International Nuclear Physics Conference INPC2013: 2-7 June 2013, Firenze, Italy

Three-nucleon forces and their importance in three-nucleon systems and heavier nuclei

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Three-body systems have been studied in detail at KVI and other laboratories around the world in the last few years. Even though a relatively good understanding of most phenomena in nuclear physics at intermediate energies has been arrived at by only considering two-nucleon forces, high precision three-nucleon data and nuclear structure studies in light nuclei have revealed the shortcomings of these forces. Hadronic reactions in three-body systems give a handle on effects such as those from three-body forces. In the last few decades, the two-nucleon system has been thoroughly investigated both experimentally and theoretically. These studies have resulted in modern potentials which describe the bulk of the data in a large range of energy. This knowledge can be employed in a Faddeev-like framework to calculate scattering observables in three-body systems. In regions and for the reactions in which the effects of Coulomb force are expected to be small or can be calculated accurately, and energies are low enough to avoid sizable relativistic effects, deviations from experimental data are a signature of three-body force effects.

At KVI, various combinations of high-precision cross sections, analyzing powers and spin-transfer coefficients have been measured at different incident proton or deuteron beam energies between 100 and 200 MeV for a large range of scattering angles and for the reactions mentioned above. Calculations based on two-body forces only do not describe the data sufficiently. The inclusion of three-body forces improves the discrepancies with data significantly. However, there are still clear deficiencies in the calculations. A selection of data will be presented and compared with the state-of-the-art calculations.