PROCEEDINGS OF SCIENCE

The differential cross-section on dp-elastic scattering at 880 MeV obtained at Nuclotron.

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The results on the cross-section of dp-elastic scattering reaction obtained at 880 MeV at internal target of Nuclotron are presented. The measurements have been performed using CH_2 and C targets and kinematic coincidence of signals from scintillation counters. The cross-section data are compared with theoretical predictions and results of previous experiments.

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1. Introduction

The study of the deuteron-proton elastic scattering has a longtime story. The first nucleon-deuteron experiments were performed already in the 1950's [1-7]. Differential cross-section and nucleon analyzing powers [5-7] were measured at few hundred MeV. Nowadays this reaction is still the subject of the investigations [8-10].

The purpose of DSS (Deuteron Spin Structure) project is the broadening of the energy and angular ranges of measurement of different observables in processes including 3-nucleon systems. The main aim of the offered experiment program is the extraction of the information on the spin dependent part of 3-nucleon forces. DSS project experimental program includes 2 experiments, one of them is the experiment on dp-elastic scattering study. It includes measurement of cross-section, vector A_y, tensor A_{yy} and A_{xx} analyzing powers in dp-elastic scattering in the range of 300 and 2000 MeV of the deuteron kinetic energy [10].

The goal of present investigation is to measure the cross-section of dp-elastic scattering at the 880 MeV using the kinematic coincidences of deuteron and proton with plastic scintillation counters. Measurements were performed using polyethylene and carbon targets and procedure of CH_2-C time difference spectra subtraction [11],[12]. The data are compared with the calculation of relativistic multiple scattering model [13].

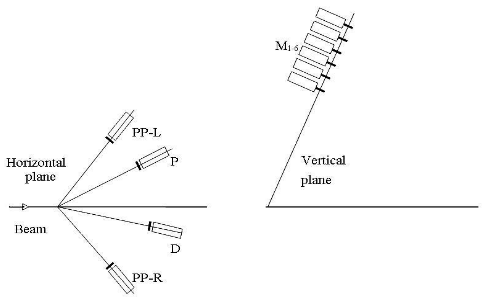

Figure 1: Scheme of the experimental setup at the internal target station: P- proton detector, D- deuteron detector, PP-L and PP-R are the detectors for pp-quasi-elastic scattering, M1-M6- monitor counters.

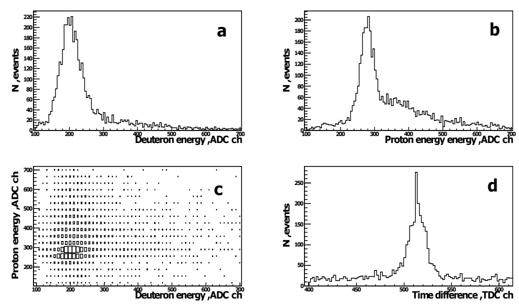

Figure 2: Data obtained with polyethylene target at 880 MeV: distributions of the amplitudes for scattered deuterons (a) and recoil protons (b). The correlation of the amplitudes (c) time difference between signals for proton and deuteron detectors (d).

2. EXPERIMENT AT INTERNAL TARGET STATION AT NUCLOTRON.

The schematic view of the experiment on the dp-elastic scattering study at Internal Target Station (ITS) at Nuclotron is shown in Fig.1. The setup consists of 4 proton and deuteron scintillation detectors (P and D) based on FEU-85 photomultiplier tubes. The amplitudes of the signals and timing information from the both P and D detectors were recorded for each event. Each detector consists of 2 scintillation counters and have geometric acceptance 20*30 mm^2.

The signals from the P, D detectors give coincidences for dp-elastic and quasi-elastic reactions, PP-L and PP-R register protons from pp-quasi-elastic reaction. This reaction is used as the relative intensity monitor of the interacting beam with the target for calculation of cross-section of dp-elastic scattering reaction. This monitor can be used also for polarization measurements, because PP-detectors are located at 90 ^{o} in c.m. and non-sensitive to the beam polarization.

Measurements were performed using 880 MeV deuteron beam and polyethylene and carbon targets. Deuteron and proton detectors were placed in the kinematic coincidence.

3. DATA ANALYSIS.

The distributions of the amplitudes for scattered deuterons and recoil protons for polyethylene target at 880 MeV are presented in Fig.2a and Fig.2b, respectively. The correlation of the amplitudes and time difference between signals for proton and deuteron detectors are shown in Fig.2c and Fig.2d.

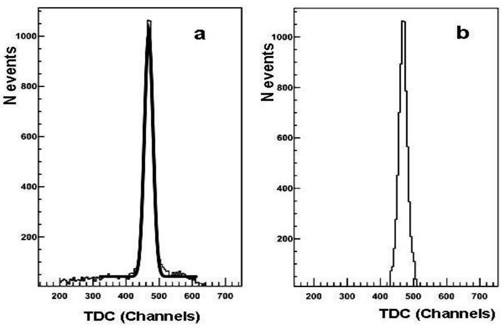

Figure 3: Applying of the gates on deuteron-proton time difference spectra: a) spectra without gates, b) spectra with gates. The fit is presented by the solid line.

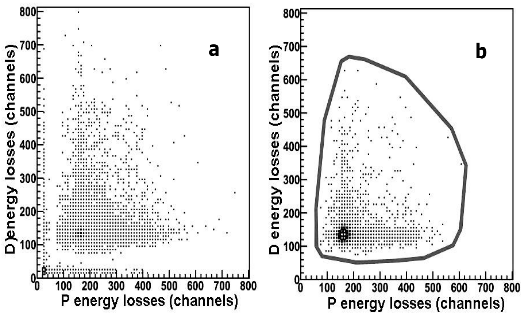

Figure 4: Correlations of proton and deuteron energy losses: a) without TDC gates, b) with TDC gates. ADC criteria is presented in the solid line.

