MEASUREMENTS OF $T_{20}$ IN BACKWARD ELASTIC $dp$ SCATTERING AT DEUTERON MOMENTA
3.5—6 GeV/c

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1. Introduction

Direct reconstruction of the deuteron wave function (DWF) based on its relation with measured quantities within the Impulse Approximation (IA) framework is possible for the reaction of the deuteron electrodisintegration \( ed \to enp \), and also for reactions with nuclear probe such as \( A(d, p)X \) at zero angle and \( \rho(d, p)d \) (at 180° in the center of mass).

The comparison of the momentum distributions of the fragments extracted in this way from experiments with electromagnetic and nuclear probes\(^1\)–\(^3\) has revealed their similarity even in a region where appreciable deviation from the IA calculations take place. This circumstance gave a strong motivation to develop a program of investigations of polarization observables in reactions with nuclear probes, which would allow to reconstruct the DWF components. The measurement of \( T_{20} \) in \( dp \) backward elastic scattering was one of the first experiments with a polarized deuteron beam at SATURNE-\(^4\).

Here we present results of measurements of this observable which were performed at the JINR synchrophasotron mainly in the range of energies unreachable at SATURNE. The investigation was carried out by the Dubna-Saclay-Virginia collaboration, which was organized to study polarization phenomena in the elastic backward \( dp \) scattering both at Saclay and at Dubna.

2. Experiment

The tensor polarized beam of intensity \( 10^9 \) deuterons/beam spill incidented on a 30 cm liquid hydrogen target. The beam polarization states were changed in a bunch-after-bunch mode during data taking; the beam polarization was \( \rho_{20}^+ = 0.49 \pm 0.03 \) and \( \rho_{20}^- = -0.52 \pm 0.04 \).

The recoil protons emitted in lab. in forward direction at 0 ± 15 mrad were detected after the beam-line in the magnetic spectrometer ALPHA. The corresponding angular acceptance in the center of mass system increased from \((180 \pm 2.4)^\circ\) at the lowest energy to \((180 \pm 3.0)^\circ\) at the highest energy of the primary beam. The backward scattered deuterons were not detected; in this case one needs to have high momentum resolution to reject non-elastic events. In this experiment \( \frac{\Delta p}{p} = 0.3\% \) was achieved; it corresponds to

![Fig.1 Forward proton momentum distribution in vicinity of backward elastic peak.](image-url)
a missing mass resolution of 4 MeV for the lowest energy and 8 MeV for the highest.

The separation of elastic events from the background (mainly deuteron breakup reaction in the region of the kinematical limit) is illustrated in Fig.1. It was also necessary to separate protons from inelastically scattered deuterons with the same momentum from the reaction \( p(d,d')X \). This contamination contribute up to 3000 deuterons per 1 proton at the highest energy. To reject such events at the trigger level, a digital TOF-trigger was tuned to make rather soft rejection.

The final separation of protons from deuterons was done using measured values of particle momenta and their times of flight. The mass separation achieved is illustrated in Fig. 2.

3. Results

In the framework of the IA the expression \( T_{20} \) is identical for \( p(d,p)d \) and \( p(d,p)X \) reactions (when one considers the deuteron as S- and D-component system only); the main goal of this experiment was to establish whether this equality of \( T_{20} \) for the two reactions holds true in reality. The rather large momentum acceptance of the spectrometer (see Fig.1) allowed us to follow the regime of change of \( T_{20} \) as the breakup process approaches its kinematical limit: backward elastic scattering. In Fig.3 the backward elastic scattering data are presented together with the breakup data from this experiment taken far away from the kinematical limit at each energy, and with the data for \( ^{12}C(d,p)X \) reaction at 9 GeV/c. One can see that breakup data from these different experiments are close to each other in spite of the different energies and targets (carbon and hydrogen). One can see also an important difference between \( T_{20} \) values for breakup reaction and for backward elastic scattering which is maximum at \( k = 0.65 \) GeV/c.

Never-the-less, the general \( k \)-dependence of \( T_{20} \) in both reactions demonstrate the same important disagreements with expectations based on IA-like approaches: \( T_{20} \) does not achieve expected value of minimum \((-\sqrt{2})\) in vicinity
of $k = 0.3 \text{ GeV/c}^8$ and in contradiction with the predictions have a tendency to remain negative at higher values of $k$.

The new measurements of $dp$ backward elastic scattering were undertook in Dubna this year. The data analysis now in progress. But it is possible to say already now that $T_{20}$ remains negative up to $k = 0.85 \text{ GeV/c}$.

To explain revealed effects one can consider the additional to IA mechanisms, different for the discussed reactions. It is possible also remaining in the framework of the IA to assume more than two-component DWF. For example, two $P$-wave in the DWF emerges when the deuteron is considered in relativistic approach\textsuperscript{9}, or $X^*X$ projections of the $6$-quark DWF\textsuperscript{10} are essential. It is important to stress that if the DWF has a $P$-wave component then the identity between the IA expressions for $T_{20}$ for the discussed two reactions disappears\textsuperscript{12}.

The relativistic model of the deuteron assuming more than two arguments of the DWF\textsuperscript{11} must be considered also. A more detailed analysis of these hypotheses in the light of the new data needs to be done.

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References

8. C.F.Perdrisat et al., talk presented at Dubna Deuteron-93 Symp., Sept.1993, Dubna. (to be published)

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Ажгирий Л.С. и др.
Измерение $T_{20}$ в упругом $dp$-рассеянии назад при импульсе дейтрона 3,5—6 ГэВ/с

Представлены данные по тензорной анализирующей способности $T_{20}$ в реакции $dp$-рассеяния назад при импульсе начальных дейтронов 3,5—6 ГэВ/с, что соответствует диапазону внутренних импульсов конституентов в дейтроне $k = 0,5—0,8$ ГэВ/с. Наблюдается новая структура при $k = 0,65$ ГэВ/с. Обсуждаются различие в поведении $T_{20}$ в $dp$-упругом рассеянии назад и в реакции фрагментации дейтрона, которая имеет плавное поведение $T_{20}$ при больших $k$.

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Measurements of $T_{20}$ in Backward Elastic $dp$ Scattering at Deuteron Momenta 3.5—6 GeV/c

We present results of measurements of the tensor analyzing power $T_{20}$ in $dp$ backward elastic scattering at initial deuterons momenta 3.5—6.0 GeV/c, which corresponds the range of internal momentum of the deuteron constituents $k = 0.5—0.8$ GeV/c. New structure was observed at $k = 0.65$ GeV/c. Difference between behavior of $T_{20}$ for $dp$ backward elastic scattering and for breakup reaction, which have a smooth behavior of $T_{20}$ at high $k$, is discussed.

The investigation has been performed at the Laboratory of High Energies, JINR.

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