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π^--C – SECONDARY PARTICLES BORN IN INTERACTIONS π DEPENDENCE OF THERMODINAMIC CHARACTERISTICS FROM THE n_C-CUMULATIVE VARIABLE DURING THE 40 GEV/c PRIMARY PULSE

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Abstract. *The study of multiparticle processes generated in hAt-hadron-nuclear and AiAt-nucleus-nucleus collisions at 40 GeV/c primari pulse. The emission radius for p-protons and $\pi^\pm$ mesons is estimated.*
The volume from which secondary particles are born is determined.
The local energy density resulting from the birth of secondary particles for a given cumulative variable is explained.
The volume, pressure and temperature of the birth of p - protons and $\pi^\pm$ mesons are related to the cumulative variable.

Keywords: *p – protons, $\pi^\pm$– mesons, V- volume, P - pressure and T – temperature, r - emission radius, $\varepsilon(n_c)$ - the local energy density, n_c – the cumulative variable.*

Introduction

The study of multiparticle processes generated in high-energy hAt-hadron-nuclear and AiAt-nucleus-nucleus collisions plays an important role in determining the mechanism of strong interactions and the quark-gluon-qg structure of nuclear matter.
According to the fundamental theory of QCD – strong interactions, the interactions between q-quarks and g-gluons weaken as the transferred momentum increases [1].
It is possible that there are phase transitions in the hAt- and AiAt-interactions, or these interactions allow us to study excited nuclear matter in an extreme state.

The analyse of thermodynamic characteristics In hadron-nucleus and nucleus-nucleus collisions

In hadron-nucleus and nucleus-nucleus collisions (as opposed to hadron-nucleon collisions), secondary particles can decay in multinucleon collisions; Or in another way - particles are born in collisions that are forbidden by hN - hadron-nucleon kinematics - they are born in the so-called cumulative particles. If hAt and AiAt interact, cumulative particles or the so-called Cumulative cases, then this should affect the dynamics of the process – the average kinematic characteristics of the secondary particles. In the paper, we will study the following reactions:

$$\pi^- C \to \pi^\pm \pm X \qquad (1)$$

$$\pi^- C \to p \pm X \qquad (2)$$

The momentum of the incident π^- ⁻– mesons is 40 GeV/c. Our statistics are 8671 cases. π^- – mesons is 29053, + – mesons — 39383. The experimental material is obtained from Dubna propane 1 meter bubble chamber (PBC – 500, JINR, Dubna) [3.4].

We will study the dependence of T-temperature from the n_c-cumulative variable, which is expressed as follows [5].

$$n_{c-}=(E-P_{||})/m_p \qquad (3)$$

where E is the total energy in the Lab - system and $P_{||}$ - transverse momentum in the same system. m_p - mass of proton. In high-energy experiments n_c is a relativistic invariant [6].

n_c - the cumulative variable at high energies is related to the transmitted impulse t by the following formula [6]

$$t = 2E_a m_p (\frac{E_i - \beta_a P_i^{||}}{mp}) \approx S_{hN} n_c \qquad (4)$$

where $S_{hN}=2E_a m_p$ is the square of the total energy hN - in collisions, which is constant in each experiment, and n_c is the main variable. For particles that are born in hN - collisions in the kinematically restrained area, the value of n_c is greater than 1, i.e. $n_c>1$. This is one of the reasons why we use hAt and AiAt - this variable to study collisions. i. e. n_c. The effective temperature T for secondary p-protons and $\pi^{\pm}$ - mesons is given in reactions (1) and (2) is practically constant T≈100 mev and then increases sharply ($n_c \approx 1.5$). T increases and in the next interval ($0.15 \le n_c \le 0.8$).There is a similar distribution for ($0.15 < n_c < 0.8$), when the temperature increases to 200 mev, may correspond to the thermalization of the colliding particles (here the strongly interacting matter passes into the thermally excited hadronic phase): the second area ($0.15<n_c<0.8$), which indicates different mechanisms of particle generation in these regions. For example, the first area ($n_c \le 0.15$). then increases significantly. The function $T=f(n_c)$ strongly depends on n_c. (first a jump up to $n_c=0.15$), then a plateau at T=200mev and then an increase (when $n_c \approx 0.8$) the temperature is constant at ($0.15< n_c < 0.8$) corresponds to the equilibrium state (hadron + quark, gluon)

The third region ($n_c>0.8$ for π - mesons and $n_c>1.5$ for protons) may be related to the formation of a pure qg-quark-gluon state –QGP.

T - temperatures are determined by the Hagedorn image

$$dN/dP_\perp = AP_\perp (E_\perp T)^{1/2} \exp(-E_T/T) \qquad 4(1)$$

where - $E_\perp = \sqrt{P_\Diamond + m_i^2}$ -is transverse energy 4(2)

Dependence of volume and energy density on n_c variable can be written as follows [7]

$$\varepsilon(n_c) = \frac{\sqrt{S_{hN} . n_c}}{V(n_c)} \qquad (5)$$

where $\sqrt{S_{hB} n_c}$ is the energy generated as a result of the birth of secondary particles for a given n_c - month and corresponding volume $V(n_c)$.

In the work [7], the emission radius of secondary particles r is estimated

$$r = \frac{r_1}{m\sqrt{n_c}} = \lambda_c^p = \frac{0.21 fm}{\sqrt{n_c}} \qquad (6)$$

The emission radius r is inversely proportional to the n_c variable. The quantity 0.21fm is the Compton wave length of the proton. 0.21fm, if n_c≈cpΛIf n_c=1 (i.e. secondary particles are born with n_c value 1) r=<1, then r>p and n_cΛ>1 (for cumulative particles), then r<cpΛ . . Knowing the r-radius of particle emission (6), we can determine V(nc) - the volume from which particles are born.

$$\varepsilon(n_c) = \frac{\sqrt{S_{nN}}\, n_c^2}{\frac{4\pi}{3}(0.21)^3} \frac{GeV}{fm^3} \qquad (7)$$

V - with a sharp decrease in the size of the volume by means of images 7 and 5, depending on the local energy density nc

$$\varepsilon(n_c) = \frac{\sqrt{S_{hN}}\, n_c^2}{\frac{4\pi}{3}(0.21)^3} \frac{GeV}{fm^3} \qquad (8)$$

increases substantially, while the volume decreases.εIt can be seen from this that with the increase of n_c, the energy density It can be seen from Figure (8) that the local energy density is defined by means of n_c^2, or in other words, defined by quantities that are experimentally measured (without model representations). This is the main advantage of Figure 8.

Consider the relationship $P(n_c)$, how the pressure depends on the variable n_c. We will use Clapeyron's equation for an ideal gas here, which relates P - pressure, V - volume and T - temperature. we can write

$$P(n_c)V(n_c) = K_B T(n_c) \qquad (9)$$

We will get it from here

$$P(n_c) = \frac{K_B T(n_c) n_c^{3/2}}{\frac{4\pi}{3}(0.21)^3} \frac{GeV}{fm^3} \qquad (10)$$

Here $P(n_c)$ is the pressure as a function of the cumulative variable n_c. - mesonab.±πAs nc increases, the pressure $P(n_c)$ increases, both for the proton-nucleus and The pressure increases faster for pions than for protons. This means that their birth mechanism is different.

Conclusions:

1. The emission radius for p-protons and $\pi^{\pm}$ mesons is estimated.
2. The volume from which secondary particles are born is determined.

3. The local energy density resulting from the birth of secondary particles for a given cumulative variable is explained.
4. The volume, pressure and temperature of the birth of p - protons and $\pi^{\pm}$ mesons are related to the cumulative variable

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