СООБЩЕНИЯ
ОБЪЕДИНЕННОГО
ИНСТИТУТА
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ
ДУБНА

E1 - 11555
18/IX-78

R.Kh.Kutuev, Kh.Murtazaev, R.Ya.Zulkarneev

POLARIZATION OF FAST PROTONS EMITTED AT 90°-130° IN THE INCLUSIVE REACTION p+C → p+... AT 640 MEV

1978

E1 - 11555

R.Kh.Kutuev, Kh.Murtazaev, R.Ya.Zulkarneev

POLARIZATION OF FAST PROTONS EMITTED AT 90°-130° IN THE INCLUSIVE REACTION p+C → p+... AT 640 MEV

Кутуев Р.Х., Муртазаев Х., Зулькарнеев Р.Я. **E1 - 11555**

Поляризация быстрых протонов, испущенных на углы 90°+130° в инклюзивной реакции p+C → p+ ... при 640 МэВ

Энергетическая зависимость поляризации протонов, испущенных на углы 90°, 110° и 130° измерена для протонов инклюзивной реакции p+C → p+ ... при 640 МэВ. Исследовался интервал энергии вторичных протонов 110–230 МэВ. Из полученных данных следует, что:

1) поляризация инклюзивных протонов велика и достигает≈40%;

2) экспериментальные ее значения для угла 130° совпадают с предсказаниями Фрэнкеля-Волошина, сделанными на основе гипотезы о существовании высокоимпульсной компоненты движения нуклонов в ядрах.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1978

Kutuev R.Kh., Murtazaev Kh., Zulkarneev R.Ya. **E1 - 11555**

Polarization of Fast Protons Emitted at 90° -130° in the Inclusive Reaction p+C → p+... at 640 MeV

Energy dependence of the polarization of fast protons emitted at 90°, 110°and 130° has been measured for the inclusive process $p + {}^{12}C \to p + ...$ at 640 MeV. The energy interval of 110÷230 MeV has been investigated. It results from our experimental data that

1) the polarization of inclusive protons is very large and amounts to ≈ 40%;

2) the experimental values of polarization at 130° coincide with Frankel-Woloshin predictions [5] made on the ground of the hypothesis of the high momenta component of nucleon motion inside nuclei.

The investigation has been performed at the Laboratory of Nuclear Problems, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna 1978

Investigation of particle production at large angles and momenta has become an important problem of nuclear physics in recent years. Numerous theoretical models (a cluster model [1], its quark-parton modifications [2,3], the model of the high momentum component of nucleons in nuclei [4,5], a cascade model and so on [6,7]) have not resulted yet in the unique understanding of the mechanism of particle production and protons from nuclei among other things. Taking into account this circumstance and the fact that the polarization experiments give us new independent data on the interaction mechanism [5], we present the preliminary results of polarization measurements of protons, emitted at angles of 90°, 110° and 130° in the inclusive reaction

$$p + {}^{12}C \to p + ... \qquad (1)$$

at the initial proton energy of 640±15 *MeV*. The measurements were performed for the momentum of 470-690 *MeV/c*, the energy range being from 110 to 230 *MeV*.

The experimental lay-out is shown in *figure 1*. A non-polarized proton beam was directed at polarizing carbon target No. 1. Counters 1 and 2 detected particles emitted by this target at the angle θ_1 . Carbon target No. 2 served as a polarization analyzer for protons emitted by target No.1. The analyzing scattering angle θ_2 was equal to (8±1.5)° l.s. The kind of particles was identified mainly after the interaction of these particles with the analyzer nuclei by means of "time-of-flight" data of particles passed through counters 3 and 5 (as well as

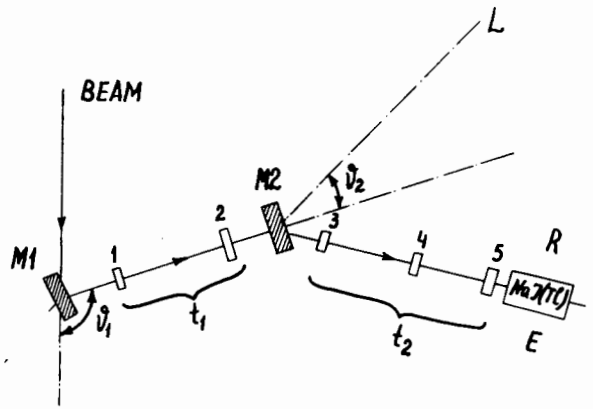

Fig. 1. Experimental set up for polarization measurements. M1, M2 - polarizing and analyzing targets. Detectors: 1÷ 5 scintillation; counters; NaJ is a total energy absorption counter, t_{12} is the time of flight of particles before and after the analyzing target.

