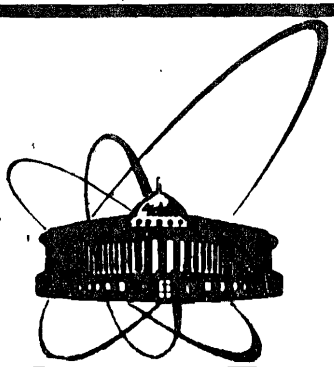

объединенный
институт
ядерных
исследований
дубна

E1-86-523

DOUBLE CHARGE EXCHANGE OF NEGATIVE PIONS IN INCLUSIVE REACTIONS ON NUCLEI AT 40 GEV/C

Submitted to XXIII International Conference
on High Energy Physics (Berkeley, 1986)

1986

M.A.Ananieva, V.V.Vishnyakov, N.D.Dikusar,
L.K.Lytkin, V.I.Nikanorov
Joint Institute for Nuclear Research, Dubna

A.A.Belozerova, K.P.Vishnevskaya, V.P.Lobanova
Branch of the Nuclear Physics Institute of the
Moscow State University, Dubna

F.Palombo
The University Institute of Physics, Milan

P.L.Frabetti
The University Institute of Physics, Bologna

Studying A-dependence of the inclusive reaction $\pi^- A \to \pi^+ X$ in the beam fragmentation region is of interest for making the mechanism of hadron-nuclear interactions more clear, in particular, by comparison with predictions of modern theoretical models [1-3]. In Ref. [4] this reaction was called an inclusive double charge exchange; it was also pointed out that the reaction is remarkable for the fact that in the hard part of momentum spectra the resulting positive pions are produced in decay of fast neutral resonances.

The inclusive reaction

$$\pi^- A \to \pi^+ X \qquad (1)$$

was studied during analysis of the experimental data obtained with the 5-meter magnet spark spectrometer (JINR) in the 40 GeV/c negative pion beam of the Serpukhov accelerator. The experimental layout is shown in Fig. 1. The intensity of the pion beam was 10^5 particles/sec per acceleration cycle; the momentum spread was $\Delta p/p \simeq 2\%$. The beam was monitored by a telescope of scintillation counters. Counters 1,7,9,11 were connected in coincidence; counters 8,15 were connected in anticoincidence. Direction of beam pions was determined by means of a system of wire chambers 2,4,6. The mean efficiency in reconstruction of coordinates of incoming particles was 90÷95%. Cherenkov gas counters 3,5 distinguished pions in the beam (the kaon impurity did not exceed 2%). Counter 15 behind the spectrometer prevented its triggering by beam particles which had not interacted with the target. Counter 11 was practically a hodoscope of scintillators to distinguish charged particles flying from the target 10 toward the spark spectrometer. Inside the spectrometer there was a 60x60 cm^2 proportional chamber 12, mounted 1.2 m off the target 10. The description and specifications of the chamber are given in Ref. [5]. The proportional chamber was a trigger element which distinguished charged particles in the spectrometer volume. The set-up acceptance was 30°.

The magnet spectrometer had a magnet with the useful volume 1.3x1.5x5 m^3; the magnetic field was about 17 kgauss. 25 neon-filled modules of optical spark chambers, each having two 2-cm spart gaps, were evenly distributed over the magnet volume. Two cameras with a stereoscopic angle 16° were used to take pictures.

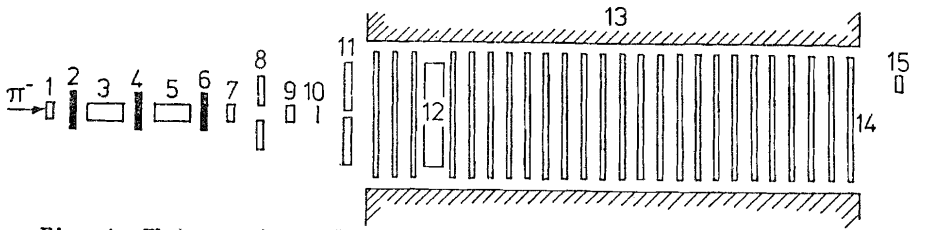

Fig. 1. The experimental lay-out. 1,7,9,11 - scintillation counters of the beam telescope, connected in coincidence; 3,5 - Cherenkov counters; 8,15 - anticoincidence scintillation counters; 10 - target; 2,4,6,12 - proportional wire chambers; 13 - magnet; 14 - spark chambers.

