The fifth response function and spin-orbit final-state interaction in the framework of Glauber theory for $(e, e'p)$ reactions

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We discuss the effects of the spin-orbit final state interaction on the fifth response function. For an in-depth description of the formalism and more results see [1].

Currently, there are many $(e, e'p)$ experiments at GeV energies being performed or planned at Jefferson Lab. The major theoretical problem in the description of these reactions is the fact that at transferred energies of 1 GeV or more, a consistent calculation for the initial bound state and the — in general rather complicated — hadronic final state from a microscopic Lagrangian is not feasible. For the ground state and low energy transfers, few-body nuclei can be described by meson-exchange based nucleon-nucleon interactions, but for energies much larger than the threshold for pion emission, this is not feasible anymore. At GeV energies, it is questionable if the physical picture of nucleons interacting by meson exchange is still valid.

In practice, one is forced to split the problem up into three separate parts, namely the calculation of the ground state, the calculation of the final hadronic state and the treatment of the electromagnetic current [2]. Here, we are concerned with the realistic description of the final state. A very suitable tool for the calculation of the final state interaction (FSI) is Glauber theory [3]. It is a high energy, small angle scattering approximation, and the only input for it are the measured NN amplitudes, which can be parametrized in terms of the total cross section, the diffraction slope, and the ratio of the real to imaginary part of the forward elastic scattering cross section. Previously [4], in Glauber calculations for $(e, e'p)$ reactions, only the central part of the NN amplitude was taken into account, and the spin-dependent parts, i.e. the spin-orbit part and three double spin-flip terms, were neglected. This is a good approximation only for the cross section, the large responses R_L and R_T, and nuclear transparencies. In the description of the smaller responses and of polarization observables, the spin-dependent final state interactions become quite important [1]. These observables are interesting, as they promise to give us more detailed information on the nuclear ground state, or, as is the case for the fifth response function, they may serve to study color transparency.

Besides the different spin structure, the spin-orbit FSI has another interesting feature: in contrast to the very short ranged central part of the final state interaction, it is longer ranged, and can therefore act on the D-wave of the deuteron, which is suppressed at short distances due to the centrifugal barrier and therefore remains largely unaffected by the central FSI. Due to its spin-flipping nature, its con-

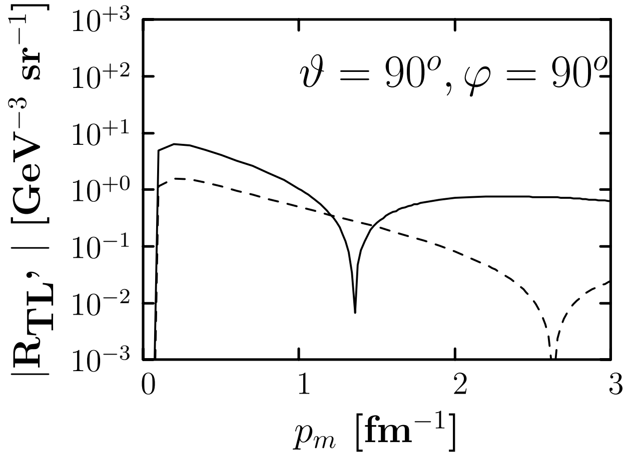

Fig. 1: The fifth response function, $R_{TL'}$, is shown calculated with the full FSI (solid line) and with central FSI only (dashed line) in perpendicular kinematics at an azimuthal angle $\varphi = 90^o$. The full response is negative for $p_m < 1.4$ fm^{-1}; with central FSI only, it is positive up to $p_m = 2.6$ fm^{-1}.

tributions to R_{TT} and R_{TL} are quite significant: in R_{TT}, the spin-orbit FSI leads to a new and dominating contribution of the magnetization current, in the fifth response function, it allows for the interference of the zeroth-order charge operator (for details on the relativistic form of the one-body current, see [2]) and the magnetization current, which leads to a large new contribution to this response. The effect of the spin-orbit FSI on the fifth response is shown in Fig. 1, which clearly shows that both shape and magnitude are altered once the spin-orbit FSI is included. Although the numerical example given here is for the deuteron, the methods of [1, 2] can be applied to any target nucleus.

This work was supported by funds provided by the U.S. Department of Energy (D.O.E.) under cooperative research agreement #DE-AC05-84ER40150 and #DF-FC02-94ER40818.

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