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INTERACTION OF NEGATIVE PIONS IN NUCLEAR EMULSION AT ENERGIES 7.5, 17, AND 60 GeV

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NIKFI-R, Ilford-G-5, and NIIKhIMFOTO-BR-2 nuclear emulsions were irradiated in the accelerators at Dubna, Geneva, and Serpukhov by π^- mesons of energy 7.5, 17, and 60 GeV. The characteristics of these emulsions, the scanning technique, etc. are described in [1 - 3]. Scanning along the track yielded 1266, 4234, and 1986 inelastic interactions of pions in the emulsions at the indicated respective energies. The most general characteristics of these interactions are shown in Figs. 1 and 2 and in the table.

Figure 1 shows the integral distributions with respect to the multiplicity n_s and the number of cascade-evaporation particles N_h; Fig. 2 shows the dependence of the mean values n_s and

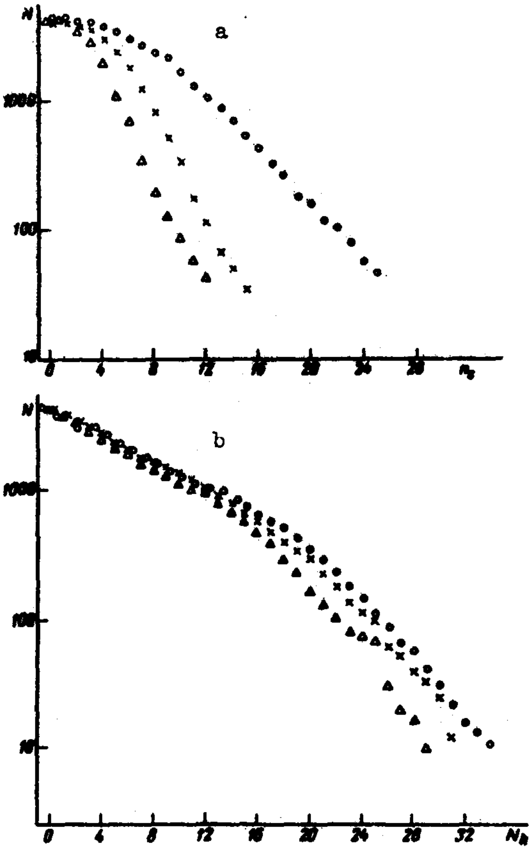

Fig. 1

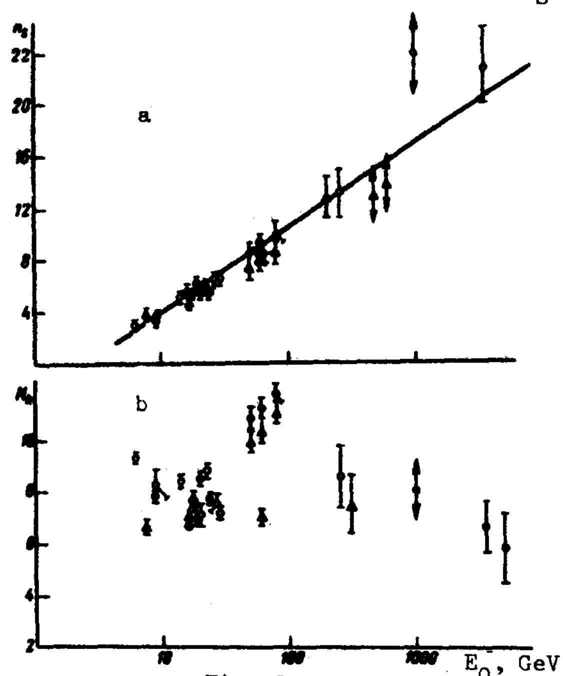

Fig. 2

Fig. 1. Integral distributions with respect to n_s and N_h. The points Δ, ×, and o correspond to pion-nuclear interactions at energies 7.5, 17, and 60 GeV.

Fig. 2. Dependence of n_s and N_h on E_0. Δ and ▲ - pion-nuclear interactions, o and ● - proton-nuclear interactions, Δ - data of present paper and of [4 - 10], o - data of [11 - 21], ▲ and ● - calculated data [22].

