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Microscopic Descriptions of 12C+ for the Oxygen-16 States in the Stellar Alpha-Capture Rate Evaluation[1] WILLIAM GOOD, University of Tennessee, MATTHEW BURROWS COLLABORATION, KRISTINA LAUNEY COLLABORATION — We report the first calculations of low-lying excited 0^+ states in ^{16}O and their rotational bands within a no-core shell-model framework. Such descriptions pose a challenge because of the cluster and collective nature of these states but become feasible in the no-core symplectic shell model (NCSpM). The model utilizes the almost perfect symmetry of nuclear dynamics that preserves equilibrium shapes. It uses an inter-nucleon interaction deduced in the symplectic effective field theory with only four parameters. The NCSpM yields the low-lying positive-parity energy spectrum of ^{16}O and other observables in reasonable agreement with experiment. We use the NCSpM wave functions of ^{16}O to project onto ^{12}C+α cluster wave functions to calculate alpha partial widths and asymptotic normalization coefficients. Our results are in good agreement with available experimental data and point to the importance of collectivity to reproduce the data. These results are crucial to further improving the evaluation of the ^{12}C$(\alpha,\gamma)^{16}$O reaction rate at astrophysical temperatures. This rate is of cosmological importance and may further inform studies of the masses of black holes that pulse pair instability supernovae produce.

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