Above 99,9% of the observed matter is built of atomic nuclei. Understanding of nuclear structure and reactions is important in fundamental research and practical applications, including power production, medicine and material studies. In turn, this understanding is based on an adequate description of nuclear interactions binding nucleons into nuclei. Nucleons, i.e. protons and neutrons, are not elementary particles; thus their interactions are not of a fundamental character. Nuclear interactions result from much more powerful so-called strong interaction between quarks composing nucleons. Currently, nuclear interactions cannot be derived directly from quantum chromodynamics (QCD) – the theory of strong interactions. Present models of nuclear interactions are based on the meson exchange theory. The newest approach is based on the so-called Chiral Effective Field Theory, making a bridge between traditional models and QCD. Deep understanding and precise description of nuclear interactions is essential for simulation of neutron stars, supernovae and black holes.

Tests of quality of the nuclear interactions should be started with the simplest 2-, 3- and 4-nucleon systems. Even in this case, theoretical calculations are very complex. The reaction of deuteron breakup in collision with proton is an ideal testing ground for nuclear interaction models. Three free nucleons, two protons and one neutron, produced in this process can be emitted in variety of kinematic configurations defined by their emission angles and energies. Registering hundreds of such kinematics and comparing measured quantities - observables - with theoretical calculations leads to detecting weaknesses of the models. The basic tests rely on studies of the cross section, describing the general probability of the reaction. Present models with the so-called three-nucleon force included pass this test very well, though there are local discrepancies between theory and precise data. Polarization observables, depending on the orientation of spins of nucleons and nuclei, pose severe challenge for theoretical description. Unfortunately, there were not many measurements of the polarization observables for the deuteron breakup reaction in collision with a proton. We propose to measure an almost unknown observable of this type: proton polarization produced in the breakup reaction. There was only one measurement of this observable for only several kinematical points at one beam energy. This challenging experiment will extend the previous cross section measurements conducted at Cyclotron Center Bronowice (INP PAS) in Krakow.

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