We discuss some properties of the central $\pi^-$-meson carbon reactions at 40 GeV/c. While these results were obtained many years ago they have not been explained completely. We attempt to interpret following: results regime change on the behavior of some characteristics of the events as a function of the centrality; anomaly peak on the angular distributions of the slow protons emitted in these reactions; charge asymmetry on the $\pi^-$-mesons production in the back hemisphere in lcs.

Understanding of the results could help to explain the new ones coming from the modern central experiments at high and ultrarelativistic energies.

**Keywords:** central; pi-meson; carbon.

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1. **Introduction**

When we pass from hadron-light nuclei interactions to nuclear-nuclear interaction at relativistic and ultrarelativistic energies we get the new possibility: to create the high density and high temperature hadronic matter and get the information on properties of matter under extreme conditions. In such new conditions the volume of information increases sharply as well as the background information. The latter can grow faster than useful signal information due to the reason that the number of secondary multiparticle interactions become more and more (it is very essential in case of central collisions). Simultaneously we can lose some information and may miss some changes that could be important to understand the dynamics of the interaction. So it is important to know what kind of information was lost or changed and how we can restore it. Best way to do it would be to turn to hadron-nuclear interactions and to try to use the connections between the properties of the hadron-nuclear interactions and the ones of the relativistic and ultrarelativistic...
heavy ion collisions. In this case the new ideas coming from the latter can help us to understand hadron-nuclear interactions too.

The goals of the paper are: to show some properties of the central $\pi + A$-reactions and the connections of ones with the properties of the relativistic and ultrarelativistic nucleus-nucleus collisions; to explain qualitatively the results on: regime change on the behavior of some characteristics of the events as a function of the centrality; anomaly peak on the angular distributions of the slow protons emitted in these reactions; charge asymmetry on the $\pi^-$-mesons production in the back hemisphere in lcs, using new ideas coming from the relativistic and ultrarelativistic nucleus-nucleus physics.

2. Regime change in central experiments

The central experiments demonstrate the point of regime change and saturation in the behavior of some characteristics of the events. This phenomenon could be connected with fundamental properties of the strongly interacting matter.

Here we would like to discuss some results connected with the properties of the central $\pi^{-12C}$-interactions at 40 GeV/c. The data has been obtained with the 2-m propane bubble chamber of LHE, JINR [1]. To fix the centrality of collisions the number of identified protons ($N_p$) were used. Fig. ?? shows a number of the $\pi^{-12C}$-interactions ($N_{star}$) as a function of the $N_p$. One can see the regime change in the behavior of the values of the $N_{star}$ as a function of the $N_p$ near the value of the $N_p = 4$. This could be used to select the $\pi^{-12C}$-reactions with total disintegration of nuclei (or central collisions).

In paper [3] the results from BNL experiment E910 on pion production and stopping in proton-Be, Cu, and Au collisions as a function of centrality at a beam momentum of 18 GeV/c are presented (see Fig. ??). The centrality of the collisions is characterized using the measured number of "grey" tracks, $N_{grey}$, and a derived quantity $\nu$, the number of inelastic nucleon-nucleon scatterings suffered by the projectile during the collision. In Fig. ?? is plotted the values of average multiplicity for $\pi^-$ - mesons ($<\pi^- - Multiplicity>$) as a function of $N_{grey}$ and $\nu$ for the three different targets. We observe that $<\pi^- - Multiplicity>$ increases approximately proportionally to centrality and for all three targets at small values of $N_{grey}$ and $\nu$ then they saturate with increasing centrality in the region of more high values of $N_{grey}$ and $\nu$. Solid line in figure shows the expectations for the $<\pi^- - Multiplicity>(\nu)$ based on the wounded-nucleon (WN) model [3] and with dashed lines, does a much better job of describing $p - Be$ yields than the WN model.

The results of the Ref. [5] have shown the regime changes on the behavior of the event numbers for the $dC$, $HeC$ and $CC$-interaction at 4.2 A GeV/c [5] as a function of the centrality.

It is very important that the regime change has been indicated even on the behavior of heavy flavor particles production in ultrarelativistic heavy ion collisions.
as a function of centrality. A mechanism to explain the phenomena could be the percolation cluster formation which is discussed to explain the results coming from the ultrarelativistic heavy ion collisions. Percolation clusters may be formed in these interactions independent of the colliding energy but the structure, maximum density and temperature of hadronic matter may depend on colliding energy and masses in the cluster framework.

3. The angular distributions of the protons emitted in central collisions

In Fig. ??, the angular distribution of protons with momentum less than $1.0 \text{GeV}/c$ is shown for $\pi^{-12}C$-reactions at $40 \text{GeV}/c$ with total disintegration of carbon nuclei (central collisions). We can see some peak at angles close to $60^\circ$. This result was confirmed by the results obtained at investigation of the angular distributions of ones emitted in $\pi^{-12}C$-interaction (at $5\text{GeV}/c$).

In the paper was presented the angular distribution for slow protons emitted in the central $H e + E m -$ (at $2.1 \text{ A GeV}$), $O + E m -$ (2.1 A GeV) and $A r + E m -$ (1.8 A GeV) collisions. Some wide structure was observed in these distributions.

So one can say that the angular distributions of slow particles emitted in central $\pi$-meson and light nuclei interactions with nuclear targets indicate a structure - peak at some angle. We think that the peak could be result of the formation and decay of the percolation cluster.

4. Charge asymmetry on the $\pi$-meson production in the back hemisphere in lcs.

In Ref. charge asymmetry in $\pi^{-12}C$-reaction at $40 \text{GeV}/c$ was observed in $\pi^{-12}C$-reactions at $40 \text{GeV}/c$: number of positively charged $\pi$-mesons were greater than negatively charged ones for back hemisphere in lcs and it becomes more with momentum of the particles. It was obtained that these particles produced mainly in central events (or events with total disintegration of nuclei). Recently some papers appeared with very interesting idea connected with charge asymmetry. In the Ref. authors tried to show that in the presence of a magnetic field QCD predicts topological charge changing transitions can separate quarks according to their electric charge along the direction of the magnetic field. This is the so-called Chiral Magnetic Effect. They argued that it might be possible to observe the Chiral Magnetic Effect in heavy ion collisions. May be it is fantastic idea to support that the observation of charge asymmetry for $\pi$-mesons production in back hemisphere in lcs in $\pi^{-12}C$-reactions at $40 \text{GeV}/c$ connected with the difference of charges of $u$ and $d$ quarks. But if we turn to percolation cluster idea we can say it may be due to the percolation cluster strongly charged system and its motion could lead to appearance of a magnetic field which could be a reason of charge asymmetry for the $\pi$-mesons production in the back hemisphere in lcs.
Captures of figures

Fig.1 A number of the $\pi^{-12}$C-interactions as a function of the $N_p$-centrality.

Fig.2 The average multiplicity of the $\pi^-$-mesons.

Fig.3 The angular distributions of protons emitted in $\pi^{-12}$C-interaction (at 40 GeV/c) with total disintegration of nuclei.

Fig.4 Momentum distributions of the $\pi^\pm$-mesons produced in $\pi^{-12}$C-interaction at 40 GeV/c.

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