SOME PROPERTIES OF THE CENTRAL π^--MESON CARBON INTERTIONS AT 40 GeV/C

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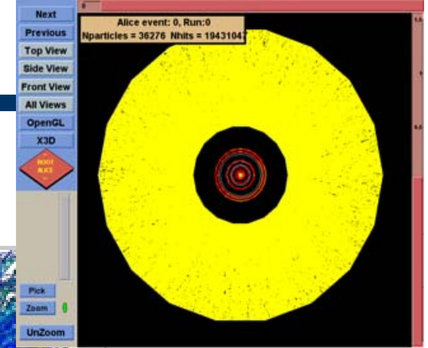
We discuss some properties of the central π^--meson carbon reactions at 40 GeV/c. While these results were obtained many years ago they have not be explained completely. The following results will be considered:

-regime change on the behaviour 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;

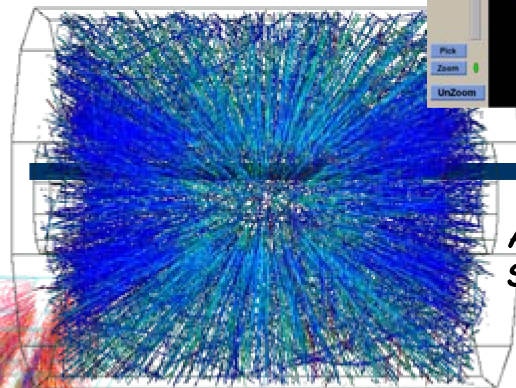
- charge asymmetry on the π^--mesons production in the back hemisphere in lcs.

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

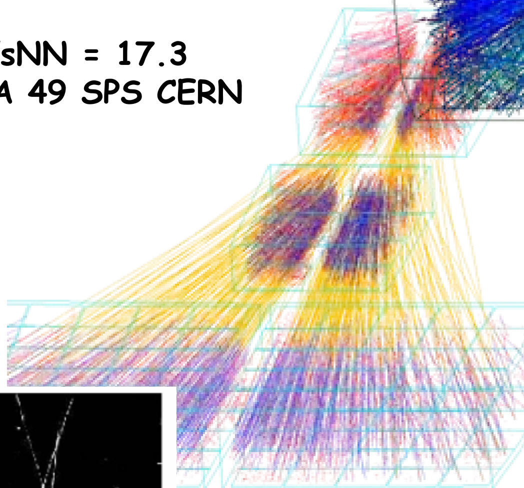


PbPb $\sqrt{s_{NN}}$= 5.5 TeV Alice LHC

CERN



Au+Au $\sqrt{s_{NN}}$ = 200 GeV
STAR RHIC BNL



Pb+Pb $\sqrt{sNN}$ = 17.3 GeV NA 49 SPS CERN

π,p + p,A

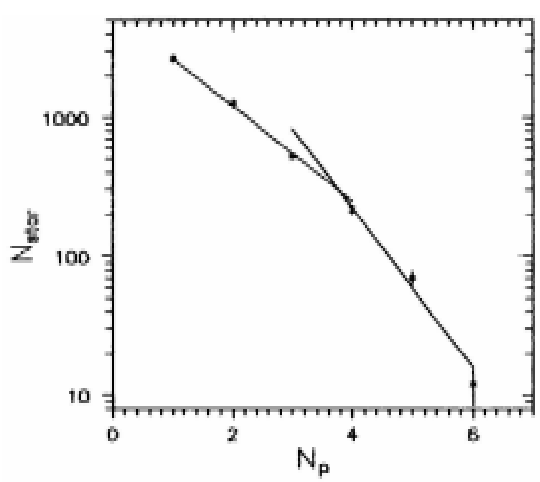
One can lose and change some information that could be important to understand the dynamic of the interaction. It is important to known what kind of information was lost or changed and how we can restore it. Best way to do it would be turn to hadron-nuclear interactions and to try to use the connections between the properties of the hadron-nuclear interactions and the ones of the relativistic and ultrarelativistic heavy ion collisions. The new ideas coming from the last can help us to understand the hadron-nuclear interaction results.

