INVESTIGATION OF PION SPECTRA IN NUCLEAR CHARGE EXCHANGE REACTIONS *A(t, ^{3}He)*

S.A.Avramenko[a], V.D.Aksinenko[a], M.Kh.Anikina[a], Yu.A.Belikov[a], K.Gajewski[b], A.G.Galperin[a], N.S.Glagoleva[a], A.I.Golokhvastov[a], S.A.Khorozov[a], E.K.Khusainov[c], V.P.Kondratiev[d], L.V.Krasnov[d], J.Lukstins[a], V.L.Lyuboshitz[a], P.K.Manyakov[a], V.T.Matyushin[a], J.Mirkowski[b], N.N.Nurgozhin[c], O.V.Okhrimenko[a], T.G.Ostanevich[a], Z.Pavlowski[b], A.Piatkowski[b], V.B.Radomanov[a], P.K.Rukoyatkin[a], I.S.Saitov[a], I.V.Stepanov[d], G.G.Taran[e], O.Yu.Tyatyushkina[a]

a. Joint Institute for Nuclear Reseach, Dubna, Russia
b. Radiotechnical Institute Warsaw, University, Warsaw Poland
c. Physical Technical Institute, MES, Almaty, Kazakstan
d. St.-Petersburg State University, St.-Petersburg, Russia
e. Lebedev Institute of Physics, RAS, Moscow, Russia

In our experiments [1] with use of the GIBS set-up [2] the charge exchange reactions *(t, ^{3}He)* on carbon and magnesium targets at the tritium mean momentum of 9 GeV/c were investigated. The experimental longitudinal momentum spectra of pions were compared with calculated ones for events, in which production of only one π^- was observed. Only 60-70 % of pions were shown may be produced by quasi-free Δ^- excitation in the target nucleus. The momentum of the remaining pions was significantly higher than for pions in delta-isobar production.

The important feature of this group of pions is the fact, that the sum of average values of their longitudinal momenta $(< P_l^{\pi} >)$ and average values of longitudinal momenta of ^{3}He $(< P_l^{He} >)$ is very close to an average momentum of primary tritium in a beam:

$$< P^t > - < P_l^{He} > - < P_l^{\pi} > \; < \; 180 \; MeV/c \qquad (Mg) \qquad (1)$$

$$< P^t > - < P_l^{He} > - < P l^{\pi} > \; < \; 150 \; MeV/c \qquad (C) \qquad (2)$$

$$< P_l^{\pi} > \; / \; (< P^t > - < P_l^{He} >) \; > \; 0.7 \qquad (Mg) \qquad (3)$$

$$< P_l^{\pi} > \; / \; (< P^t > - < P_l^{He} >) \; > \; 0.7 \qquad (C) \qquad (4)$$

E-mail: a) khorozov@lhe17.jinr.dubna.su (S.A.Khorozov),
b) juris@sunhe.jinr.ru (J.Lukstins)
c) nurgozh@satsun.sci.kz (N.N.Nurgozhin)

This is the strong indication on to the fact, that the reason of appearance of these pions must be searched in coherent processes.

In work [1] we have shown, that the appearance of these pions can be explained by the several reasons (fig.1): by an excitation of projectile nucleus; by coherent production of π^- with $\Delta(1232)$ and heavier isobar *(N(1440))* or *(N(1520))* in an intermediate state in a nucleus - target. However the statistics in this experiment was insufficient to define a probability of observation of each possible channel. Besides, an imperfection of an experimental installation did not allow to measure a momentum of tritium for each event. In ratios (1-4)

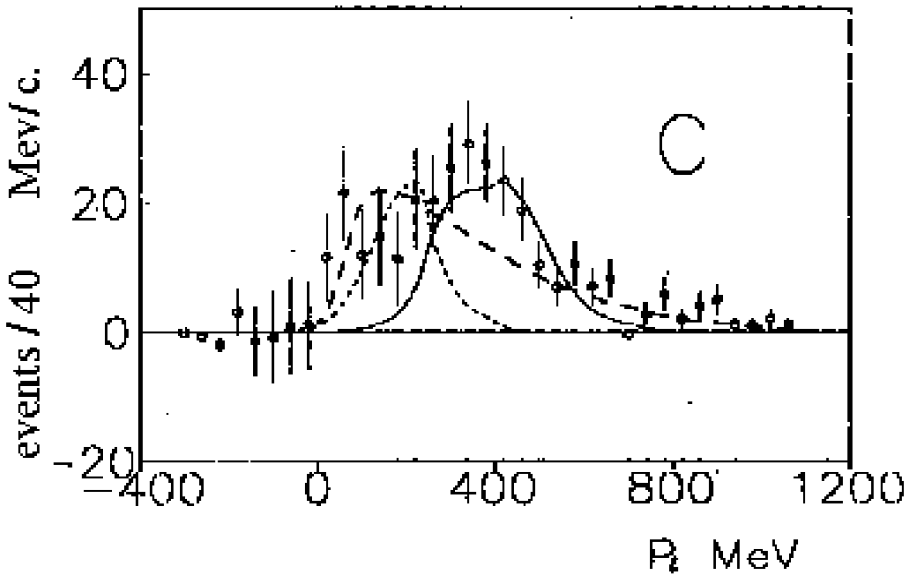


Fig.1. The momentum spectrum for pions produced not from delta -isobars decay. The calculations for different production hypotheses: coherent pions with Δ (dotted curve) or with heavy isobar (solid curve) excited in the target; projectile excitation (doshed curve) .

an average value of $< P^t >$ is only used. The difficulties of identification of the mechanism of formation of these pions in our previous researches are connected, in many respects, with that circumstance, that the momentum of tritium is known with accuracy of only about 5 %. It is connected with the fact, that the tritium beam is secondary one and is obtained by the fragmentation of nuclei ^4He [3,4], with large spread of momenta, therefore it is necessary to measure a momentum of each nucleus projectile by special system. For detailed kinematical analysis of each event it is necessary also to increase a precision of measurement of the momentum of ^3He. Thus, we have obtained an indication on a presence of several unusual charge exchange reaction channales, requiring the detailed analysis.

