

Symmetry-Guided *Ab Initio* Approach to Light and Medium Mass Nuclei

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We investigate the low-lying states of ${}^6\text{Li}$, ${}^8\text{B}$, ${}^8\text{Be}$, ${}^{12}\text{C}$, and ${}^{16}\text{O}$ using *ab initio* symmetry-adapted no-core shell model approach. We demonstrate an important role of many-particle correlations associated with large quadrupole deformations and a narrow set of low intrinsic spin quantum numbers. Our results suggest that a small subspace of symmetry-adapted configurations can very closely approximate the exact solutions while allowing for exact factorization of the center-of-mass degrees of freedom. This, in turns, allows to extend reach of *ab initio* structure and reactions studies toward heavier nuclei of the *sd*-shell and beyond.