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THE BEHAVIOUR OF GENERONS IN INTRANUCLEAR MATTER

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1. INTRODUCTION

In studying experimentally the hadron-nucleus collisions by means of the 180 litre xenon bubble chamber [1—3], it has been concluded that the particle creation proceeds through some «intermediate or excited state» formed in some hadron-nucleon elementary collision inside the target nucleus; this «state» follows the incident hadron course [1].

Further our investigations of the particle production precess using nuclear targets [4—6] supported our conclusion; the objects were named GENERONS, and their properties were described [5]. The existence of the generons was supported by special experimental testing [6, 7].

The subject matter in this paper is experimental investigation of the behaviour of generons in their passage through layers of intranuclear matter.

2. METHOD OF INVESTIGATION

Generons should cover some distances in intranuclear matter before to use decay into observed produced particles — mainly pions — after having left the parent nucleus. As any of hadrons, the generons should lose their kinetic energy in passing through layers of intranuclear matter. This energy loss should be observable quantity: the degradation of the energies of the produced particles, or their momenta, may be observed in experiments.

The multiplicity of the emitted nucleons indicates the thickness of the intranuclear matter layer involved in the hadron-nucleus collision — the larger is the nucleon multiplicity the thicker is the intranuclear matter layer involved in the collision. And so, the dependences of momentum distribution of the produced pions on the multiplicity of the emitted nucleons in the collision events contains information about generon energy loss in passing through layers of intranuclear matter; such dependence may be prepared simply for the neutral pions registered in the xenon bubble chamber large enough, it may be the 180 litre xenon bubble chamber. The neutral pions are recorded in the chamber with recording efficiency high enough, near to 100%, and kinetic energy or momenta of the pions are measured with the accuracy high enough [8]. In a first approximation, the dependences may be on the proton multiplicity only.

3. EXPERIMENTAL PROCEDURE

Experimental procedure is described in the publication on experimental investigations of the characteristics of the neutral pion production in pion-xenon nucleus collisions at 3.5 GeV/c momentum [8]. The references concerning the 180 litre xenon bubble chamber and the methodical questions are cited in it as well.

4. EXPERIMENTAL DATA

Results obtained, in analysing of the chamber photographs, are shown in fig. 1, fig. 2 and fig. 3.

Shortly, we obtained that:

1. Kinetic energy of the neutral pions, produced in π^- + Xe nuclear collisions at 3.5 GeV/c momentum, decreases with increasing of the multiplicity n_p of the protons emitted in the collision reaction, fig. 1.

2. Longitudinal momentum of the produced neutral pions decreases evidently with increasing the multiplicity n_p of the emitted protons, fig. 2.

3. Transverse momentum of the produced neutral pions decreases as well with increasing of the multiplicity n_p of the protons emitted in the collision, fig. 3.

The above presented facts indicate that the energy loss of the produced pions depends on the thickness of the intranuclear matter involved in the collision; the thickness is presented by the proton multiplicity n_p.

But, what loses the energy in intranuclear matter — the generons or pions? the answer may be obtained experimentally only. In order to obtain it, the dependence of the neutral pion multiplicity n_{π^o} distribution $N(n_{\pi^o})$ on the multiplicity n_p of the emitted protons was prepared, fig. 4.

From fig. 4, it can be concluded that the multiplicity n_{π^o} distribution $N(n_{\pi^o})$ does not depend on the multiplicity n_p of the protons emitted in the collision. In other words, the multiplicity n_{π^o} does not depend on the intranuclear matter layer thickness involved in the collision. Such independence may take place only when the generons lose the energy in passing through intranuclear matter, the neutral pions make their appearance after decaying of the generon outside the parent nucleus.

