Role of the Higher-Spin Configurations and the Universal Description of Low-Energy Structure of $N \sim Z$ Even-Even sd-Shell Nuclei in the Algebraic Microscopic Mixed-Mode Approach

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The role of the less symmetric spatial and the higher-spin configurations in the single-oscillator-shell description of the low-lying collective states in $N \sim Z$ even-even sd-shell nuclei is revealed and explained. We use the Algebraic Microscopic Mixed-Mode Approach to solve the Schrodinger equation for a pairing-plus-quadrupole schematic Hamiltonian. The full isoscalar plus isovector pairing mode (described by the group $O(6)$ in the sd shell) and the $SU(3)$ rotational mode of Elliott type are treated on an equal footing by introducing a two-mode shell-model scheme. So, instead of using the $SU(3)$ Elliott scheme, as was usually done in the past, we work with a basis comprised of two subsets. Specifically, as suggested by the combined dominance of the pairing and the quadrupole-quadrupole terms in the Hamiltonian over terms like the spin-orbit interaction for the description of the low-energy structure in even-even sd-shell nuclei, our basis consists of the lowest-lying pairing-type- (with lowest seniority) eigenstates and the Elliott-type rotational leading configurations with maximal value of the second-order Casimir invariant of $SU(3)$. Our main focus are the low-energy excitation spectra as well as the energy eigenstates described in various truncated model spaces. Comparison of our outcome with the experiment is given as well.