N_h on the energy of the primary particles E_0 in accordance with our data and the data of [4 - 10]. Figure 2 shows for comparison analogous plots for proton-nuclear interactions [11 - 21] and the results of calculations by the cascade model with allowance for many-particle interactions [22]. In the region of accelerator energies, we used only the data obtained by analysis of more than 350 nuclear interactions, found by scanning along the track.

The dependence of n_s on E_0 for pion-nuclear (π-n) and proton-nuclear (p-n) interactions (Fig. 2a) turned out to be practically the same ($n_s \sim \log E_0$), and the dependence of N_h on E_0 (Fig. 2b) turned out to be different and greatly differing from the results of the calculation [22]. For p-n interactions, there is a tendency towards decreasing N_h with increasing E_0, and for π-n interactions there is a tendency towards a very weak growth. It is important to note that the experimental points (Fig. 2b) for p-n interactions lie as a rule higher than for π-n interactions.

The dependences of N_h and n_s on E_0 for π-n and p-n interactions can be understood by assuming that the probability of a second collision is smaller for a pion than for a proton, and the multiplicity in pion-nucleon interactions is higher than in proton-nucleon interactions, as is confirmed to some degree by [3, 23, 24]. The probability of a second collision depends on the density of the nucleons in the nucleus and on the particle interaction cross section. Consequently, the difference in N_h between π-n and p-n interactions, for the same nuclei, is determined by the different cross sections $\sigma_{\pi N}$ and σ_{pN} of the pion-nucleon and proton-nucleon interactions.

The insignificant dependence of N_h on E_0 is due to the weak participation in the interaction inside the nucleus by the secondary particles produced in the first collision of the incident particle with the nucleon of the nucleus, where the increase of n_s with increasing E_0 is due to the development in the nucleus of a cascade of successive interactions of the leading ("conserved") primary particle.

The number of collisions ($n_{\pi n}$ or n_{pn}) can be estimated from the ratio $n_{pn}/n_{\pi n} = \sigma_{pN}/\sigma_{\pi N}$, assuming that the difference in the number of collisions of the primary pion and the proton in the nucleus is equal to $2\Delta N_h$. In the energy region 9 - 28 GeV, where $\Delta N_h = 1.1 \pm 0.02$, and where numerous accelerator data give $\sigma_{pN} = 1.6\sigma_{\pi N}$, we get $n_{\pi n} \simeq 3.7$. Knowing $n_{\pi n}$ and ΔN_h, we can find the ratio of the cross section $\sigma_{pN}/\sigma_{\pi N} \simeq (1 + 2\Delta N_h/n_{\pi n})$.

Dependence of mean values of n_s on N_h

N_h	7.5 GeV		17 GeV		60 GeV	
	n_s	N_h	n_s	N_h	n_s	N_h
0 – 1	3.30 ± 0.11	0.49 ± 0.04	3.75 ± 0.06	0.45 ± 0.03	6.18 ± 0.11	0.42 ± 0.03
2 – 7	3.47 ± 0.08	3.82 ± 0.06	4.97 ± 0.06	3.95 ± 0.05	7.61 ± 0.11	4.03 ± 0.03
≥ 8	4.08 ± 0.10	13.90 ± 0.20	6.20 ± 0.10	14.44 ± 0.10	11.77 ± 0.13	15.22 ± 0.15
≥ 0	3.64 ± 0.06	6.59 ± 0.07	5.24 ± 0.04	7.27 ± 0.04	9.23 ± 0.07	7.02 ± 0.05

If the excitation of the nucleus depends on the nature of the particle passing through it, then ΔN_h will be determined not only by the cross section of the interaction of the particles in the nucleus, but also by its excitation energy.

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MAKING A MEDIUM TRANSLUCENT TO RADIATION EXCITED BY A DIRECTED STREAM OF ATOMIC PARTICLES

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Excitation by atomic collision, unlike excitation by electron impact or photoexcitation, is frequently accompanied by transfer of considerable momentum