Systematic Study of Three-Nucleon Systems Dynamics in the Cross Section of the Deuteron-Proton

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Three-nucleon system dynamics can be investigated quantitatively by comparing observables calculated with the use of Faddeev equations with results of precise measurements. The calculations including different pieces of nucleon-nucleon dynamics like three nucleon force 3NF, the long-range Coulomb interaction or relativistic effects, predict their influence to reveal with different strength at different parts of the phase space. Especially, cross section observables are expected to be very sensitive to all these effects.

Experiments devoted to study such subtle ingredients of nuclear dynamics were carried out at KVI Groningen [1,2] and FZ-Jülich [3] with the use of the ${}^1H(\vec{d}, pp)n$ breakup reaction at 100 MeV, 130 MeV and 160 MeV deuteron beam energy. These measurements of the cross sections at different deuteron beam energies have demonstrated that inclusion of 3NF or Coulomb force in the theoretical calculations is necessary for a correct description of the experimental data and, as predicted, strength of those effects is very sensitive to the kinematical configuration of particles in the exit channel.

In recent years the relativistic treatment of the breakup reaction in 3N system was developed using the NN potential in Ref. [4] and this approach has also been extended for calculations including 3NF in Ref. [5]. It was shown that in some particular region of the breakup phase-space, relativistic effects can increase or decrease the calculated breakup cross sections by up to 60%. At the same time the effects of 3NF may change certain observables by a similar factor. The relativistic effects and their interplay with 3NF become more important with increasing available energy in the three nucleon system. Therefore the investigations at relatively high energies are important to confirm the theoretical predictions for relativistic effects and to unambiguously fix a relevance of the 3NF.

The experiment using the deuteron beam of 340, 360 and 400 MeV and the WASA detector has been performed in January 2013 at FZ-Jülich with the aim to shed more light on the role of the relativistic effects in three nucleon system. The preliminary analysis of the collected data will be shown.

1 St. Kistryn *et al.*, Phys. Rev. C 72, 044006 (2005);

2 St. Kistryn *et al.*, Phys. Lett. B 641, 23 (2006);

3 E. Stephan *at al.*, Int. J. Mod. Phys. A 24, 515 (2009);

4 H. Witała R. Skibinski and J. Golak, The European Physical Journal, A30:369 (2006);

5 H. Witała *et al.*, Phys. Rev., C83:044001 (2011);

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