Deuteron elastic scattering and stripping processes off ^{12}C as a three-body problem

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In this work we performed the first full-scale three-body calculations of the stripping reaction ^{12}C(d,p)^{13}C. First deuteron elastic scattering and stripping processes off a target nucleus consisting of A nucleons are treated within the framework of the few-body integral equations theory. By projecting the (A+2)-body operators onto target states, matrix three-body integral equations are derived which allow for the incorporation of the excited states of the target nucleons. This approach is applied to deuteron scattering off ^{12}C when the latter is in its ground state before and after the reaction. For the nucleon-^{12}C subsystem three sets of (quasi-separable) potentials are employed. The first such potential is based on the one derived in Ref. [1] for orbital angular momentum states with $L \leq 2$, which is valid for low energies. As second set we use the potential of Miyagawa and Koike [2] which is fit to semiphenomenological higher-energy phase shifts for states up to L = 6. The third one finally consists for $3 \leq L \leq 5$ of the potential set of Miyagawa and Koike while the potential parameters for $L \leq 2$ are determined by simultaneously fitting the elastic-channel T matrix obtained as solution of multichannel two-body Lippmanr-Schwinger equations, to the experimental low-energy and the semi-phenomenological higher-energy phase shifts. For the nucleon-nucleon interaction we take one of the separable 3S1 − 3D1 potentials from Ref. [3]. Differential cross sections for the elastic scattering reaction d+^{12}C→d+^{12}C and the transfer reaction d+^{12}C→p+^{13}C(^{13}C*) are calculated at deuteron bombarding energies 4.66 and 15 MeV (up to 36-channel calculation), and at 56 MeV (up to 76-channel calculation) together with some selected analyzing powers, and are compared with experimental data. At the highest energy considered, the decomposition of the differential cross section into the near-side and the far-side components shows the appearance of nuclear rainbow scattering. In Figs 1 and 2 we present the calculated and experimental differential cross sections for the elastic scattering d+^{12}C→d+^{12}C and transfer reaction d+^{12}C→p+^{13}C at deuteron energy 4.66 MeV. The elastic scattering data are taken from Ref. [4] and the transfer data from Ref. [5]. The paper has been accepted for publication in Physical Review C (2007).

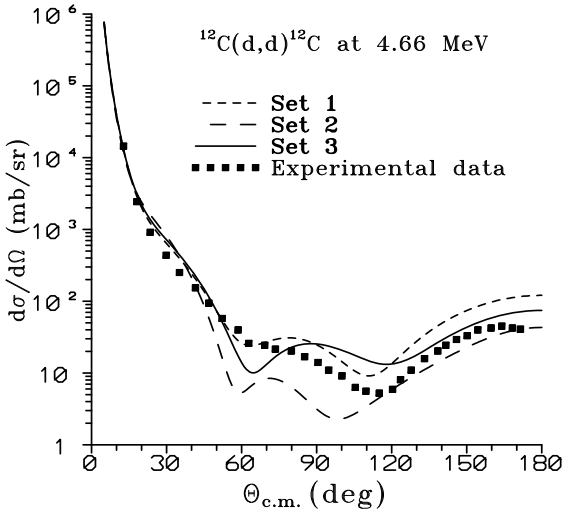

Figure 1. Differential cross section for the elastic (d,d) scattering . Experimental data are from Ref.[4].

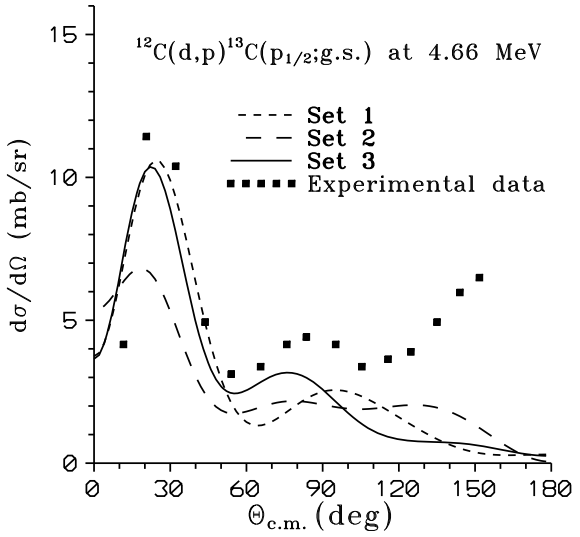

Figure 2. Same as Figure 1 but for the differential cross section for the ^{12}C(d,p)^{13}C(p$_{½}$) stripping reaction to the ground state of ^{13}C. Experimental data are from Ref. [5].

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