# SHORT-RANGE CORRELATION INVESTIGATION IN DEUTERON INDUCED REACTIONS.

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## Introduction

The investigation of dp breakup reaction at deuteron energy of 270 MeV at RIKEN [1], IUCF [2] and KVI [3] reveals variation in contribution of nucleon-nucleon (NN) and three nucleon forces (3NFs) in polarization observables. Vector analyzing power $A_y$ can be described using only NN forces. Inclusion of 3NF improves a part of the polarization data but breaks other. The spin structure of the np SRCs has been investigated at JINR via the measurements of the tensor analyzing power $A_{yy}$ in deuteron inclusive breakup at different energies in the wide regions of the $x_F$ and transverse proton momentum $p_T$ [4]. Obtained results were compared with calculations using standard [5] and covariant deuteron wave functions [6], respectively. The Ayy data clearly demonstrate the dependence on two internal variables, $x_F$ and $p_T$ (or their combinations). However, the use of the deuteron structure function that depends on two variables [6] does not allow to describe the data.

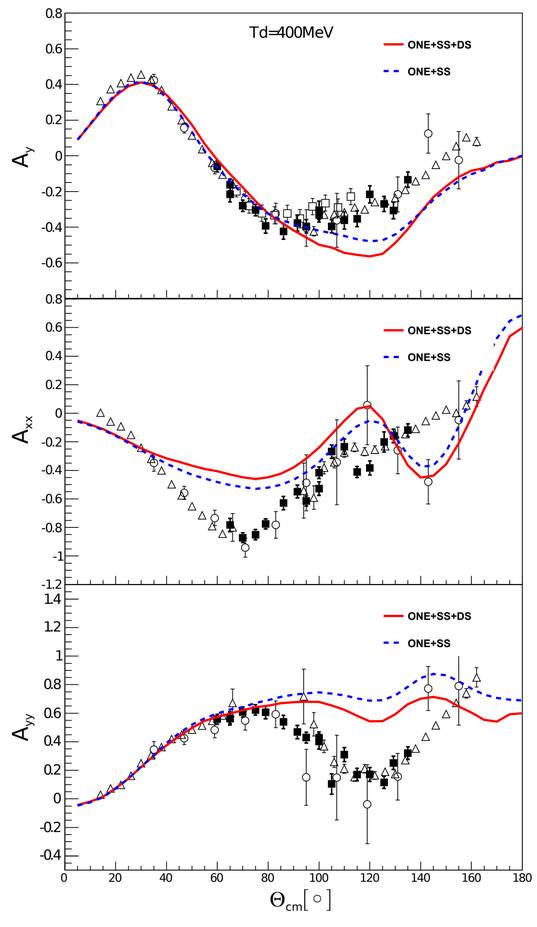


*Fig. 1:* The angular dependence of the deuteron vector analyzing power $A_y$, $A_{xx}$ and $A_{yy}$ at the deuteron kinetic energy $T_d$ of 400 MeV. The full squares are preliminary results of the present experiment at ITS at Nuclotron. Open symbols are the world data. Curves are the calculation within relativistic multiple scattering model [7, 8].

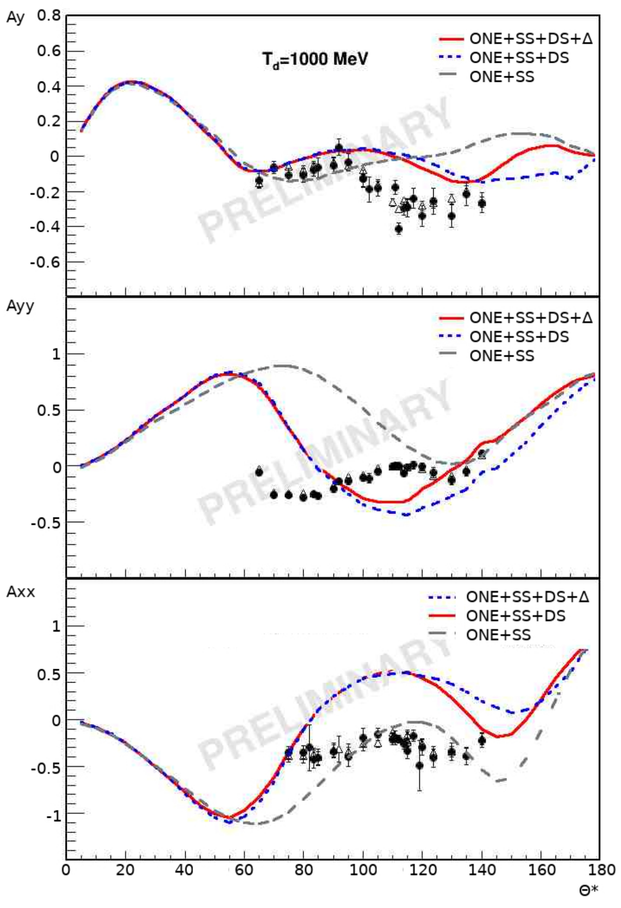


*Fig. 2:* The angular dependence of the deuteron vector analyzing power $A_y$, $A_{xx}$ and $A_{yy}$ at the deuteron kinetic energy $T_d$ of 1000 MeV. The full symbols are preliminary results of the present experiment. Curves are the calculation within relativistic multiple scattering model [7, 8].