The goal of the talk is :

-to show some properties of the central π-A-reactions and the connections of ones with the properties of the relativistic and ultrarelativistic nucleus-nucleus collisions;

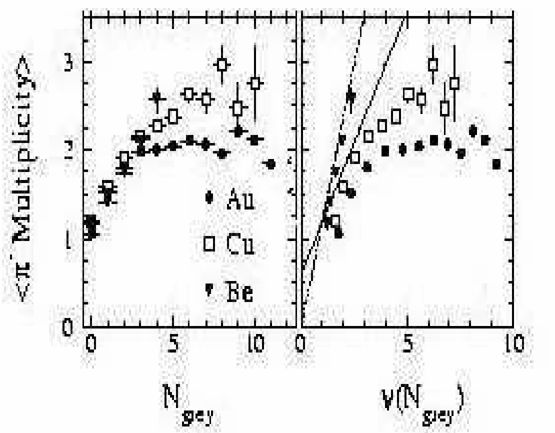
-to explain qualitatively the above mentioned results using new ideas coming from the relativistic and ultrarelativistic nucleus-nucleus physics.

1. Regime change in central experiments

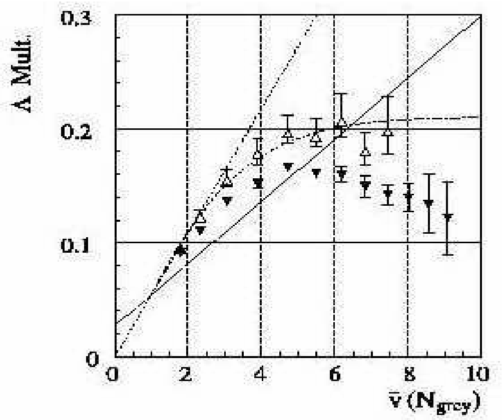


A number of the $\pi^{-12}C$-interactions (N_{star}) as a function of the N_p. *[18. O.B. Abdinov et al. JINR RC, 1996, No 1[75]-96 p.51.]*

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. The last was used to select the $\pi^{-12}C$-reactions with total disintegration of nuclei (or central collisions).



- The regime changes were indicated in pA –reactions to. 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 ***[I. Chemakin et al. The BNL E910 Collaboration, 1999, E-print: nucl-ex/9902009]*** are presented in the picture. The centrality of the collisions is characterized using the measured number of «grey» tracks, N_{grey}, and a derived quantity ν, the number of inelastic nucleon-nucleon scatterings suffered by the projectile during the collision. The wounded-nucleon (WN) model

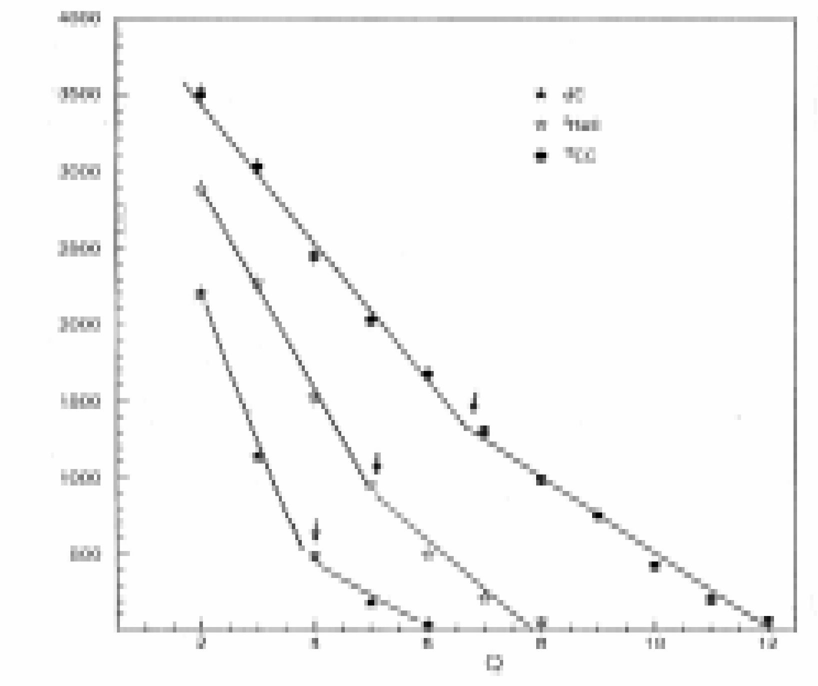


BNL E910 has measured Λ production as a function of collision centrality for 17.5 GeV/c p–*Au* collisions [*Ron Soltz for the E910 Collaboration, J. Phys. G: Nucl. Part. Phys., 2001, 27, pp. 319-326*]. *Collision centrality is defined by v*. *The* Λ yield versus *v* is plotted in the Fig. The open symbols are the integrated gamma function yields, and the errors shown represent 90% confidence limits including systematic effects from the extrapolations. The full symbols are the fiducial yields. The various curves represent different functional scaling.