through counters 1 and 2) and their kinetic energy, measured by a NaI counter. The latter was a total absorption counter with a crystal of cylindrical shape, the diameter and the height of which was 10 *cm*.

The time-of-flight data were obtained by the HP-2116 computer, which treated these data to identify particles and define their kinematical characteristics during the experiment. The particle velocity and energy absorbed by the NaI counter undoubtedly defined the mass of particles scattered by the analyzer. The time-of-flight, the energy and the mass absolute values of particles were calibrated in a separate experiment on the elastic pp - scattering. The energy resolutions obtained in those measurements have been found to be ±(7÷9) *MeV* and the time-of-flight, ± 0.3 *nsec*.

When both the targets were placed simultaneously a total number of recorded events N was found by means of the formula

$$N = N^{+} + N^{-} + N^{re} + N^{fal} \quad . \qquad (2)$$

Here N^{+} is scattering events of the investigated protons by the analyzing target; N^{-} is a number of events of the investigated protons scattered by the scintillator of counters 2 and 3; N^{re} is a random event contribution; N^{fal} is an admixture of protons generated by tatget 2 as a result of absorption of pions emitted by the polarizer *.

The total contribution of quantities N^{-} and N^{re} was controlled in the course of measurements and usually did not exceed (1÷5)%. In the experiment we did not measure the contribution of N^{fal} But the evaluations show that the possible admixture N^{fal} changes the experimental asymmetries not greater than (15÷20)%. In the future we shall study the influence of this phenomenon experimentally and more thoroughly.

The false asymmetry absence was tested by measuring proton polarization in the elastic pp -scattering at an angle of 90 °. We have found that the possible false asymmetry was equal to $+0.01 \pm 0.020$. The experimental asymmetry values "e" are given in *table 1*.For the left-right asymmetry we used the expression, in which the "left" direction was implied as a scattering to the left with respect to the beam axis the polaruzation of which is under investigation (see *fig. 1*).

The energy dependence of polarization, $\mathcal{P}$, is shown in *figure 2*. To calculate it the experimental asymmetries were divided by the table values of the carbon analyzing power[8], which we tested experimentally for the two energy intervals only (see *table 2*).

Presently the analyzing power for the rest energy intervals is under measurement. From *figure 2* one can see that the polarization of protons emitted at angles of 90 ° and 110° depends on the proton energy and can be (30÷40)%. This fact makes it doubtful to use the Weber-Miller mechanism[6] for the interpretation of the nature of backward emitted energy protons in type (1) re-

---

* We could not exclude completely the detection of such protons owing to insufficiently precise separation of the particles in front of the analyzer. The main contribution of N^{fal} was brought by the reaction $\pi^{+} + d \to 2p$ "in flight" at the deuterium cluster of carbon.

Table 1

The left-right experimental asymmetries (in %) for the angles of 90°, 110° and 130° l.s.

Energy, *MeV*	108±5	118±5	130±7	155±15	185±15	215±15
90°	-11±2	-17±1	-11±2	-6±2	5±2	31±6
110°	-4±3	0±1	7±2	5±3	-1±4	-1±6
130°	-	7±2	12±4	16±4	15±8	20±10

Table 2

The carbon analyzing power

Energy, *MeV*	108	118	130	155	185	215
Analyzing power[8],%	34±5	38±5	42±7	50±8	56±8	61±8
Analyzing power, present data,%	-	-	42±3	44±5	-	-

actions. It is interesting to compare our results with the angle dependence of proton polarization, obtained for the process p+d → p+d at 640 *MeV* ref.[9]. From this comparison one can see (*figures 2a, 2b* open circles) that apparently our data at 90° and 110° do not coincide with the polarization of protons, emitted at the same angles in free elastic pd-scattering. Perhaps, this fact points out the important role of 3,4 and more nucleon associations as it has been indicated earlier by A.Efremov[2].

