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Tagged spectator DIS off a polarized spin-1 target

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We introduce the theoretical framework for deep-inelastic electron scattering (DIS) on the polarized deuteron with detection of a nucleon in the nuclear fragmentation region ("spectator tagging"). Such experiments enable measurements of neutron spin structure and nuclear modifications with full control of the nuclear configuration. We discuss the general expressions of the cross section of electron scattering from a polarized spin-1 target with an identified hadron in the final state, including the dependence on the transverse momentum and azimuthal angle. The target is described by a spin-1 density matrix with vector and tensor polarization.

We calculate the DIS cross section on the deuteron in a factorized approximation suitable for high-energy scattering (virtual nucleon scheme). Deuteron structure is described by the NN light-front wave function, which can be related to the non-relativistic wave function in a well-defined scheme. We evaluate the tagged DIS cross section in the impulse approximation, discuss the analytic properties in the nucleon recoil momentum (free nucleon pole at $t = M_N^2$, "pole extrapolation"), and comment on the effects of final-state interactions (FSI). The pole extrapolation has method has the advantage that nuclear effects such as FSI and Fermi motion are suppressed in a model-independent way at the free nucleon pole.

We discuss the application of the method to measured semi-inclusive DIS data (BONuS). The neutron structure functions obtained in this way demonstrate a surprising x dependence at x> 0.6, indicating a possible rise of the neutron to proton structure function ratio.

As a second application we consider the extraction of the free neutron spin structure function g_{1n} through DIS on the longitudinally polarized deuteron with proton tagging and on-shell extrapolation in the recoil momentum. Tagged DIS measurements on the polarized deuteron will become feasible at a future Electron-Ion Collider (EIC) with forward proton and neutron detectors.

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