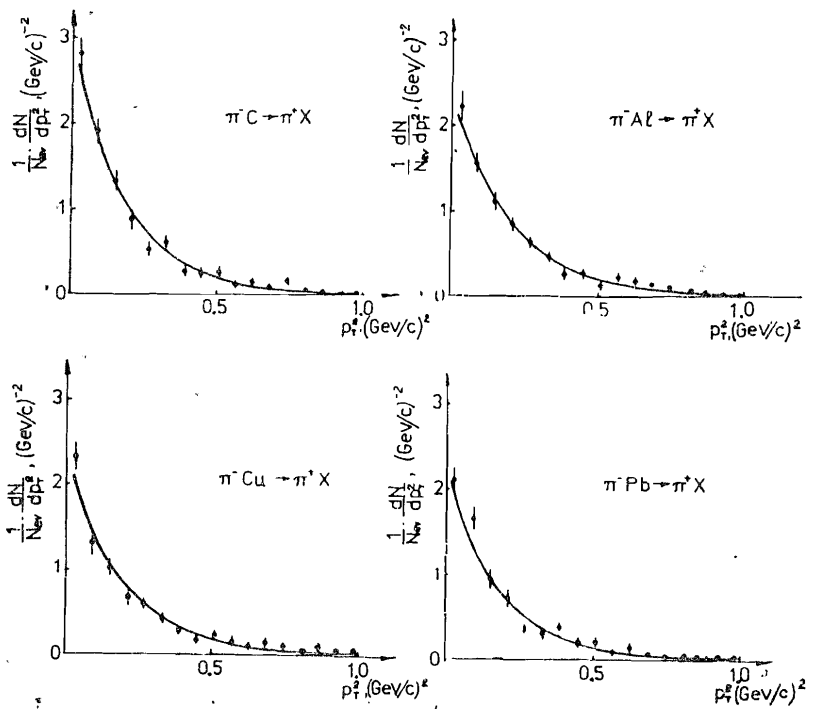

Fig. 2. Distributions of π^+ over p_T^2 for the reaction $\pi^- A \to \pi^+ X$ at 40 GeV/c.

Carbon, aluminium, copper and lead targets were used in the experiment. They were 4.28, 3.25, 1.70 and 1.14 g/cm^2 thick, respectively.

Creation of fast positive pions in reaction (1) was measured in the region of the Feynman variable $0.1 < x_F < 0.9$ at the transversal momenta $p_T < 1$ GeV/c, which corresponds to soft hadron collisions.

Over 4000 events of inelastic interactions for 4 targets were measured at HPD JINR (Dubna). Further analysis of the tracks was performed by means of the programme for automatic analysis of track information ROMEO /6/. Estimation of efficiency of track finding with this programme showed that in the above-mentioned kinematic region of x_F the track losses did not exceed 2%.

Fig. 2 shows distributions over the squared transversal momentum for positive pions from reaction (1). The solid curves are the results

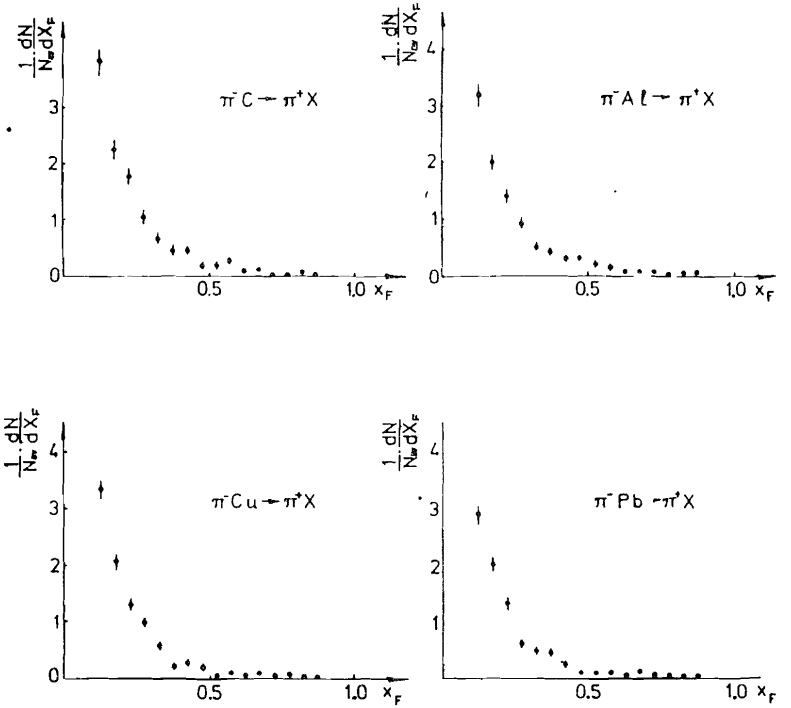

Fig. 3. Distributions of π^+ over x_F for the reaction $\pi^- A \to \pi^+ X$ at 40 GeV/c.

Table 1. Results of fitting of the distribution $\frac{1}{N_{ev}} \cdot \frac{dN}{dp_T^2}$ by the function $a \cdot \exp(-bp^2)$.