The first stage of dp-elastic scattering events selection is the applying of the temprorary gates on the deuteron-proton time difference spectra to see the behaviour of the ADC data (see Fig.3). ADC correlation with and without TDC gates are shown in Fig.4a and Fig.4b, respectively. The second stage of the analysis is the applying of the criteria on the signal amplitudes correlation from the deuteron and proton detectors (see Fig.4b). This allows to reduce significantly the background in the time difference spectrum shown in Fig.3a. The same graphical cut was imposed for the data obtained with the carbon target. The graphical criteria for PP detectors are the same for each angle, because PP detectors weren't moved. The graphical criteria for D and P detectors are different depending on the scattering angle. The time difference for polyethylene and carbon targets after applying of the graphical cut on the amplitudes correlation are shown in Fig.5a and Fig.5b, respectively.

The relative normalization of the spectra was obtained from the ratio of the background events placed on the left and right from the peak.It is posible because background in CH_2 spectra corresponds carbon contribution in CH_2 data. As should be noticed, the carbon contribution increases with the energy increasing. The time difference spectra in Fig.5a and Fig.5b were fitted by the sum of gaussian and constant. The ratio of the obtained constants was considered as a normalization factor. The procedure of the of the CH_2-C normalized time difference spectra subtraction [11],[12]

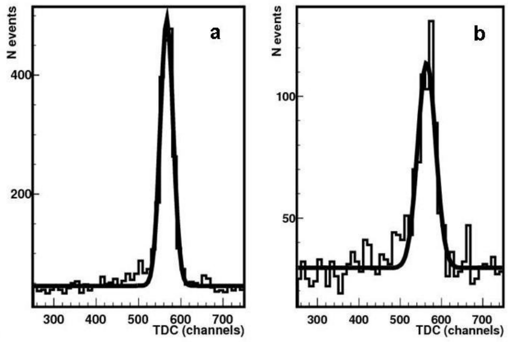

Figure 5: Normalization of TDC spectra: a) polyethylene data, b) carbon data.

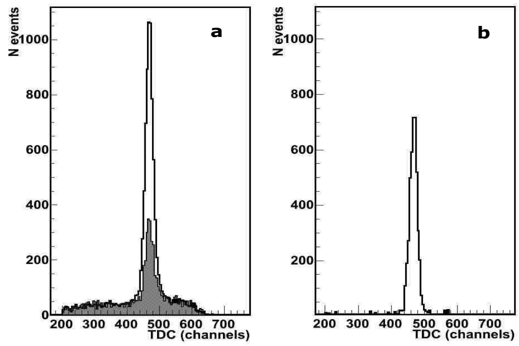

Figure 6: Procedure of CH_2-C subtraction (a) and result of subtraction (b). White spectra- are CH_2 data, gray- are C data.

for 880 MeV is presented in Fig.6. The relative normalisation of the dp-elastic scattering data was performed using pp-quasielastic scattering data.

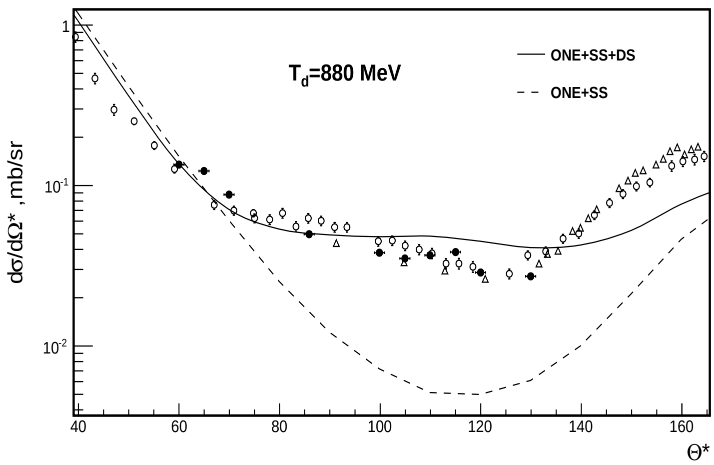

Figure 7: The differential cross-section of dp-elastic scattering reaction in relative normalisation at the deuteron energy of 880 MeV obtained at Nuclotron is show by solid symbols. Open sircles and triangles are the data taken from [15],[14], respectively.

4. RESULTS OF THE CROSS SECTION MEASUREMENTS.

Angular dependences of the dp-elastic scattering cross-section obtained at 880 MeV is presented by the solid symbols in Fig.7. The experimental data obtained at Nuclotron are normalised to the theoretical calculation performed within relativistic multiple scattering model [13] at the 60^o c.m.s. given by the solid curves. These calculations take into account the single scattering one-nucleon exchange and double scattering terms. The dashed curves are obtained by the consideration of only single scattering and the nucleon exchange. One can see that the contribution of the double scattering at the angles larger than 70^o c.m.s. is increasing with the energy encreasing. The shape of the angular dependence of the relatively normalised data obtained data at Nuclotron agree with the behaviour of the previously obtained data [14],[15].

5. CONCLUSION.

The results of the cross-section measurement using CH_2-C subtraction in dp-elastic scattering at the energy of 880 MeV have been obtained. The angular dependence has been obtained using relative normalisation to pp-quasielastic scattering at 90^o c.m.s. The data demonstrates a good agreement with results of previous experiments at all deuteron scattering angles. The deviation of the theoretical predictions (relativistic multiple scattering model) with the experimental data are observed at the deuteron scattering angles above 100^o c.m.

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