Abstract

Studies of few-nucleon systems form the basis for understanding nuclear interactions and enable precise tests of the theoretical models. This work focuses on the experimental studies of the proton-deuteron breakup reaction at the beam energy of 108 MeV. The main goal was to determine the differential cross-section for this reaction.

The experiment was conducted in 2016 in collaboration with physicists from the University of Silesia, Jagiellonian University, Warsaw University, the Institute of Nuclear Physics of the Polish Academy of Sciences, and the Kernfysich Versneller Institute (KVI, University of Groningen, the Netherlands). For this purpose, the BINA detection system has been transported from KVI and successfully installed at Cyclotron Center Bronowice. This work concentrates on data registered by the BINA detector at the proton beam energy of 108 MeV, with the use of a liquid deuterium target. This measurement was a part of the broader program focused on testing the three-nucleon system dynamics at beam energies of 108, 135, and 160 MeV.

To determine the differential cross section, the experimental data were pre-selected, and a number of methods were applied to reconstruct the particle angles, identify particles, perform the energy calibration, and determine the efficiency of individual elements of the detection system. The data were normalized to the luminosity determined from a number of registered deuterons and the known cross section for a proton-deuteron elastic scattering.

This work presents differential cross sections for the breakup reaction for a set of 252 angular configurations of outgoing protons in the range of polar angles from 13 to 27 degrees, which gives 1767 data points. The experimental results are compared to the state-of-the-art theoretical calculations based on the CD-Bonn potential, considering the Three Nucleon Force (3NF) effects and Coulomb interactions between protons. The quality of the data description was determined by performing the chi-square test. The results show a significant influence of Coulomb interactions, while the effects of 3NF for the analyzed configurations are negligible.