Chapter 81
Experimental Study of Few Nucleon Correlations Using Deuteron Beam at Nuclotron

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Abstract Polarized and unpolarized data for the dp breakup reaction at deuteron energies of 270, 400 MeV and 300–500 MeV using $\Delta E - E$ technique are obtained. Dp elastic scattering has been investigated using polarized deuteron beam under various kinematic configurations in the angular range (65°–135°) in c.m. at deuteron energies of 400, 700, 800, 1000, 1100, 1300, 1500 and 1800 MeV. Preliminary results of analyzing powers obtained in dp elastic scattering at 800 MeV of deuteron energy are compared with the calculations based on relativistic multiple scattering model.

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81.1 Short Introduction

Processes in which the lightest nuclei are participating, such as dp elastic scattering and dp breakup reaction, have great advantage that can be studied in almost independent way with relatively small number of parameters.

Short range deuteron structure can be obtained from dp elastic scattering. Dp breakup reaction has richer phase space to be investigated which allows us to study reaction mechanisms in different kinematic conditions. Three nucleon scattering can be solved with modern two and three nucleon forces up to 200 MeV/nucleon [1]. Experiments performed at RIKEN [2] were aimed to study three nucleon forces (3NFs) contribution and to test modern models of 3NFs.

81.2 Results

Few nucleon correlations are studied using polarized and unpolarized deuteron beams and polyethylene and carbon targets at Nuclotron, JINR. More detailed information about performed experiments can be found in [3]. The dp breakup reaction is investigated at the deuteron energies from 300 to 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 $\Delta E - E$ technique [4]. Recent studies of dp breakup reaction are aimed to study 3NFs and relativistic effects behaviour under special kinematic conditions. In order to obtain polarization observables calibration procedure has been performed using unpolarized deuteron beam data [5]. Recently, dp elastic scattering is investigated using polarized deuteron beam at ITS under various kinematic configurations in the angular range (65°–135°) in c.m. at deuteron energies of 400, 700, 800, 1000, 1100, 1300, 1500 and 1800 MeV. The A_y, A_{yy} and A_{xx} analyzing powers for the dp elastic scattering have been obtained for the first time at the ITS of the Nuclotron at deuteron energy of 800 MeV in angular range between 60° and 135° in the center of mass system. Theoretical calculations based on relativistic multiple scattering model are compared with the data containing statistical errors only, see Fig. 81.1. Dot-dashed, dashed and solid curves represent relativistic multiple scattering model calculations including only single scattering term, single + double scattering term [6] and calculations including single + double scattering term and also Δ—isobar excitation [7], respectively. Reasonably good agreement is found in description of vector analyzing power A_y in the middle of the angular range (85°–115°). The contribution which comes from double scattering and Δ isobar excitation ones is relatively small in this range. Behaviour of tensor analyzing power A_{yy} is reproduced qualitatively using double scattering and Δ isobar terms. It shows on importance of double scattering term in the range the data were obtained. Quantitative description is obtained around the angle of $\sim$115° only. Tensor analyzing power A_{xx} shows linear growth in the angular range from 65° to 90° and then the data have constant behaviour which is in agreement with calculation based on single scattering term.

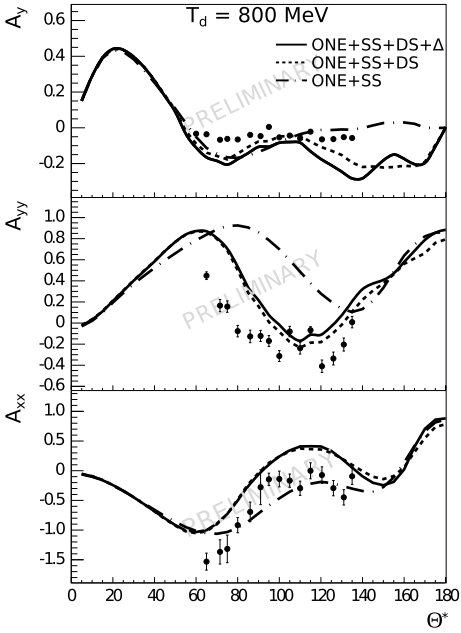

Fig. 81.1 The angular dependencies of the vector A_y and tensor A_{yy} and A_{xx} analyzing powers in dp elastic scattering measured at 800 MeV at ITS of Nuclotron. Theoretical calculations based on relativistic multiple scattering model are presented, see text for the curve explanation

81.3 Conclusion

Dp elastic and dp breakup reactions are investigated at intermediate energies using polarized and unpolarized deuteron beams of Nuclotron. Dp elastic data along with theoretical calculations based on multiple scattering model obtained at 800 MeV of deuteron energy are discussed.

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