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B.S.Aladashvili, B.Badełek, V.V.Glagolev,
R.M.Lebedev, J.Nassalski, M.S.Nioradze,
G.Odyniec, I.S.Saitov, A.Sandacz, T.Siemiarczuk,
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Dubna — Warsaw Collaboration

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B.S. Aladashvili,[1] B. Badełek,[2] V.V. Glagolev,[1]
R.M. Lebedev,[1] J. Nassalski,[3] M.S. Nioradze,[1]
G. Odyniec,[2] I.S. Saitov,[1] A. Sandacz,[3] T. Siemiarczuk,[2]
J. Stepaniak,[2] V.N. Streltsov,[1] P. Zielinski[3]

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[1] Joint Institute for Nuclear Research, Dubna.

[2] Institute of Experimental Physics, Warsaw University.

[3] Institute of Nuclear Research, Warsaw.

Аладашвили Б.С., Бадэлэк Б., Глаголев В.В., Лебедев Р.М.
Нассальски Я., Ниорадзе М.С., Одынец Г., Саитов И.С.,
Сандач А., Семярчук Т., Стэпаняк И., Стрельцов В.Н., Зелински П.

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Распределение квадрата четырехмерного переданного импульса в канале прямого развала дейтрона при импульсе падающего дейтрона 3,3 ГэВ/с

Изучалось дифференциальное сечение $\frac{d\sigma}{dt}$ для реакции $dp \to pnp$ при импульсе дейтрона 3,3 ГэВ/с, которое сравнивалось с теорией многократного рассеяния Глаубера. В пределах неопределенности существующих данных по элементарному рассеянию расчеты по модели Глаубера с реалистическим дейтронным форм-фактором дают удовлетворительное согласие с экспериментом.

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Aladashvili B.S., Badełek B., Glagolev V.V.,
Lebedev R.M., Nassalski J., Nioradze M.S.,
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Stepaniak J., Streltsov V.N., Zielinski P.

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The Four-Momentum Transfer Distribution for the Charge Retention Breakup at 3.3 GeV/c Incident Deuteron Momentum

The $\frac{d\sigma}{dt}$ differential cross section is studied for the $dp \to pnp$ reaction at 3.3 GeV/c deuteron momentum and compared with the Glauber multiple scattering theory. Within the limits of the uncertainties of the existing elementary nucleon-nucleon data, the simple Glauber model calculations with the realistic deuteron form factor give satisfactory agreement with experiment.

Communications of the Joint Institute for Nuclear Research.
Dubna, 1974

1. The Sample

The events used in this study have been obtained in an exposure of the JINR 1 m hydrogen bubble chamber to the deuteron beam with a momentum of 3.33 ± 0.08 GeV/c. A sample of 838 events fitting the reaction

$$dp \to pnp \qquad (1)$$

was collected. The events of reaction (1) belong to the one-constraint fit category. A fraction of these events (12%) has one or two competitive hypotheses. Among the ambiguous hypotheses we always accept the fit to reaction (1) with a weight equal to 1. As a result of this procedure, some misidentified events are accepted; however, as was shown elsewhere /1/, the fraction of events accepted with wrong mass assignments is still less than 1%, and the fraction of events going to other channels is about 4%. The events going to other channels do not affect the shape of the overall $d\sigma/dt$ distribution, and therefore no bias is introduced.

As usual, in deuteron bubble chamber experiments a deuteron target is used when substantial biases are introduced due to losses in spectator-nucleons. That is why an opposite beam-target configuration was chosen as it allows the spectator-nucleons to be easily seen in the bubble chamber.

Preliminary results of this study were presented at Batavia /2/, Uppsala /3/ and Moscow /4/. Our present estimate of the $dp \to ppn$ total reaction cross section is 37.2 ± 1.4 mb whereas in the preliminary data /2,3/ the value of 40.5 mb was

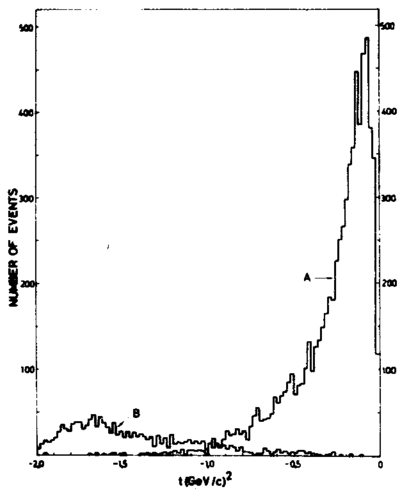

Fig. 1. The four-momentum transfer distribution from the proton target to the slowest proton in the laboratory system.

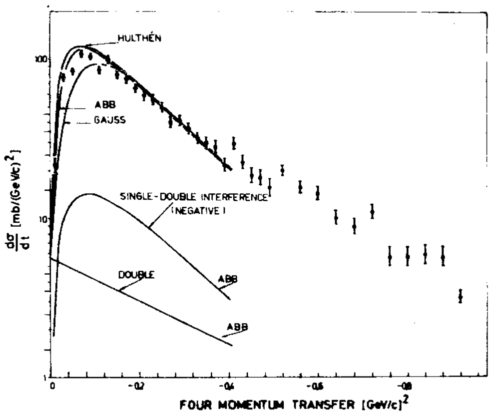

Fig. 2. The differential cross section $d\sigma/dt$ for the charge retention channel.

used (the latter value was used by Saudinos and Wilkin in their review /5/). Information on the deuteron breakup reaction induced by the proton at high energy is still very scanty.