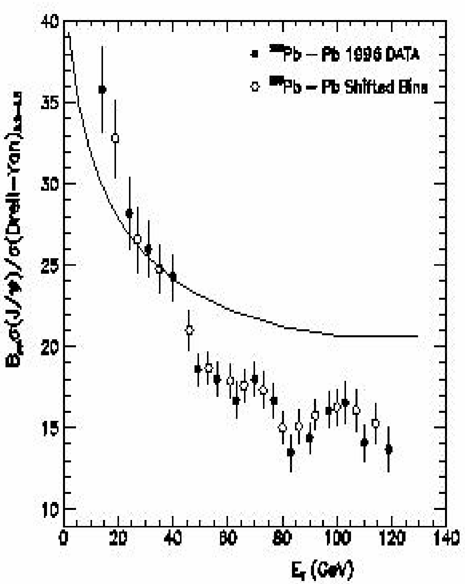
The same result have been obtained by BNL E910 Collaboration for K^0_s and K^+ -mesons emitted in p+Au reaction.

From Fig. one can see the the behaviour of the event number as a function of centrality for light nuclei interactions: results for dC, HeC and CC-interaction at 4.2 A GeV/c ***[Preprint JINR 1-12114,1979; 1-12424, 1989, P1-98-292,; M. K.Suleimanov et al., Phys.Rev.C, 1998, 58, pp. 351.]*** **there are the regime changes again for these interactions. These point of regime change could be used to select the central collisions to.**

N



Np



It is very important that the regime change has been indicated even on the behaviour of heavy flavour particles production in ultrarelativistic heavy ion collisions as a function of centrality. The ratio of the J/ψ to Drell-Yan cross-sections has been measured by NA38 and NA50 SPS CERN as a function of the centrality of the reaction estimated, for each event, from the measured neutral transverse energy E_t *[M.C. Abreu et al., Phys.Let. B 1999, 450, p. 456; M.C. Abreu et al., Phys.Let. B, 1997, 410, p. 337; M.C. Abreu et al. Phys.Let. B, 1997, 410, p. 327; M. C. Abreu et al. By NA50 Collaboration, Phys.Lett.B, 2001, 499, pp. 85-96].* Whereas peripheral events exhibit the normal behaviour already measured for lighter projectiles or targets, the J/ψ shows a significant anomalous drop of about 20% in the Et range between 40 and 50 GeV. The detailed pattern of the anomaly can be seen in Fig. which shows the ratio of the J/ψ to the Drell-Yan cross-sections divided by the exponentially decreasing function accounting for normal nuclear absorption.

Other significant effect which is seen from this figure is a regime change in the Et range between 40 and 50 GeV both for light and heavy ion collisions.

- So we can say that the regime change has been observed: at some values of centrality as a critical phenomena; for hadron-nuclear, nuclear-nuclear interactions and ultrarelativistic ion collisions; in the ranges of wide energies almost for all particles. The existing simple models cannot explain the effect. For this it is necessary to suggest that the dynamics is the same for all such interactions, independent of energy and mass of the colliding nuclei and their types.