The energy loss may be evaluated. The momentum of the projectile pion, when it collides with the xenon nucleus is about 3.2 GeV/c, the maximum

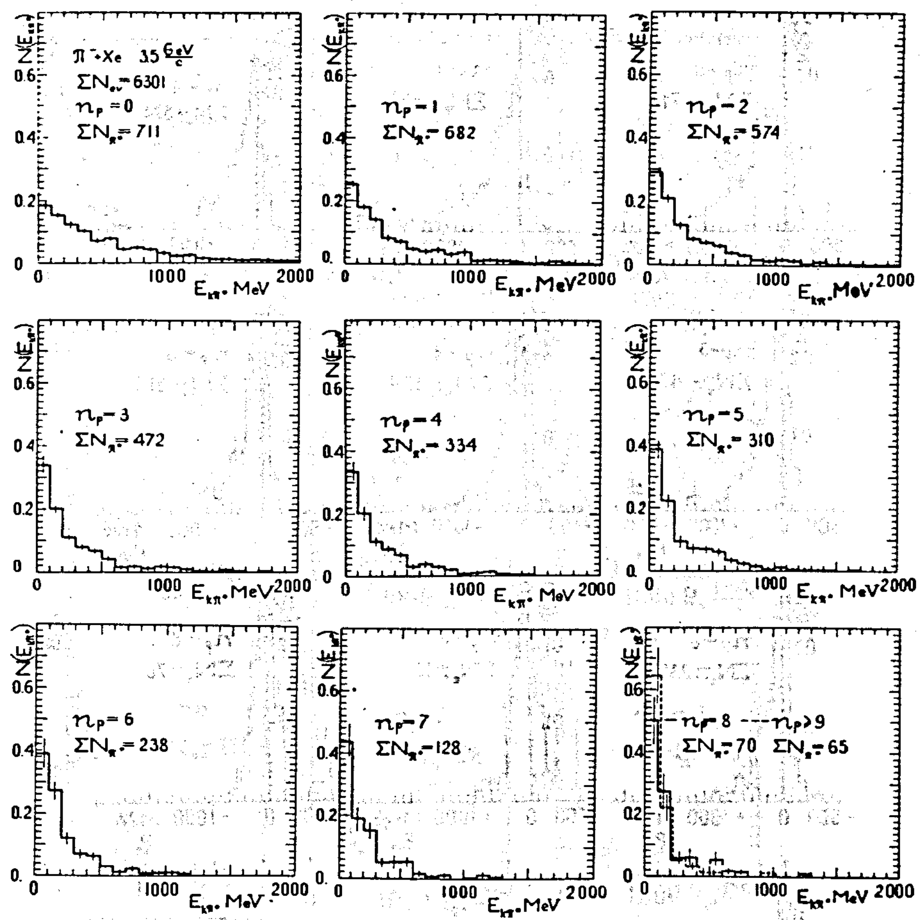

Fig. 1. Energy $E_{k\pi^0}$ spectrum of neutral pions produced in pion-xenon nuclear collisions at 3.5 GeV/c momentum, in events with n_p = 0, 1, 2, ..., ≥ 9 emitted protons; $\sum N_{\pi^0}$ — number of pions in a histogram

thickness of the intranuclear matter layer covered in the collision is about 18 nucleons/S, where S is about 10 fm^2. Then the energy ΔE loss of the generon is about $\Delta E \cong$ 0.18 GeV S/nucleon. In one of the works, it was estimated the energy loss of the incident hadron in intranuclear matter [9]; the obtained value was $\Delta E \cong$ 0.18 GeV S/nucleon.

It can be concluded, therefore, that the energy loss of the intermediate object is similar to the energy loss of usual hadron, in intranuclear matter.

