Four-body continuum-discretized coupled-channels calculations: Application to ^{6}He+^{64}Zn at 13.6 MeV

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Abstract. The recently developed four-body continuum-discretized coupled-channels (CDCC) method, making use of the binning procedure [1], is applied to the reaction ^{6}He+^{64}Zn at 13.6 MeV (around the Coulomb barrier). Excellent agreement with available elastic data [2] is found.

Keywords: Few-body systems. Direct reactions induced by halo nuclei. Coupled-channel models.
PACS: 21.45.-v,24.50.+g,25.60.-t,24.10.Eq,27.20.+n

INTRODUCTION

The motivation of this work is to learn about Borromean nuclei such as ^{6}He. Borromean systems are halo nuclei with two nucleons in the halo such that the binary subsystems are unbound. For the reactions induced by halo nuclei with only one nucleon, that is, for three-body reactions (two-body projectile plus a target) the Continuum-Discretized Coupled-Channels (CDCC) formalism [3] has been widely used among the Nuclear Physics community. The first extensions [4, 5] of CDCC to four-body reactions (three-body projectile plus a target), were performed using Pseudo-State bases to represent the continuum of the projectile instead of discretizing the true continuum (binning procedure) as in the standard three-body CDCC [3]. These extensions show a slow oscillatory convergence of the scattering observables [5] for reactions where Coulomb breakup is important. Recently, in Ref. [1] the binning procedure has been extended to three-body projectiles, using the eigenchannel (EC) expansion of the three-body S-matrix for the continuum representation. In this work we applied this formalism to the reaction ^{6}He+^{64}Zn at 13.6 MeV to assess the accuracy of the method.

^{6}HE+^{64}ZN AT 13.6 MEV

We have applied the formalism presented in Ref. [1] to the reaction ^{6}He+^{64}Zn at 13.6 MeV. We have included ^{6}He states with total angular momentum $j^{\pi} = 0^{+}, 1^{-}$ and 2^{+} and projectile-target interaction multipole couplings with order $Q = 0, 1, 2$. Coulomb

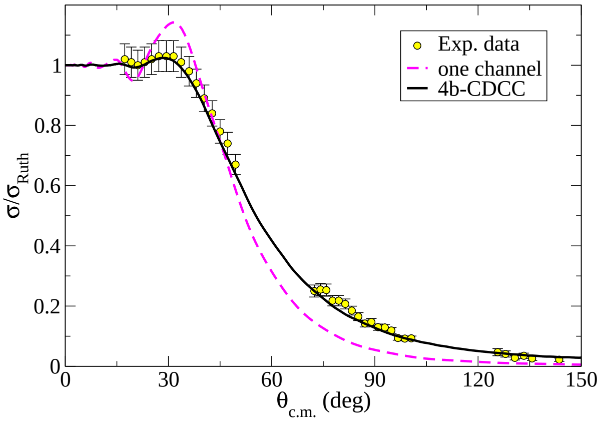

FIGURE 1. (Color online) Elastic differential cross section (ratio to Rutherford) in the center of mass frame for the ^{6}He+^{64}Zn reaction at 13.6 MeV. The experimental data are taken from Ref. [2].

and nuclear potentials are included. The nuclear interactions with the target used optical potentials. The n+^{64}Zn and α+^{64}Zn potentials were taken from Refs. [6] and [2], respectively. The maximum ^{6}He excitation energy needed was 8 MeV. The coupled equations describing the projectile-target motion are solved with the code FRESCO [7], the coupling form factors being read from external files. The coupled equations were solved for partial waves up to $J = 75$ and were matched to their asymptotic forms at matching radius $R_m = 200$ fm. The number of eigenchannels (EC) of the S-matrix used was $n_{ec} = 4$ and the number of energy bins used for each j^π was 4 (0^+ and 2^+) and 7 (1^-). So, the total number of states included in the CDCC calculation is $N = 61$.

In Fig. 1 we show the elastic differential cross section (ratio to Rutherford) in the center of mass frame for this reaction. The dashed line is the one channel calculation (including only the ground state). The solid line is the full CDCC calculation. From the figure it is evident the relevance of the inclusion of the continuum in these kind of calculations. Also remarkable is the fast convergence of the calculation.

ACKNOWLEDGMENTS

This work was supported by the DGICYT under Projects FIS 2008-04189, FPA 2006-13807-C02-01, and consolider CPAN, by the U.S. Department of Energy by LLNL under Contract DE-AC52-07NA27344, and by the U.K. STFC under Grant EP/D003628.

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