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Few-Nucleon System Dynamics Studied via Deuteron-Deuteron Collisions at 160 MeV

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According to our present knowledge the modern nucleon-nucleon forces based on the meson-exchange theory are unable to reproduce the experimental data for the systems with A>2. One needs to include additional piece of dynamics in the calculations, so-called three-nucleon force (3NF) [1,2]. To investigate the nature of 3NF the proton-deuteron breakup reaction characterized by very rich kinematics of the final state was explored in the medium energy region [1-3]. The interpretation of the experimental data is possible due to rigorous calculations of three nucleon (3N) observables potentials. In heavier systems composed of four nucleons (4N) the 3NF effects are expected to be larger in comparison to 3N. This makes the experimental studies more attractive, however the theoretical treatment of 4N scattering is much more complicated and challenging than for 3N systems due to e.g. variety of entrance and exit channels, various total isospin states etc. [4]. The calculations in the 4N field are mainly developed by three groups: Pisa [5], Grenoble-Strasbourg [6] and Lisbon [4]. Only the Lisbon group calculates observables for multichannel reactions, also above the breakup threshold, and with the Coulomb force included. The development of exact numerical calculations for four-nucleon breakup are still distant in time given complexity of the problem. The first estimate calculations for the d-d system at higher energies were performed in the so-called single-scattering approximation (SSA) for the three-cluster breakup and elastic scattering [7]. Moreover, the experimental data for four-body breakup are very scarce [8,9,10], especially for exclusive measurements.
In this talk a set of data for differential cross section of the 2H(d, dp)n breakup [8], d-d elastic scattering and 2H(d, 3He)n transfer [9] reactions measured with the BINA@KVI setup at 160 MeV will be presented. The breakup data will be compared with the recent SSA calculations [7]. In addition, the scheme of analysis of the exclusive d-d three-body and four-body breakup data collected with the WASA@COSY detector at 350 MeV will be outlined.
References
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