The Coulomb Problem in Momentum Space without Screening

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Single particle transfer reactions (d,p) involving rare isotopes are an important tool to study nuclear structure. In addition, one can connect the (d,p) process with the neutron capture process, a topic of great relevance to astrophysics and the questions around the synthesis of heavy elements. The (d,p) reaction may be viewed as a three-body $n+p+A$ problem, in which the deuteron and the nucleus A act as participants in the reaction. Currently, the most advanced momentum space Faddeev-type reaction calculations use a screening procedure for the Coulomb interaction, which is adequate only for light and medium mass nuclei [1]. Recently, a Faddeev-AGS formalism for (d,p) reactions with explicit inclusion of the unscreened Coulomb interaction was proposed [2]. A crucial difference here is the use of a Coulomb basis instead of the plane wave basis.

A first step in the practical implementation of this new formulation is the computation of vertex functions: these are matrix elements of momentum space partial wave Coulomb functions integrated with the nuclear form factor in momentum space [3]. Employing separable interactions derived from realistic nucleon-nucleus phenomenological optical potentials [4], Coulomb distorted form factors are computed for a wide range of cases, including charge, angular momentum and energy dependence.

Essential features and their numerical implementation will be briefly described. When calculating Coulomb distorted form factors it turns out that they differ significantly from the nuclear form factors except for the very highest momenta: the structure of the form factor is shifted away from zero momentum due to the Coulomb interaction. Unlike Yamaguchi forms which are typically employed in three-body methods, the realistic nucleon-nucleus form factors have a short high-momentum tail, which allows for a safe and efficient truncation of the momentum grid.

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