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DOUBLE CHARGE EXCHANGE OF 50—176 MEV π^--MESONS IN PHOTOEMULSION

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(*)

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SUMMARY

The total double charge-exchange cross-sections for π^--mesons on photoemulsion nuclei have been measured for eight energy values in the region 50—176 Mev.

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The double charge-exchange process of π^--mesons on nuclei in photoemulsion was registered in the work ref. [1]. The total cross-section of this process in the 40-87 Mev interval, measured in this work, was found to be less than the bouble charge-exchange cross-section of π^+-mesons in the same energy range.

With a 140 Mev energy of primary mesons the double charge-exchange of π^- -mesons in photoemulsion was studied in the work ref. [2]; obtained there were also the total cross-sections of double charge-exchange on Be, C and Pb nuclei. It was noted in [2] that this process' cross-section increases with the atomic number of the nucleus, however remaining smaller than the cross-section of the double charge-exchange of π^+-mesons

Attempt was made in subsequent experiments to improve the precision of measurements and to broaden the area of investigations to 176 Mev energy of π^--mesons. With this in view pellicle stacks were irradiated in beams of π^--mesons with energy 80, 144 and 176 Mev on an OIYAI-synchrocyclotron. Research for events of double charge-exchange of π^--mesons was conducted in these stacks by the method described in [3]. Presented below are the results of examination and measurements obtained on these experiments. 493 events were registered during the survey.

B (*) DVOYNAYA PEREZARYADKA π^--MEZONOV S ENERGIYEY 50—176 Mev V FOTOEMUL'SII

No cases of double charge exchange of π mesons were found in the 0--50 Mev energy range. In the 50--176 Mev energy interval the total cross-section of double charge-exchange of π^--mesons on nuclei in photoemulsion were determined for eight energy intervals (Fig.1). It may be seen from Fig.1 that the total cross-section of the double charge-exchange increases with the energy of primary mesons. One may notice that its magnitude in the entire energy range investigated remains less than the double charge-exchange cross-section of π^+-mesons [4].

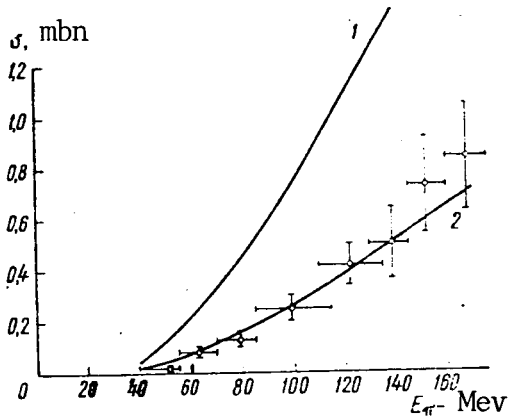

Fig.1. Double charge-exchange cross-section as a function of primary π^--meson energy; 1) calculation with $r_0 = 1 \cdot 10^{-13}$ cm; 2) calculation with $r_0 = 0.6 \cdot 10^{-13}$ cm

When computing this process by the Monte-Carlo method, the distinction in the Coulomb interaction of π^+- and π^--mesons and the difference in interaction cross-sections of π-mesons of different sign with nucleons were taken into account. The calculations were conducted in the assumption that the double charge-exchange in the nucleus takes place in two stages by the scheme

$$\pi^- + p \to \pi^0 + n$$
$$\hookrightarrow \pi^0 + p \to \pi^+ + n.$$

The results of calculations of total cross sections are plotted in Fig.1.