On the new LHE JINR accelerator Nucleotron [5] we are planning an experiment, a main purpose of which is a detailed study of the formation mechanism for pions produced not from quasi-free Δ(1232) decay in nuclear charge exchange reaction $A(t,^3He)$. For achievement this purpose an improvement of installation is necessary: to supplement time of flight (TOF) system [6] for precise measurement of a momentum of tritium; to change a system of photography by the device of filmless registration and to install proportional chambers for measurement of a momentum of the nucleus ^3He.

The scheme of planned improvement of the GIBS set-up of experiment is shown in fig. 2. The main detector is the streamer chamber SC, operating at intensity of a beam of 10^5 *nuclei/sec* in the magnetic field of the magnet M of 0,9 T. In the streamer chamber it is possible to place any target (T in the fig. 2), for example, carbon or magnesium, as it was in experiment [1]. At charge exchange $t \rightarrow {}^3He$ the charge of passing nucleus is changed from 1 to 2. This change is fixed by counters C_1 and C_2, which trigger the streamer chamber. The chamber (SC) allows to register all charged particles (pions, protons and others) and to measure their momenta with precision of about 0,5-1,0 %. The momentum of tritium will be measured by the TOF system (counters S_1 *and* S_2) with precision of *20 MeV/c* at momentum of tritium of *6 GeV/c* [6]. The momentum of ^3He is determined by two blocks of proportional chambers PC_1 and PC_2, with the precision of *~20÷30 MeV/c*. It is by 5÷6 times more precious than in previous [1] experiment. Precision of momentum measurements for all particles allows rather reliably to select processes of coherent production of pions and to investigate a character of intermediate states.

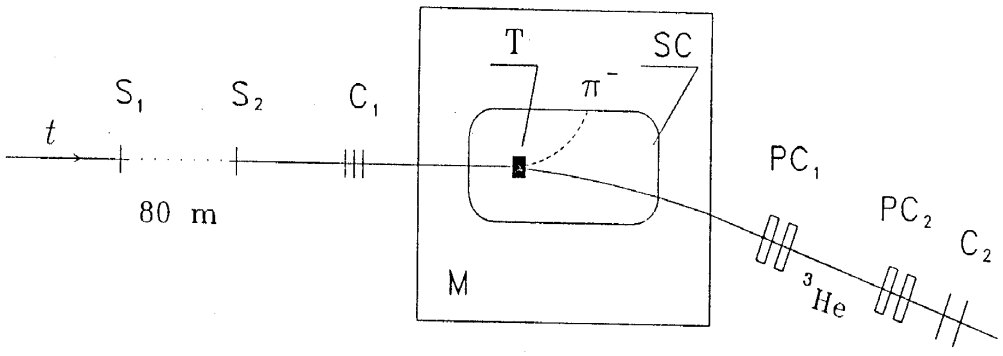


Fig.2. The sheme of experiment: SC is the streamer chamber; T the target inside the chamber; M the analyzing dipole magnet; S_1 and S_2 are TOF counters; C_1 and C_2 are trigger counters; PC_1 and PC_2 are are proportional chambers.

For essential increase of statistics it is intended to use a filmless system of registration of tracks in the streamer chamber. For registration the classical telechamber [7] with silicon CCD - matrix will be used. A sensitivity and the dynamic range of PZS - matrix is better, than ones of photographic film. It allows to decrease a pressure in streamer chamber, to reduce a probability of break downs and bright flashes and, hence, to increase efficience of operation (to reduce a fraction of spoilt photographs). The time of obtaining of physical results will decrease up to several months instead of 1÷3 years, necessary for measurements of photographs. The expected precision of momentum measurements for secondary particles is not worse, than in film variant of registration.

The other systems of the set-up were used in experiments and are in detail described in [2].

It is necessary to note, that the 4π - geometry of the SC detector for all charge secondary particles has appeared very favourable for registration of pions with a large longitudinal momentum. At installations in KEK [8] and Sacle [9] secondary particles with the emission angles of $< 20^0$ and more than $> 160^0$ are not registered. But just in these intervals of angles we observed fast pions from coherent production with heavy isobar in intermediate state.

Thus the planned experiment at the improved GIBS set-up gives reasons to hope obtain new experimental data, which will help essentially to clear up the mechanism of formation of pions and to study insufficiently investigated channels of charge exchange reactions and of isobar interactions with a nuclear matter.

Although the expected statistics (10^4 events) is less than obtained one in Sacle, our data can give an information, inaccessible for experiments, carried out in France. Our data will be unique ones and, at the same time, successfully supplement data obtained in Sacle in reaction $A(^3He, t)$.

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