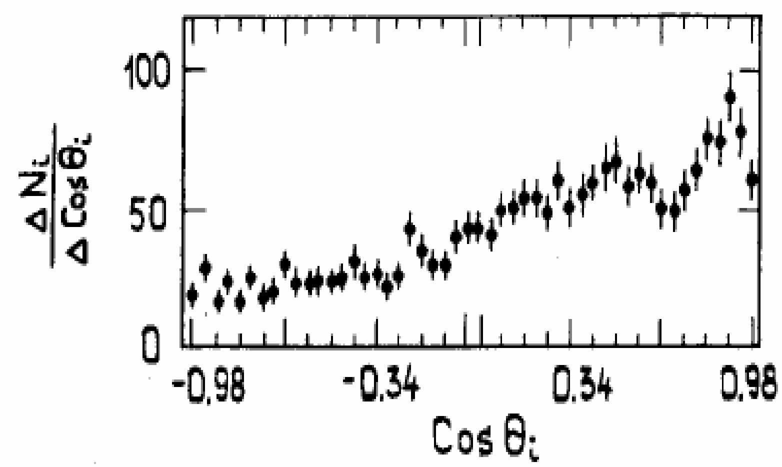
  The mechanism to explain the phenomena could be the percolation cluster formation which is discussed to explain the result coming from the ultrarelativistic heavy ion **collisions** ***[H. Satz, hep-ph/0212046; Janusz Brzychczyk,nucl- th/0407008; C. Pajares, hepph/*****0501125.]**

  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.

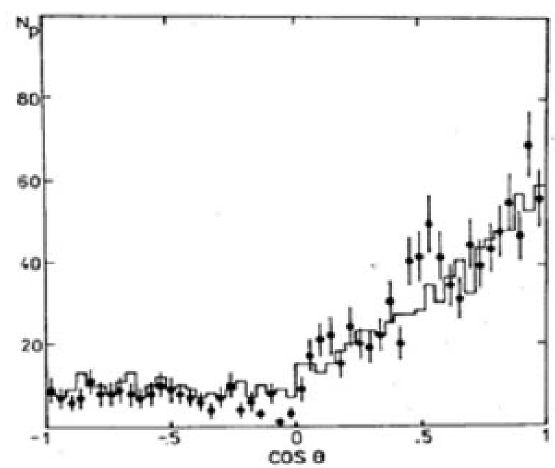
The angular distributions of the slow protons emitted in central collisions.

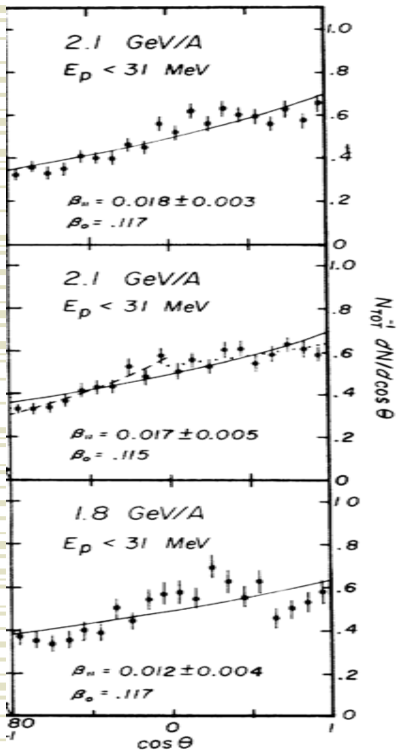
The angular distribution of slow protons is shown for $\pi^{-12}C$-reactions at 40 GeV/c with total disintegration of carbon nuclei (central collisions) [*A.I.Anoshin* et al.Yad.Fiz.33: 164(1981)]. We can see some structure, peak at angles close to 60^0. The existence of the peak on the angular distribution of slow protons was confirmed by the data which were obtained at investigation of the angular distributions of ones emitted in $\pi^{-12}C$-interaction (at 5 GeV/c) with total disintegration of nuclei [*O.B.Abdinov* et al. Preprint JINR, 1-80-859, Dubna (1980)] (next Fig.). There were several ideas to explain the result but it could not been understood completely.

40 GeV/c



5 GeV/c





In the paper *[H.H. Hecman et al. Phys.Rev. C17, N5(1978)]* was presented the angular distribution for slow protons emitted in the central He+Em-(at 2.1 A GeV), O+Em - (2.1 A GeV) and Ar+Em - (1.8 A GeV) collisions. Some wide structure was observed in these distributions.

