NUCLEAR VERTEX CONSTANTS AND ASYMPTOTIC NORMALIZATION COEFFICIENTS OF ^{16}O BOUND AND RESONANT $\alpha+^{12}$C STATES FROM EFFECTIVE-RANGE AND PADÉ APPROXIMATIONS

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The radiative capture reaction $^{12}C(\alpha,\gamma)^{16}O$ is a key nuclear process for the creation of oxygen in stellar nucleosynthesis. This defines the abundance ratio $^{12}C/^{16}O$ for helium burning in stars. To calculate the cross-section of this reaction one needs to know the asymptotic normalization coefficient (ANC) of the radial wave function for the ground ^{16}O state.

We calculate the renormalized Coulomb-nuclear constants for the vertex $^{16}O\leftrightarrow\alpha+^{12}C$ and the ANC for the wave functions of the ground state ^{16}O ($J^\pi=0^+$) and for the two subthreshold bound states with a total angular momentum of $J^\pi= 1^-, 2^+$. We use the analytical continuation method developed in [1]. We also apply this method to the resonances. In the states $J^\pi= 0^+, 1^-$ we use the effective-range function $K_L(E)$ (L is the orbital momentum, E is the α-particle energy) expanded up to E^2, and in the state $J^\pi=2^+$ we use the Padé-approximant for $K_2(E)$. In the energy region considered, the latter has two poles whose positions we find from the results of paper [2]. We expand the numerator $N(E)$ of $K_2(E)$ up to E^4.

To fit the parameters of $K_L(E)$, we include in the input data not only the Coulomb-nuclear phase shifts, but also the ^{16}O binding energies for the ground and excited states, and the energy and width of the resonances. We borrow the results of the phase shifts calculation from the R-matrix approach [2], which agree well with the experimental data [3]. The nucleus ^{16}O has quite a rich spectrum. The one channel approximation in our approach means that the poles considered have to be reproduced just for the channel $\alpha+^{12}$C and must not contradict the α^{12}C scattering phase shifts energy behavior for a concrete state. So we ignore the α particle structure, which is reasonable for a low-energy region. The fitted sets of the $K_L(E)$ parameters well describe the phase shift results of the paper [2]. Every J^π state is treated separately. The energy dependence of the functions $K_L(E)$ with the orbital momenta L =0 and 1 are nearly linear, whereas the function $K_2(E)$ is much more complex. The preliminary results for the bound ground ^{16}O state and resonant states with L =0 and 2 are presented in [4].

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