

AN ANOMALY IN INCLUSIVE PION  
DOUBLE CHARGE EXCHANGE  
ON  $^{16}\text{O}$  AT ABOUT 1 GeV\*

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The new results on the inclusive double charge exchange (DCX) reaction  $^{16}\text{O}(\pi^-, \pi^+)X$  at incident kinetic energy  $T_o = 0.75$  and  $1.15$  GeV are presented. The data were taken without using Cherenkov counters. The new DCX cross sections agree well with the old ones. Both the values are about an order of magnitude larger than the theoretical cross section calculated for the standard sequential mechanism. Two other approaches which seem to explain the discrepancy are also briefly reviewed.

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In our previous publications [1,2] we reported on the measured cross section of the inclusive pion DCX reaction on  $^{16}\text{O}$  at incident kinetic energy  $0.6$ ,  $0.75$  and  $1.12$  GeV in a kinematical region where no additional pions are produced. Here we present the new values of the same cross sections obtained in the independent measurement without using Cherenkov counters. In this case the main electromagnetic background was rejected kinematically.

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We measured the  $\pi^+$  energy spectra in the reaction  $^{16}\text{O}(\pi^-, \pi^+)X$  at  $\theta = 2 - 10^\circ$  and incident pion kinetic energy  $T_o = 0.75$  and  $1.15$  GeV in the kinematical region  $\Delta T = T_o - T \leq m_\pi = 140$  MeV ( $T$  is the kinetic energy of the positive charged particle) where the  $(\pi, 2\pi)$  reaction does not occur.

The events were taken, as in our main experiment [2], on the ITEP 3m magnet spectrometer (see, *e.g.*, [3]) with spark chambers. The  $\text{H}_2\text{O}$  and  $\text{D}_2\text{O}$  targets were placed in the middle of the magnet, so that the first and the second parts of the spectrometer served for measuring the incident and outgoing momenta respectively. To separate  $e^+ + \pi^+$ ,  $p$  and  $d$  events the TOF system was used. The sequential steps of the DCX signal extraction from the whole event sample for  $T_o = 1.15$  GeV are illustrated in the momentum distribution of Fig. 1. The main (positron) background due to the electron admixture in the beam (6% for  $T_o = 0.75$  and 3% for  $T_o = 1.15$  GeV) was rejected using the cut of vertical projection of the reaction angle,  $\Delta\lambda$ , at  $|\Delta\lambda| \geq 0.03$  rad (Fig. 2a). After all the selections, the events in fiducial momentum region were taken as DCX candidates and the subtraction of nongaussian tail of protons ( $(12 \pm 2)\%$  and  $(25 \pm 3)\%$  of all residual events at  $T_o = 0.75$  and  $1.15$  GeV respectively) was made.

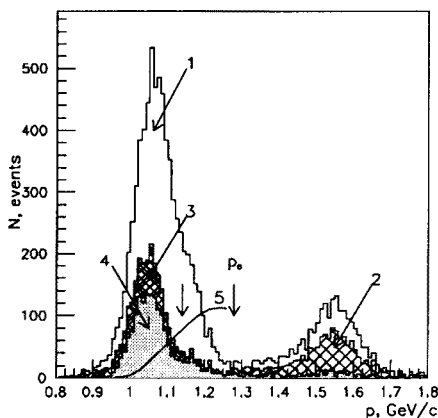


Fig. 1. The background rejection: 1 — events with  $|\Delta\lambda| \leq 0.03$  rad; 2 — TOF rejected protons; 3 — “fake” particles; 4 — residual events (mainly pions); 5 — acceptance (arbitrary units). DCX events are between the arrows.