First results concerning the pd → ppn reaction at 1 GeV incident proton energy at fixed scattering angles have been obtained in the counter experiment by Simpson et al. /6/.

In this paper we are concerned with the "charge retention" reaction, i.e. the process proceeding without charge exchange between incoming particle and target. Experimentally, we ascribe to this channel all the events in which the proton is the slowest particle in the laboratory system (6917 events). The remaining 1441 events corresponding to the charge exchange reaction were analysed in a separate paper /7/.

2. Results and Discussion

Figure 1 shows the four-momentum transfer distribution from the proton target to the slowest proton in the laboratory system. The distributions A and B correspond to the events ascribed to the charge retention and charge exchange channels, respectively. A distinct separation is observed for $|t|$ less than 0.6 $(GeV/c)^2$. The cross section for the charge retention channel was found to be equal to 30.8 ± 1.2 mb.

The experimental $d\sigma/dt$ differenetial cross section for the charge retention reaction is shown in fig. 2. A study of the slow proton azimuthal angular distribution shows that there are no systematic losses in the events above the 0.01 $(GeV/c)^2$ $|t|$ value, i.e. above the first bin of our distribution.

We compare the measured $d\sigma/dt$ distribution with the simple Glauber model calculations (neglecting the spin)*. According to Franco and Glauber /3/, the differential cross section for the deuteron breakup reaction is

$$(d\sigma/dt)_{breakup} = (d\sigma/dt)_{scatt.} - (d\sigma/dt)_{el.} ,$$

where $(d\sigma/dt)_{breakup}$ represents the differential cross section leading to dissociation of the deuteron into two nucleons; $(d\sigma/dt)_{scatt.}$ was calculated using a closure approximation. The calculations were made for three different deuteron form factors :

1) The form factor we have obtained from the Hulten deuteron wave function $\varphi(p) \sim [(p^2 + \alpha^2)(p^2 + \beta^2)]^{-1}$ with $\alpha = 45.8$ and $\beta = 236.8$:

$$S(q) = \sum_{i=1}^{3} A_i \exp(-B_i q^2)$$

$A_1 = 0.4062$ $B_1 = 114.8\ (GeV/c)^{-2}$

$A_2 = 0.4594$ $B_2 = 27.07\ (GeV/c)^{-2}$

$A_3 = 0.1272$ $B_3 = 5.769\ (GeV/c)^{-2}$

2) The Gaussian form factor /9/:

$$S(q) = \exp(-33\ q^2)$$

3) The form factor obtained by Alberi, Bertocci and Białkowski (ABB) from the Bressel-Kerman deuteron wave function /10/:

$$S(q) = \sum_{i=1}^{3} A_i \exp(-B_i q^2)$$

$A_1 = -0.03799$ $B_1 = 1.871\ (GeV/c)^{-2}$

$A_2 = 0.3384$ $B_2 = 12.33\ (GeV/c)^{-2}$

$A_3 = 0.6952$ $B_3 = 64.59\ (GeV/c)^{-2}$.

We have used the following parametrization of the elementary proton-nucleon amplitude :

$$f_{pN} = A_N (i + \alpha_N) \exp(1/2\ b_N t)$$

$A_n = 9.52 \pm 0.45\ mb^{1/2}(GeV/c)^{-1}$

$A_p = 12.57 \pm 0.62\ mb^{1/2}(GeV/c)^{-1}$

$\alpha_n = -0.4 \pm 0.1$

$\alpha_p = 0.0$

$b_n = 5.7 \pm 0.6\ (GeV/c)^{-2}$

$b_p = 6.8 \pm 0.7\ (GeV/c)^{-2}$.

The A_n, A_p and b_n, b_p values were obtained from the fit to the elementary pp and np data /11,12/ in the (0.1-0.4) $(GeV/c)^2$ interval of the four-momentum transfer.

The results for the different form factors are given in fig. 2 together with the contributions of double scattering and the interference between single and double scatterings for the ABB form factor.

The solid curve in fig. 3 represents $d\sigma/dt$ calculated with the ABB form factor fitted to the experimental distribution. The value χ^2 was calculated with terms which allow one to keep the fitted parameters A_n, A_p, b_n and b_p of the elementary amplitudes within the limits of their errors.

* There is a large probability that at low $|t|$ values a deuteron remains unbroken. Corresponding events can be found in the elastic channel. This does not take place if there occurs a spin-dependent interaction, and therefore the $d\sigma/dt$ behaviour near $t = 0$ reflects the spin-dependent contribution to the nucleon-nucleon amplitude.

A comparison of the experimental $d\sigma/dt$ differential cross section with the calculated curves shows that within the accuracy of the existing elementary nucleon-nucleon data the simple Glauber model calculations with the form factor obtained from the Bressel-Kerman wave function are consistent with the experimental data.

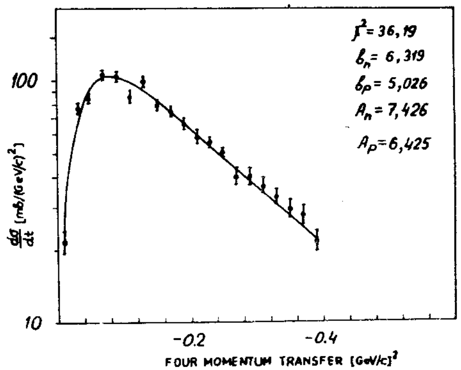

Fig. 3. The fitted $d\sigma/dt$ distribution with the AB3 form factor.

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