Target	C	Al	Cu	Pb
a, $(GeV/c)^{-2}$	3.0±0.2	2.4±0.2	2.3±0.2	2.4±0.2
b, $(GeV/c)^{-2}$	5.5±0.4	5.0±0.2	4.9±0.3	5.6±0.3
χ^2/DF	0.89	1.03	2.11	1.69

Table 2. Mean characteristics of positive pion distributions in the reaction $\pi^- A \to \pi^+ X$.

Target	C	Al	Cu	Pb
$\langle n_+ \rangle$	0.58±0.03	0.49±0.02	0.47±0.02	0.44±0.02
$\langle p_T \rangle$, GeV/c	0.38±0.01	0.39±0.01	0.40±0.01	0.38±0.01
p, GeV/c	10.2±0.3	10.3±0.2	9.6±0.2	9.8±0.2
$\langle p_L^* \rangle$, GeV/c	1.05±0.03	1.05±0.03	0.97±0.02	1.00±0.02
$\langle \cos\theta^* \rangle$	0.893±0.005	0.893±0.004	0.885±0.004	0.891±0.005

of fitting of these distributions by the function $a \cdot \exp(-bp_T^2)$. Values of parameters a and b, obtained at the fitting, and the ratio χ^2/DF are listed in Table 1. Distributions for C and Al are well described by an exponential, while distributions for Cu and Pb are somewhat worse. One can see from Fig. 2 and Table 1 that the form of p_T^2 distributions and values of parameters a and b slightly depend on the target atomic number.

Distributions of positive pions over x_F (Fig. 3) do not show noticeable A-dependence as well. This fact indicates at a slight influence of the target on production of fast neutral resonances.

Table 2 lists mean characteristics of inclusive π^+ in the region $0.1 < x_F < 0.9$; multiplicity, momentum, transversal momentum, longitudinal momentum and $\langle \cos\theta^* \rangle$ (an asterisk in Table 2 points out the primary pions and intranuclear nucleon c.m.). None of the values shows a significant dependence on the atomic number. We note, among others, that A-dependence of $\langle n_+ \rangle$, implied by the additive quark model [7], does not agree with our experimental data. In this connection it can be mentioned that the experimentators who studied A-dependence of hadron inclusive fragmentation on nuclei at 100 GeV/c [8] arrived at a conclusion that both the additive quark

model and the dual parton model do not agree with their experimental results. Thus, accumulating experimental data on hadron-nuclear interactions and making more precise theoretical concepts in this region is still a task of current importance.

We are grateful to B.Z.Kopeliovich for useful discussions.

References

1. V.V.Anisovich et al. Nucl.Phys., 1978, B133, 477.
2. A.Capella, J.Tran Than Van. Z.Phys., 1981, C10, 249.
3. B.Z.Kopeliovich, L.I.Lapidus. Proc.of 6-th Balaton Conf. on Nucl.Phys., 1983.
4. B.Z.Kopeliovich, Ch.Tseren. Yad.Fiz., 1977, 26, 643.
5. P.L.Frabetti et al. Nucl.Instr.and Meth., 1978, 148, 489.
6. M.A.Ananieva et al. JINR, 10-82-232, Dubna, 1982.
7. Yu.M.Shabelsky. Yad.Fiz., 1981, 33, 1379.
8. D.S.Barton et al., Phys.Rev., 1983, D27, 2580.

Received by Publishing Department
on July 25, 1986.

Ананьева М.А. и др. E1-86-523

Двойная перезарядка отрицательных пионов
в инклюзивных реакциях на ядрах при 40 ГэВ/с

Инклюзивные реакции двойной перезарядки $\pi^-A \to \pi^+X$ на ядрах C, Al, Cu и Pb анализируются на основе экспериментальных данных, полученных с помощью пятиметрового искрового спектрометра ОИЯИ. В области фрагментации пучка получены распределения по x_F и p_T^2 для инклюзивных π^+; даны их средние характеристики. Отсутствие заметной A-зависимости этих распределений указывает на слабое влияние мишени на процесс рождения быстрых нейтральных резонансов.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1986

Ananieva M.A. et al. E1-86-523

Double Charge Exchance of Negative Pions
in Inclusive Reactions on Nuclei at 40 GeV/c

Inclusive reactions of double charge exchange $\pi^-A \to \pi^+X$ on C, Al, Cu, Pb nuclei are analysed on the basis of experimental data, obtained by means of the 5-m magnet spark spectrometer of JINR. In the beam fragmentation region distributions over x_F and p_T^2 are given for inclusive π^+; their mean characteristics are obtained. Absence of noticeable A-dependence of the distributions is pointed at a slight influence of the target on production of fast neutral resonances.

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

Preprint of the Joint Institute for Nuclear Research. Dubna 1986