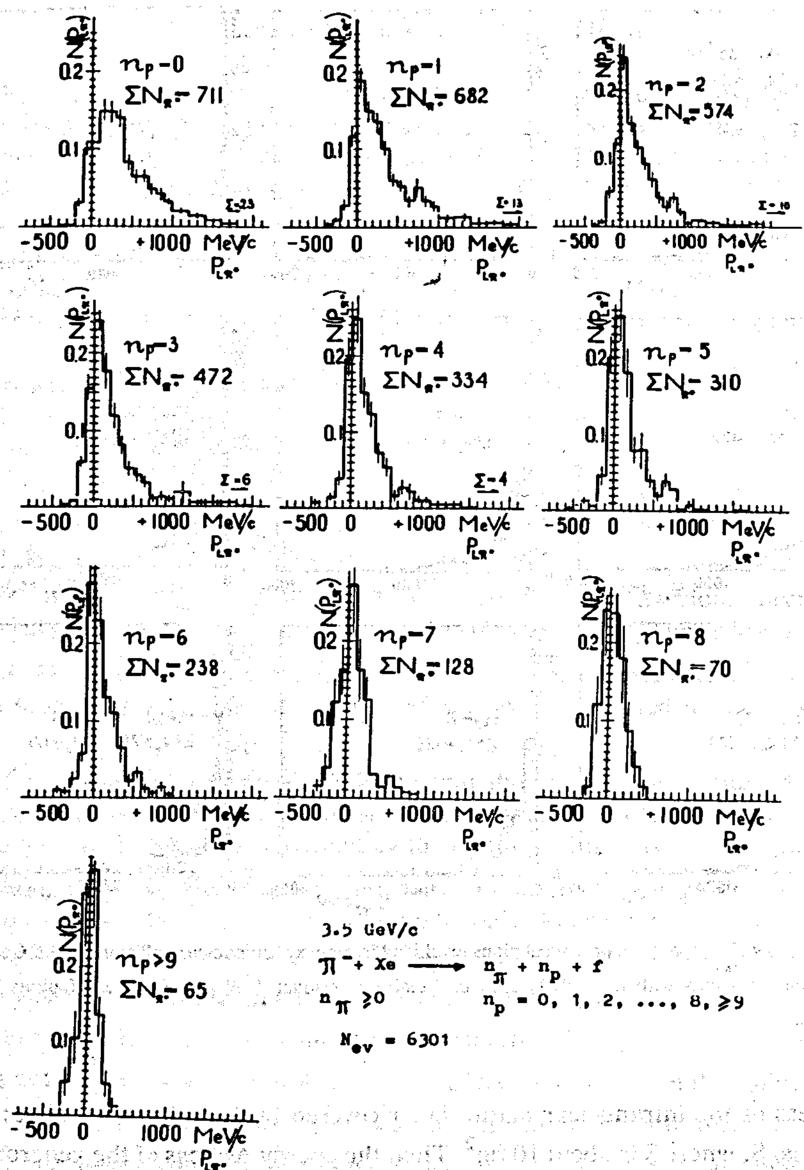

Fig. 2. Longitudinal momentum $P_{L\pi^0}$ distribution $N(P_{L\pi^0})$ for the neutral pions produced in pion-xenon nuclear collisions at 3.5 GeV/c, in the classes of events with various numbers n_p = 0, 1, 2, ...,≥9 of the emitted protons. $\sum N_{\pi^0}$ — number of pions in a histogram, N_{ev} — total number of collision

