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Understanding the structure of ^{16}C and the $B(E2)$ problem through Large-Scale Shell-Model (LSSM) calculations

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The structure of neutron-rich carbon isotopes continues to be a subject of interest in nuclear physics, particularly the nucleus ^{16}C. One of the key unresolved issues is the variation in measured $B(E2)$ values for the transition from the first-excited 2_1^+ state to the ground state, with reported values spanning nearly an order of magnitude. Traditional interpretations assume a simple model in which two valence neutrons couple to a ^{14}C core, requiring the introduction of a large effective charge to match experimental data. However, this approach does not fully capture the complexity of ^{16}C's nuclear structure.

This work presents results from a large-scale $(2+4)\hbar\omega$ no-core shell-model calculation of ^{16}C, incorporating six major shells and employing the Zheng *et al.* interaction within the OXBASH framework. The analysis of the wave functions indicates significant mixing of higher-order configurations, challenging the validity of the simple two-neutron model. The theoretical predictions are further validated by comparing the computed excitation spectrum and intermediate-energy elastic proton scattering cross-sections with experimental data. Notably, the results demonstrate that a smaller, or even negligible, effective charge is sufficient to reproduce the accepted $B(E2)$ value, resolving discrepancies observed in previous studies.

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