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The Hoyle state and the 12C continuum

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The structure of 12C, and especially the nature of its excited states above the three-alpha threshold, is still one of the most actively investigated questions in nuclear physics.

In this talk we extend our previous studies of the Hoyle state obtained in bound state approximation and focus on the structure of the resonances and the continuum above the three-alpha threshold. Results of the microscopic alpha-cluster model with Volkov and Minnesota forces are compared with results in the fermionic molecular dynamics (FMD) approach, where individual nucleons are considered as degrees freedom. For the FMD calculations an effective realistic interaction derived in the unitary correlation operator method (UCOM) is employed.

We describe the continuum by explicitly coupling the internal region with 8Be+alpha channels in the external region, including both the narrow ground state of 8Be and excited 0+, 2+ and 4+ pseudo states obtained by diagonalization in a large box. The 12C resonance parameters and 8Be-alpha scattering phase shifts are obtained with the microscopic R-matrix method. Of particular interest are the properties of the second 0+ state, the famous Hoyle state, and the second 2+ state. Monopole and quadrupole transition strengths are analyzed and compared to experiment.

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