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Three-Nucleon Force Effects in the FSI configuration of the $d(n, nn)p$ Breakup

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We investigated three-nucleon force (3NF) effects in the Final State Interaction (FSI) configuration of the $d(n, nn)p$ breakup reaction. Solutions of the 3N Faddeev equations [1] with the CDBonn nucleon-nucleon potential [2] and the Tucson-Melbourne 3NF [3] give access not only to the elastic scattering observables but also to the three-body breakup ones. In this contribution we focus on an integrated breakup cross section around the final state interaction condition for two neutrons:

$$\frac{d^2\sigma}{d\Omega_1 d\Omega_2} \equiv \int_{S_0-\Delta S}^{S_0+\Delta S} \frac{d^3\sigma}{d\Omega_1 d\Omega_2 dS} dS \Big|_{\Omega_1=\Omega_2} \quad (n + d \rightarrow p + (nn)) \quad (1)$$

Here Ω_1 and Ω_2 represent the directions of the momenta of outgoing neutrons 1 and 2, respectively. For fixed Ω_1 and Ω_2 , the arc-length variable S defines uniquely the three-nucleon kinematics, yielding a specific (E_1, E_2) point on the allowed kinematical curve in the (E_1, E_2) plane, where E_1 and E_2 are the kinetic energies of neutron 1 and 2, respectively. Choosing an appropriate starting point where $S = 0$, S is calculated as a distance taken along the curve from its starting point:

$$S = \int dS = \int \sqrt{(dE_1)^2 + (dE_2)^2} \quad (2)$$

where E_1 and E_2 are the kinetic energies of neutron 1 and 2, respectively. The FSI occurs at the condition $E_1 = E_2$ at the parameter $S = S_0$.

Fig.1 shows the integrated breakup cross section of Eq.(1) at the incident neutron laboratory energy $E_{lab}=200$ MeV with the averaging width parameter $\Delta S= 20$ MeV. The angle θ_{lab} is the laboratory scattering angle of nucleons 1 and 2, for which the FSI condition is realized.

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We found a large deviation between the theoretical predictions including or not including 3NF. Although the 3NF effects for the elastic scattering cross section are located predominantly in the region starting from middle up to backward scattering angles, the 3NF effects for the integrated FSI configuration breakup cross section are found also at forward scattering angles.

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