The  $e^+$  background induced by the beam pion interactions in the target was estimated on the base of our previous experiment. We used the  $\Delta\lambda$  distributions for the events tagged with Cherenkov detector as positrons (YES) and as mainly pions (NO) (see Fig. 2 b,c). The appropriate analysis

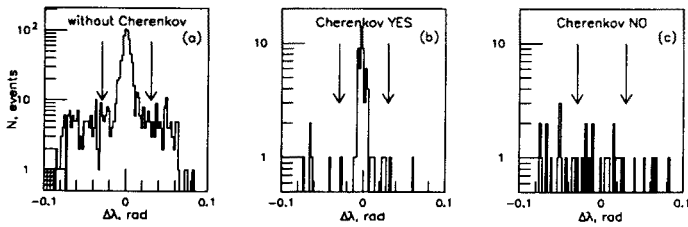


Fig. 2.  $\Delta\lambda$  distributions after TOF proton rejection for  $T_o = 1.1$  GeV. The rejected positrons are within the arrows.

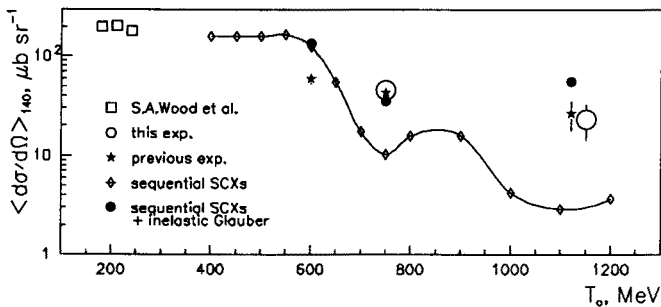


Fig. 3. Energy dependence of double differential cross section integrated over the  $\Delta T$  region from 0 to 140 MeV for  $^{16}\text{O}(\pi^-, \pi^+)X$ .

of these data gives for the  $e^+$  contamination ratio in the number of the remaining events the value of  $0.21 \pm 0.05$  and  $0.25 \pm 0.11$  at  $T_o = 0.75$  and 1.15 GeV respectively.

The obtained double differential cross sections of the reaction  $^{16}\text{O}(\pi^-, \pi^+)X$  integrated over the region  $0 \leq \Delta T \leq 140$  MeV are shown in Fig. 3 together with our earlier measurements and with the results of Wood *et al.* [4].

Our new points are in a good agreement with the previous ones. Thus, we confirm the slow decrease with incident energy above 0.6 GeV for the DCX cross section. The theoretically expected fast fall of the DCX cross section from 0.6 to 1.3 GeV/c [5] is due to the strong decrease of the single charge exchange (SCX)  $\pi N$  amplitudes. Indeed, as it was shown in [6], the conventional model with two sequential SCXs predicts a deep min-

imum at about 1.3 GeV/c for the DCX cross section to the isobar analog states. Our experimental values are up to one order of magnitude higher than the theoretical ones of [5]. So, some nonstandard mechanism is needed to overcome the discrepancy. There are two such approaches to DCX which seem to correspond to short-range  $NN$  correlations in the nucleus and consider, as appears, the process from different points of view. The former is based on the well known mechanism of meson exchange currents (MEC) while the latter is a phenomenological one and takes into account the inelastic Glauber rescattering (for a brief review see, *e.g.*, [2], Fig. 1). As it was shown, the both mechanisms could be important in the region of the anomaly. In fact, a simple MEC model with Weinberg chiral lagrangians shows for  $^{18}\text{O}(\pi^+, \pi^-)^{18}\text{Ne}$  reaction [7] a very weak energy dependence of a cross section at the level about three times larger than that predicted by the standard DCX mechanism with two sequential SCXs. It is clear that an analogous energy behavior should be expected for the inclusive DCX cross section too. As for the second mechanism, the contribution of inelastic intermediate states in the Gribov-Glauber formalism for nuclear rescatterings [8] appears to be overwhelming at  $T_o > 0.6$  GeV [9] (see black circles in Fig. 3).

Summarizing, the inclusive cross sections calculated for two different interpretations of DCX (MEC, as it could be expected, and the inelastic Glauber rescattering with two-pion intermediate states, as it is seen) are relevant to the experiment at  $T_o > 0.6$  GeV. It is most interesting to confirm the anomaly at other laboratories and to investigate inclusive DCX at higher energies.

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