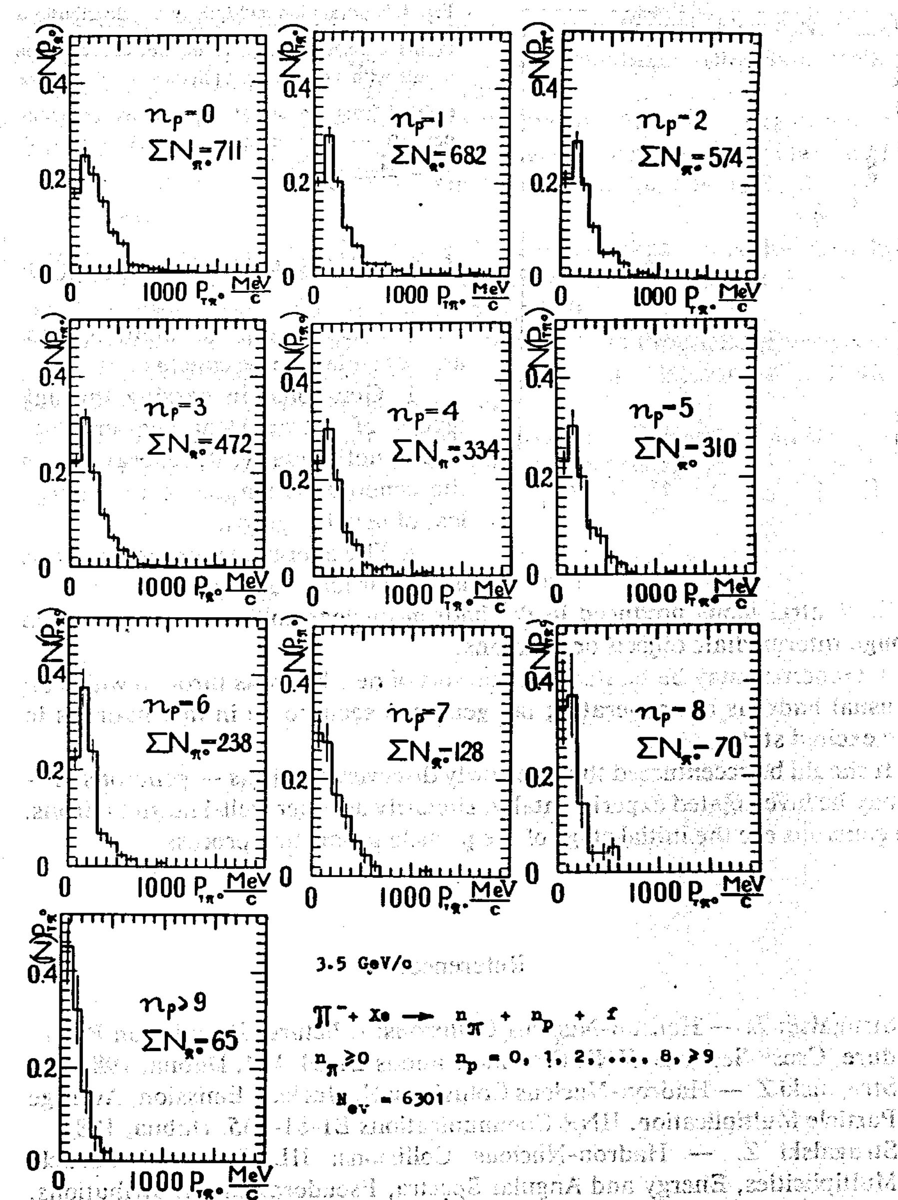

Fig. 3. Transverse momentum $P_{T\pi^0}$ spectrum $N(P_{T\pi^0})$ for neutral pions produced in pion-xenon nuclear reactions at 3.5 GeV/c, in classes of events with n_p = 0, 1, 2, ...,≥9 emitted protons. Symbols are as in previous figures

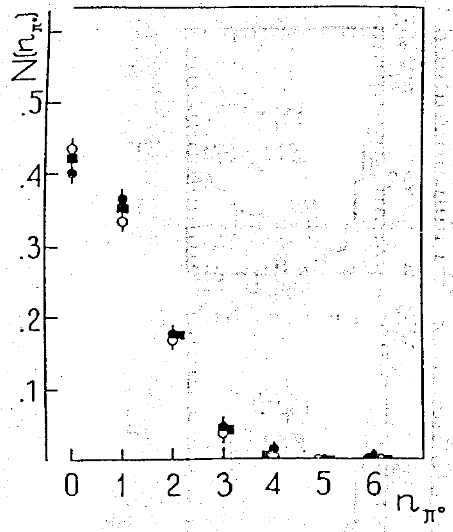

Fig. 4. Neutral pion multiplicity n_{π^0} distributions in the classes of pion-xenon nuclear collision events with various multiplicities n_p of protons emitted from the target nucleus. Experimental data: ⧫ — when $n_p \geq 0$, when ϕ — $n_p = 0$, ⧫ — when $n_p = 6$

5. RESULTS AND CONCLUSION

Let us sum up the main results, and formulate some conclusions.

1. Generons, in passing through layers of intranuclear matter, lose their kinetic energy; the energy loss of the generons is similar to the energy loss of usual hadrons.

2. The energy loss of the generons is measurable quantity.

3. Neutral pions produced in the hadron-nucleus collisions are produced through intermediate objects or generons.

4. Generons may be treated as some sort of new hadrons through which all the usual hadrons are generated; the generons seem to be in fact hadrons in some excited states.

It should be accentuated that the newly discovered objects — generons [1—6] may be investigated experimentally, similarly as other well-known hadrons. The generons are the initial stage of the particle production process.

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