Contribution ID : **129** Type : **Poster**

Experimental investigation of few-nucleon dynamics in deuteron-deuteron collision at 160 MeV

Saturday, 31 May 2014 15:00 (2:00)

Collaboration

Abstract content

Few-nucleon systems are basic laboratories to study nuclear forces. Among them, the system composed of three nucleons (3N) is the simplest and non-trivial environment, in which models of nuclear interaction can be tested. Nucleon-nucleon (NN) interaction is here dominant; there are, however, reasons to assume existence of additional dynamics, referred to as the three-nucleon force (3NF) [1]. Nowadays, there are many theoretical predictions based on rigorous solutions of Faddeev equations. Besides the realistic potentials, combined with models of 3N forces (e.g. TM99 and Urbana IX), the 3N system dynamics can also be modelled with the coupled-channels (CC) method [2]. In parallel, the theoretical approach based on dynamics generated via Chiral Perturbation Theory (ChPT) [3] is being gradually developed. These approaches are able to predict different components of few-nucleon interaction, not only 3NF but also even more subtle four nucleon force (4NF) effects (rigorous predictions are limited to a domain below breakup threshold), Coulomb interaction [2] and relativistic effects. Thus, for verification and further development of the models, possibly large basis of precise data is necessary. The d+d breakup reaction offers unique environment to study all the mentioned effects with further advantages of enhanced 3NF effects in the 4N system. We have performed an experiment at KVI laboratory (The Netherlands) with use of the BINA detector and 160 MeV deuteron beam impinging on deuteron target. Aim of the measurement was to determine the differential cross-sections for three-(dd→dpn) and four-body breakup (dd→ppnn) reactions. The experiment appears even more important due to the fact that the experimental database for d+d breakup is scarce. Our experiment is a continuation of previous very successful measurements at other medium energies [4-8]. The apparatus is a new-generation construction which offers access to almost full phase-space of the studied breakup process, well suited for such experiments at intermediate energies. The preliminary results covering test of data consistency, geometry cross-check, calibration, identification of the reaction channels and precision of kinematical reconstructions, as well as sample distributions of differential cross section will be presented.

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Session Classification : Poster Session