cm^2 ^{9}Be target, as the first of a series of commissioning “FAIR-0” experiments with the DESPEC **[4]** experimental setup at the GSI- FAIR facility in Germany. The isomeric states of ^{94}Pd and ^{96}Pd were populated directly, whereas the β-decay of ^{95}Pd populates the isomeric states of ^{94}Ru and ^{95}Rh. The nuclei were implanted on an active stopper, AIDA, and the γ-rays of interest were detected using the six triple cluster HPGe detectors as well as 36 LaBr$_3$(Ce) detectors of the FAst Timing Detector Array (FATIMA)**[5]**. Direct lifetime measurements via γ- γ coincidences using FATIMA has been applied to determine the lifetimes for the yrast states below the isomer of the mentioned nuclei. The Generalised Centroid Difference (GCD) **[6]** method was implemented for the lifetime measurement in the picosend regime. The transition rates were obtained from the measured lifetimes and the BE(2) values were compared with the shell model calculations in various model spaces. With the remeasured ^{96}Pd lifetimes, the new results for the ^{94}Ru nucleus was successfully described using the Δν=2 seniority admixture allowed in the fpg model space using the Jun-45 interaction **[7]**, on the other hand a large anomaly from the seniority scheme was found for the ^{95}Rh**[8]**. The transition rates for the ^{94}Pd was compared with the state-of-the- art shell model calculations to provide a successful interpretation **[9]**.

Thus, in summary, the lifetime measurement for the yrast states of ^{94}Ru, ^{95}Rh, ^{94}Pd, and ^{96}Pd puts up a stringent test to the existing concept of isovector and isoscalar couplings between nucleons, and could possibly open up some new direction to understand the aspects of nucleon-nucleon interactions.

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