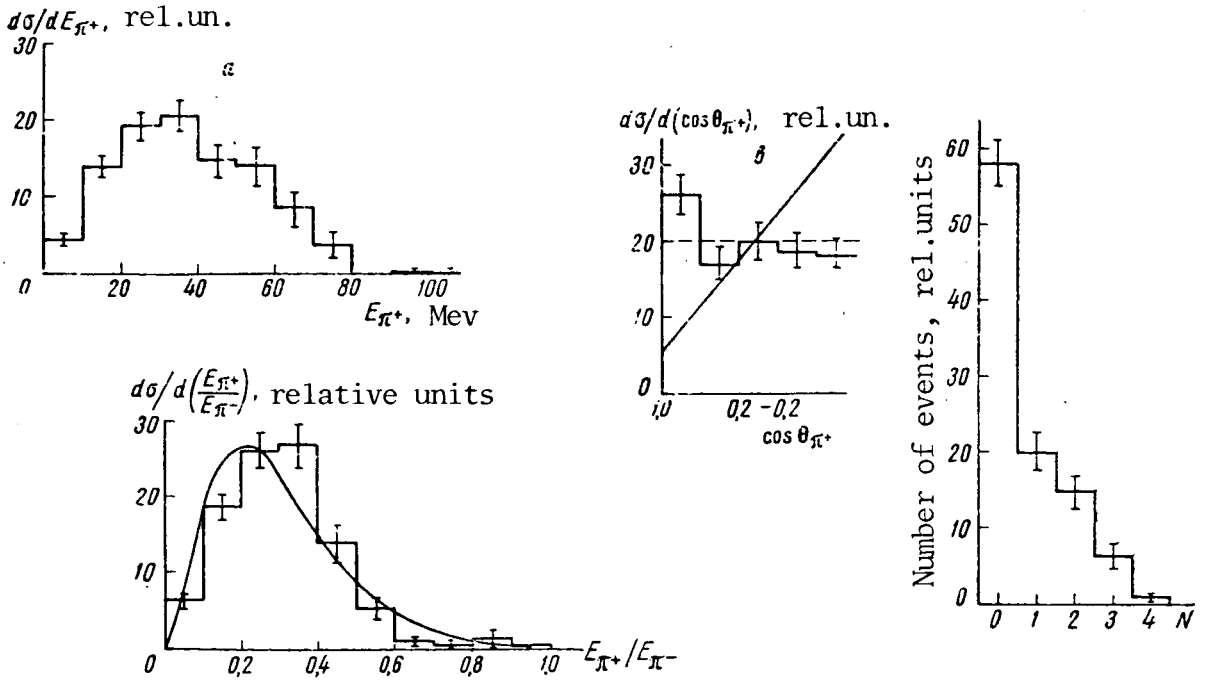

Fig.2. Energy (a, b) and angular (c) distributions of π^+-mesons at double charge-exchange of π^--mesons with average energy 128.5 Mev and distribution of stars by the number of rays (d)

The theoretical calculation explains satisfactorily the increase of the total cross-section with energy. The agreement of computed values of total cross-sections with experiment is reached at $r_0 = 0.6 \cdot 10^{-13}$ cm. The calculation also forecasts the difference in cross-sections of double charge-exchange of π^+- and π^--mesons.

The energy distribution of secondary π^+-mesons is shown in Fig.2,a. Included in the distribution are the cases related to the broad energy range of primary mesons. It is more appropriate to consider this distribution in the form when the energy of the secondary π^+-meson is expressed in fractions of primary energy. Such a distribution is shown In Fig. 2,b. The smooth curve shows the results of computations by the method of consecutive collisions. The correspondence of theoretical computations with the experimental results is characterized by the quantity $\chi^2 / \bar{\chi}^2 = 6$.

The angular distribution of secondary π^+-mesons (Fig.2, c) is close to the isotropic and is not in agreement with the results of calculations ($\chi^2 / \bar{\chi}^2 = 34$).

Presented in the same figure is the distribution of cases by the number of rays. Contrary to the double charge-exchange of π^+-mesons, at which two-pronged stars form most probably, 0 - prong events prevail in the distribution When characterizing the events by the number of prongs (rays?) only wakes of heavy charged particles with a path > 5 mk were taken into account). In order to ascertain the details of the double charge-exchange process more accurate measurements of angular and energy distributions of secondary mesons in various nuclei are required.

**** THE END ****

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REFERENCES

1. YU. A. BATUSOV, C. A. BUNYATOV, V. M. SIDOROV, V. A. YARBA. YAF, 1, 383, 1965.

2. SAME AUTHORS. Ib. 3, 309, 1966.

3. SAME AUTHORS. ZHETF, 46, 817, 1964.

4. SAME AUTHORS. XII Mezhdunarodnaya konferentsiya po fizike vysokikh energiy. (12th Intern.Conf. on High-Energy Physics). pp 64-6, DUBNA 1964.