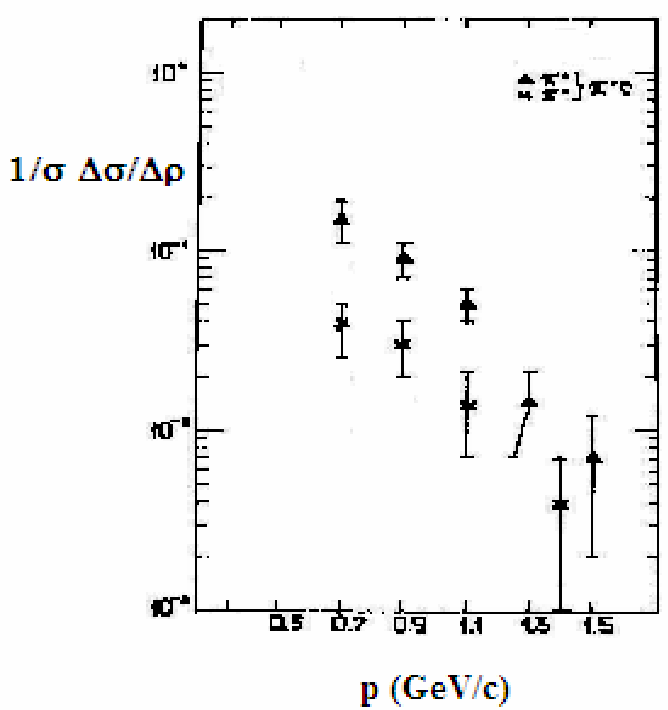
The Ref. *[N.P. Andreeva et al. Yad.Fiz.45:123-131,1987]* also reported that they had been observed some wide structure in the angular distributions of the b-particles emitted in the Ne+Em reactions at 4.1 A GeV. They commented that the structure become cleaner in central collisions.

The main result of these experiments is that the angular distributions of slow particles emitted in π-meson and light nuclei interactions with nuclear targets indicate a structure – peak at some angle. The other result is the one that with increasing the mass of colliding nuclei the peak become wider. We could not find any information on the peak for the slow protons angular distributions in heavy nuclear interactions. It could be explained easily as follows: during the interaction of the heavier projectile with nuclear target, the number of secondary interactions as well as number of nucleon-nucleon elastic scattering and re-scattering events increases. These effects could lead to the disappearance of the information of any intermediate formations as well as the clusters.

The pick on the angular distribution could be result of the decay of the percolation cluster.

Charge asymmetry on the π-meson production in the back hemisphere in lcs

In Ref. *[N. Angelov et al. Preprint JINR-P1-11951, Dubna 1978]* charge asymmetry was observed for $\pi^{-12}C$-reactions at 40 GeV/c: number of positively charged π-mesons (with momentum more than ~ 0.6 GeV/c) were great than negatively charged ones for back hemisphere in lcs and it become more with momentum of the particles. It was shown that the particles produced mainly in central events (or events with total disintegration of nuclei).



At that time we could not find any explanation for this phenomenon though we tried to use quark-gluon picture of the interaction. We could not get a notice on our interpretation since at that time nobody believed that the electrical charge of the quarks could be used to explain any phenomenon at multiparticle production at high energies.

But recently some papers appeared with very interesting idea connected with charge asymmetry. Ref.*[Harmen J. Warringa. E-print: hep-ph/0805.1384; QM2008]* discussed that Quantum Chromodynamics predicts that topological charge changing transitions will take place in hot quark matter. Such transitions induce P and CP-violating effects. Authors tried to show that in the presence of a magnetic field these 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.

This may be a fantastic idea to support that the above mentioned charge asymmetry for π-meson in back hemisphere connected with the difference of u and d quark charges.

But if we will turn to percolation cluster idea we can say may be due to the percolation cluster strongly charged system and its moving could led to appearance of a magnetic field which could be a reson of charge asymmetry for the π--mesons production in the back hemisphere in lcs.

Summary

The regime change on the behavior of the event numbers as a function of the centrality; anomaly peak on the angular distributions of the protons emitted in these reactions; charge asymmetry on the π--mesons production in the back hemisphere in lcs could be explained quantitatively as a consequence of formation and decay of the percolation cluster in hadron-nuclear and nuclear-nuclear interaction at relativistic and ultrarelativistic energies.

* at some values of centrality the percolation cluster starts to form as some critical phenomenon and we see the regime change in the behavior of the values of event number as a function of the centrality.

* the pick on the angular distribution could be result of decay of the percolation cluster.

* the percolation cluster strongly charged system and its moving could led to appearance of a magnetic field which could lead to charge asymmetry on the π--mesons production in the back hemisphere in lcs.