Three-body Faddeev equations in two-particle Alt-Grassberger-Sandhas form with distorted-wave-Born-approximation amplitudes as effective potentials

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A(d,p)B reactions on heavier nuclei are peripheral at sub-Coulomb energies and can be peripheral even at energies above the Coulomb barrier due to the presence of the distorted waves in the initial and final channels. Usually, to analyze such reactions the distorted-wave Born approximation (DWBA) is used. The DWBA amplitude for peripheral reactions is parametrized in terms of the asymptotic normalization coefficient (ANC) of the bound state B = (nA). However, in the DWBA, the coupling of the different channels is not taken into account explicitly. The three-body Faddeev equations written as the two-particle Alt-Grassberger-Sandhas (AGS) equations are very suitable for the analysis of the A(d,p)B reactions because they take into account explicitly the coupling of the different channels. It is well known that the overall normalization of the DWBA amplitude or even of the more advanced continuum-discretized coupled channels (CDCC) amplitude for peripheral reactions (both sub-Coulomb and above the Coulomb barrier) is determined by the ANC. However, it is not apparent that it is the case for the AGS solution due to the coupling of the (d,p) channel to other channels. In this paper, it is proved that the sub-Coulomb *A(d,p)B* reaction amplitude, which is a solution of the two-body AGS equations, is peripheral and is parametrized in terms of the ANC of the bound state B = (nA) if the corresponding DWBA amplitude is peripheral. Both nonlocal separable and local nuclear interaction potentials between the constituent particles are considered. To prove the peripheral character of the AGS amplitude for the sub-Coulomb A(d,p)B reactions the effective potentials are expressed in terms of the corresponding sub-Coulomb DWBA amplitudes of the different channels. The analysis of the *A(d,p)B* reactions above the Coulomb barrier requires the inclusion of the optical potentials. Hence, to analyze such reactions, the AGS equations are generalized by including the optical nuclear potentials in the same manner as it is done in the DWBA. The obtained AGS equations contain the DWBA effective potentials with distorted waves generated by the sum of the nuclear optical and the channel Coulomb potentials. It is shown that if the DWBA amplitude is peripheral than this is also the case for the AGS amplitude, which is also parametrized in terms of the ANC of the bound state B = (nA). The inclusion of the coupling of the different channels in the AGS formalism allows one to improve, compared to the DWBA and CDCC methods, the treatment of peripheral (d,p) reactions at sub-Coulomb energies and at energies above the Coulomb barrier.

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