Applicability of the continuum-discretized coupled-channels method to the deuteron breakup at low energies

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It is well known that the Faddeev theory [1], or, alternatively, the Alt-Grassberger-Sandhas (AGS) theory [2] gives the exact solution to a three-body scattering problem. On the other hand, the continuum-discretized coupled-channels method (CDCC) [3, 4, 5] has widely been applied with high success to projectile breakup reactions at various incident energies. The theoretical foundation of CDCC was given in Refs. [6, 7] in connection with the distorted-wave Faddeev formalism [8]. In a systematic comparison [9] between the Faddeev-AGS theory (FAGS) and CDCC, however, it was found that at low incident energies E_d of deuteron, the elastic breakup cross sections obtained with CDCC overshoot those of FAGS by about a factor of three at most.

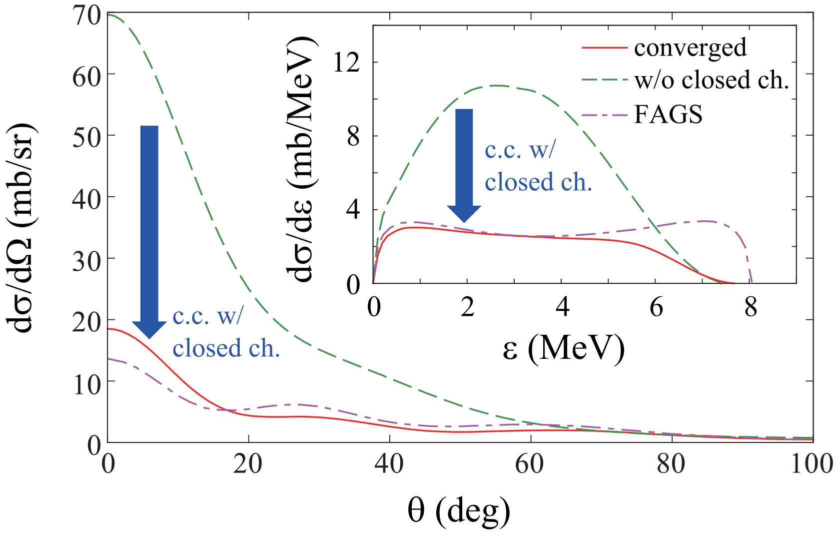

Figure 1: Deuteron elastic breakup cross section on ^{12}C at $E_d = 12$ MeV. See the text for detail.

In the present study, we have revisited the problem reported in Ref. [9] and showed that the disagreement between FAGS and CDCC was mainly due to the neglect of the closed-channels, in which the relative energy between the target nucleus and the center-of-mass of the p-n system is negative. In other words, the CDCC model space adopted in Ref. [9] was not sufficient to make the result of CDCC converged. Figure 1 shows the comparison between the results obtained by CDCC (solid line), CDCC with no closed channels (dashed line), and FAGS (dash-dotted line), for the angular distribution of the deuteron elastic breakup cross section on ^{12}C at $E_d = 12$ MeV. The inset shows the comparison for the breakup-energy distribution. Thus we have demonstrated the applicability of CDCC to deuteron elastic breakup reactions at low energies. For complete discussion and further details, readers are referred to Ref. [10].

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