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Investigation of single-particle and collective behavior in K-isotopes

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Nuclei in the neighborhood of doubly closed ^{40}Ca usually exhibit characteristics of spherical single particle excitations [1] and their excitation spectra are well explained by spherical shell model. However, in Nilsson diagram, the low Ω orbitals from pf shell, especially for $1f_{7/2}$ are sharply down sloping for increasing deformation. Therefore, one may expect deformed or superdeformed structures with multi-hole multi-particle configurations in the sd shell nuclei. The observation of super deformed bands in ^{42}Ca [2], ^{40}Ca [3], ^{40}Ar [4, 5], ^{38}Ar [6], ^{36}Ar [7], and ^{35}Cl [8] have generated new interest in this mass region. The observed bands were also explained successfully by shell model calculations. Therefore, this region gives us a unique opportunity to investigate experimentally, the interplay between single-particle and collective degrees of freedom and interpret them theoretically by larger-scale shell model calculations.

^{38}K (N=Z=19) and ^{40}K (Z=19 and N=21) are odd-odd nuclei in this region. ^{38}K and ^{40}K nuclei were previously studied by C.J. van der Poel *et. al.* [9] and P.-A. Soderstrom *et. al.* [10], respectively, through heavy-ion reaction. The level scheme of ^{38}K was extended to 11 MeV, whereas 8 MeV for ^{40}K. The spin and parity of most of the levels were not confirmed / assigned for both nuclei. Lifetime information was also not available for most of the levels. In the present work, we have experimentally investigated the high spin structure of ^{38}K and ^{40}K and interpreted them theoretically through Large Basis Shell Model (LBSM) calculations.

We have performed two heavy-ion experiments at IUAC, New Delhi, to populate ^{38}K and ^{40}K nuclei. We have added 4 new transitions and 2 new levels above the isomer in the existing level scheme of ^{38}K. Our current work identifies 14 new transitions and 6 new levels in ^{40}K. The R_{DCO}, R_{ADO} and linear polarization measurements were carried out to assign / confirm / modify the spin and parity of the levels for both nuclei. In our present work, we have measured the mixing ratio of most the transitions for the first time. LBSM calculations have been performed using the code OXBASH [11] to understand the microscopic origin of each excited state in ^{38}K and ^{40}K. The SDPFMW [12] interaction was used in these calculations. Two-nucleon transfer spectroscopic factor calculations have been carried out for a few levels of interest in these nuclei to understand the spectroscopic co-relation with the levels in the neighboring nuclei (A±2). Evolution of collectivity with angular momentum has also been studied in terms of particle partitions of the levels. Based on the theoretical analysis, we have predicted the presence of a deformed band at the higher excitation energies in ^{38}K.

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Presentation type

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