## Goal

The main goal of the deuteron spin structure (DSS) collaboration is to investigate the structure of few nucleon correlations through the measurements of the polarization observables in the deuteron induced reactions at intermediate energies. Few nucleon correlations are studied using polarized and unpolarized deuteron beams and Polyethylene and Carbon targets at Nuclotron, JINR. The dp breakup reaction is investigated at the deuteron energies from 300 - 500 MeV in the region where non-nucleonic degrees of freedom and relativistic effects can play a significant role. Analyzing powers of the dp breakup reaction using polarized beam were investigated at Internal Target Station (ITS) of Nuclotron at deuteron energies of 270 and 400 MeV using ΔE−E technique. Recently, dp elastic scattering was measured using polarized deuteron beam at ITS under various kinematic configurations in the angular range ($70^\circ$ - $120^\circ$) in c.m. at deuteron energies of 400, 700, 800, 1000, 1100, 1300, 1500 and 1800 MeV.

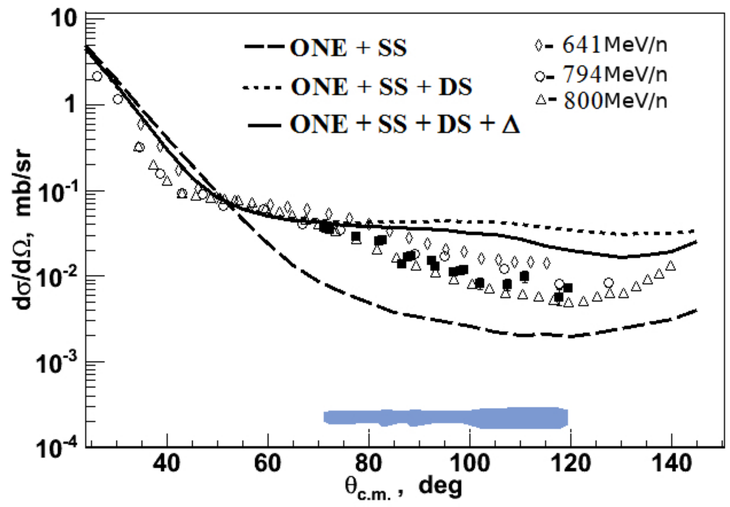


*Fig. 3:* Angular dependence of the cross section at deuteron energy of 1400 MeV. Curves are predictions based on relativistic multiple scattering model when one nucleon exchange and single scattering term (dashed curve), additional double scattering term (dotted curve) and Δ isobar (solid curve) are included. Nuclotron data are represented by closed symbols.

## Results and future plans

Deuterons are extracted from polarized ion source and accelerated by Nuclotron. Targets from Carbon and CH2 are enclosed in a spherical hull of Internal Target Station (ITS) which is made from stainless steel with an external diameter of 160 mm and a thickness of 0.5 mm. To produce collisions of the deuteron with hydrogen, CH2 target is used. Eight ΔE-E scintillation detectors and 40 counters are used for the case of dp breakup and dp elastic scattering reaction investigations, respectively.

Analyzing power $iT_{11}$ at $72.3^\circ$ and $76.5^\circ$ in cm was measured under pp quasi conditions. Obtained values at $72.3^\circ$ and $76.5^\circ$ are 0.10 ± 0.02 and 0.11 ± 0.06, respectively. Results are in agreement with world pp- elastic scattering data within experimental errors. Values of the vector $iT_{11}$ and tensor $T_{20}$ analyzing powers at polar angles of $34.8^\circ$ and $36.8^\circ$ and difference in azimuthal angles of $135^\circ$ are 0.47 ± 0.10 and 0.02 ± 0.20, respectively.

The relativistic multiple scattering model [7, 8] of dp elastic scattering describes the $A_y$ data up to ~$90^\circ$ only, while it fails to reproduce the data at larger angles, double scattering (DS) term does not improve the agreement, see Fig. 1. The consideration of the ONE+SS terms allows to describe the behaviour of the $A_{yy}$ analyzing power up to ~$80^\circ$ only. The DS term gives a significant contribution at larger angles, however, does not remove the discrepancy of the calculation with the data. The $A_{xx}$ behaviour is not described by the model over the whole angular range. The reason of the deviation can be the neglecting of the 3N SRCs. The angular dependence of the deuteron vector analyzing power $A_y$, $A_{xx}$ and $A_{yy}$ at the deuteron kinetic energy $T_d$ of 1000 MeV is shown in Fig. 2.

Cross section of dp elastic scattering and predictions of relativistic multiple scattering model at 1400 MeV is presented in Fig. 3. Good agreement is observed up to $70^\circ$. Δ isobar contribution improves the qualitative description of the cross section at this energy.

Preliminary results of the five fold differential cross section of dp breakup reaction investigated at 400 MeV for the case of detector arms placed at the angles of $31^\circ$ and $43^\circ$ , $35^\circ$ and $43^\circ$ , $39^\circ$ and $43^\circ$ have been obtained. There are some structures in kinematic S− curve at the vicinity of ≈100 MeV and ≈260 MeV. The next step is to estimate contribution of statistical and systematical errors mainly by means of simulation based on Geant4 and ROOT packages.

The next stages of the DSS experiment using polarized deuterons and protons at ITS are the systematic studies of the analyzing powers in dp- elastic scattering at 270-700 MeV and in dp- nonmesonic breakup at 300-500 MeV using new polarized ion source of Nuclotron to study the relativistic effects in 2NFs and manifestation of the short-range 3NFs. The availability of the polarized proton beam allows to extend the DSS physics program at ITS, to perform the experiments on the measurements of the nucleon analyzing power $A^p_y$ in pd- elastic scattering at 135-1000 MeV, in pd- nonmesonic breakup at the energies between 135-250 MeV for different kinematic configurations, in the pA → ppX reactions etc.

## Acknowledgments

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