Calculation of the triple-alpha reaction strengths using the hyperspherical slow variable description

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A numerical method is developed for calculating the bound and continuum energy spectrum of three particles interacting through both short-range and Coulomb potentials. Our method combines hyperspherical coordinates with the slow variable discretization (SVD) approach, while a complex absorbing potential (CAP) is employed to describe accurately the continuum wave functions. The method is well known in atomic and molecular physics, but is extended here to nuclear physics, with a special emphasis on the long-range Coulomb interaction. The method is applied to compute the energy spectrum of \(^{12}\text{C}\) in a 3alpha-particle model, focusing on an accurate calculation of the Hoyle resonance width of the narrow near-threshold \(J^\pi = 0^+_2\) state, which plays an important role in stellar nucleosynthesis. We employ an effective alpha-alpha interaction potential which reproduces both the energy and width of \(^8\text{Be}\), while a three-body force is added in order to fix the \(^{12}\text{C}\) energy levels at the experimental values. We analyze the structure of the bound and resonance states by calculating the wave functions and one-dimensional distribution functions. We also report our progress in calculating the E0 and E2 transition matrix elements and strength functions.