In conclusion the comparison with the theoretical evaluations of polarization, made recently by S.Frankel and R.Woloshin on the basis of a dominant role of the high momentum component of the nuclear wave function[5], shows essential discrepancy in the angular region

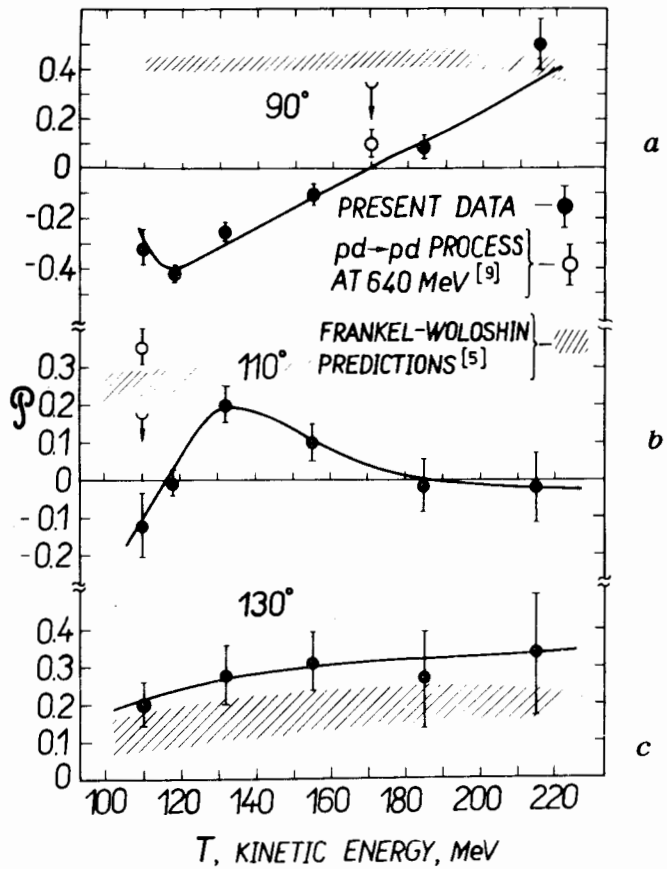

Fig. 2. Energy dependences of inclusive proton of polarization in reaction (1). The arrow points to the expected energy place for protons in the reaction pd → pd *at 640 MeV.*

of 90°÷110° and remarkable agreement of our data for 120°÷130° with predictions[5] made for reaction p+Ta→p... at 800 *MeV*.

The authors are grateful to G.A.Leksin, A.V.Efremov and V.D.Toneev for stimulating discussions.

REFERENCES

1. *Blokhintsev D.I. ZhETF (USSR), 1957, 33, p.898; Baldin A.M. Comm.on Phys. (Acad.Sci.USSR), 1971, 1, p.35.*
2. *Efremov A.V. Jad.Fiz., 1976, 24, p.1208; JINR, D1,2-10400, Dubna, 1977, D2-11244, Dubna, 1978.*
3. *Burov V.V., Lukjanov V.K., Titov A.I. Phys.Lett., 1977, B67, p.46; Fujita T. Phys.Rev.Lett., 1977, 39, p.174.*
4. *Amado P.D., Woloshin R.M. Phys.Rev.Lett., 1976, 36, p.1435.*
5. *Frankel S., Woloshin R.M. Phys.Rev., 1977, C16, p.1680. Баюков Ю.Д. и др. ЯФ, 1967, т.5,вып.2, с.337.*
6. *Weber M.J., Miller L.D. Phys.Rev., 1977, C16, p.726.*
7. *Gudima K.K., Mashnik S.G., Toneev V.D. JINR, E2-11307, Dubna, 1978.*
8. *Feissner H. Polarization of the Nucleons at Scattering, Moscow, 1960, p.161.*
9. *Murtasaev H., Nadezhdin V.S., Satarov V.I. ZhETF Lett., 1978, 27, p.336.*

Received by Publishing Department on May 6 1978.