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ASTROPHYSICAL S-FACTOR OF THE DIRECT 3He(α,γ)7Be CAPTURE REACTION IN CLUSTER MODELS

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The direct ^{3}He(α,γ)^{7}Be radiative capture reaction is studied in the framework of two- and three-body potential cluster models [1,2]. E1 and E2 transitions are described at the long-wavelength approximation. The two-body model is based on a simple Gaussian form ^{3}He-potential of Dubovichenko V_D^a from Ref.[1], with a modification in d waves. The new potential parameters are V_0=-180 MeV, α=0.4173 fm^{-2} and V_0=-190 MeV, α=0.4017 fm^{-2} in the $d_{3/2}$ and $d_{5/2}$ partial waves, respectively. The potential describes correctly the phase shifts in the s, p, d and f waves and binding energies of the ground $p_{3/2}$ and the first excited $p_{1/2}$ bound states. As can be seen in Fig.1, the modification of the potential in d waves allows to improve the description of the astrophysical S factor for the direct ^{3}He(α,γ)^{7}Be radiative capture reaction at intermediate energies E>0.5 MeV in comparison with the results of Ref.[1]. In the three-body model the ^{7}Be nucleus is described as a bound state of α+p+d in the Hyperspherical Lagrange mesh method. The initial state is factorized into the p+d bound state and the α+^{3}He scattering state. The αd-potential is from Ref.[2], while αN-potential was taken from Ref.[3]. The pd-potential of the Gaussian form [4] with parameters V_0=-34.92 MeV, α=0.15 fm^{-2} and V_0=2.4 MeV, α=0.01 fm^{-2} are used in the even and odd partial waves, respectively. The α^{3}He-potential is the same as in the two-body model. The three body bound state wave functions of ^{7}Be was corrected at R=6 fm with the help of the Whittaker asymptotics.

Fig. 1. (a) Astrophysical S factor within the two- and three-body models in comparison with the available experimental data. Panel (b) highlights the low energy region.

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