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Abstract

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CROSS SECTIONS OF CERTAIN ABSORPTION REACTIONS OF FAST π^+ MESONS BY LIGHT NUCLEI

(Presented by Academician B. P. Konstantinov, 27 VI 1964)

Stars in a photoemulsion relating to the absorption of π^+ mesons by light nuclei C, N, O were investigated. Plates with a fine-grained emulsion of the PR type were irradiated at the synchrocyclotron of the Joint Institute for Nuclear Research with a beam of π^+ mesons of energy 80 ± 6 MeV. For analysis, stars were selected that contained one or two gray tracks (by ionization such tracks correspond to protons with energy greater than 20 MeV) and 2–4 tracks of heavy particles (presumably α particles). In a volume of 1.32 cm^3 of emulsion, 789 disintegrations of the indicated type were found, which were subjected to a kinematic check using the laws of conservation of energy and momentum. A search was made for the following possible reactions in the selected cases:

$$\pi + N^{14} \to 2p + 3\alpha. \tag{1}$$

$$\pi + N^{14} \to p + d + 2\alpha + He^3. \tag{2}$$

$$\pi + N^{14} \to \pi' + d + 3\alpha. \tag{3}$$

$$\pi + O^{16} \to 2p + 2\alpha + Li^6. \tag{4}$$

$$\pi + O^{16} \to p + He^3 + 3\alpha. \tag{5}$$

$$\pi + C^{12} \to p + He^3 + 2\alpha. \tag{6}$$

By the method of least squares, from 4 conservation equations the energies of the particles forming the gray tracks were determined.

Such particles could be, in reactions (1) and (4), $2p$; in (2), p and d; in (3), π and d; in (5) and (6), p. The energies of the remaining particles were determined

from their range in the nuclear emulsion. The calculations were carried out on the Ural-2 electronic computer.

For the selection of events, the selection criteria indicated in ([1]) were applied. The results of the analysis performed and the cross sections are given in Table 1.

Table 1

Reaction	(1)	(2)	(3)	(4)	(5)	(6)	Undetermined events: (1) or (4)	Undetermined events: (1) or (2)
Number of events found	169	6	0	15	8	6*	3	1
Cross sections, mb	$27.4^{+7.2}_{-6.3}$	$1.14^{+0.82}_{-0.63}$	—	$0.86^{+0.52}_{-0.35}$	0.46 ± 0.22	0.61 ± 0.34		

* Events of reaction (6) were searched for in an emulsion volume of 0.55 cm^3.

The reaction cross sections were determined from the known flux of the bombarding π mesons, taking into account the admixture of μ mesons in it ([1]), and the frequency of the disintegration events found. The contents of carbon, nitrogen, and oxygen in the emulsion were taken to be, respectively, 0.277, 0.087, and 0.283 g/cm^3.

The errors quoted in the cross-section values include the statistical error, the errors in the value of the scanned emulsion volume, and in the value of the π-meson flux. In 4 cases the selection criteria did not allow a final choice to be made between reactions (1) and (2) (1 case) and between reactions (1) and (4) (3 cases). These cases are included in the upper limits of the cross sections for the corresponding reactions.

In conclusion, we express our gratitude to V. F. Kosmach for assistance in carrying out the calculations.

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Note: Figure translations are in progress. See original paper for figures.