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INTERACTIONS OF 180 GEV/NUCLEON ^{207}Pb NUCLEI IN EMULSION CHAMBERS WITH COPPER AND LEAD TARGETS.

Kraków[1]-Louisiana[2]-Minnesota[3] Collaboration.

M.L.Cherry[2], A.Dąbrowska[1], P.S.Freier[3], R.Hołyński[1], W.V.Jones[2], A.Jurak[1], J.Kapusta[3], A.Olszewski[1], K.Sengupta[2], M.Szarska[1], A.Trzupek[1], C.J.Waddington[3], J.P.Wefel[2], B.Wilczyńska[1], H.Wilczyński[1], W.Wolter[1], B.Wosiek[1], K.Woźniak[1].

1. Institute of Nuclear Physics, Kawiory 26A, 30-055 Kraków, Poland.
2. Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA, 70808, USA.
3. School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455, USA.

Spokesman: W. Wolter

Summary.

Nuclear emulsions will be used as targets and trackers to investigate the interactions of ^{207}Pb nuclei in emulsion, copper and lead targets; specifically (i) the pseudorapidity distributions of charged particles including analysis of particle fluctuations in pseudorapidity and azimuthal angle distributions, (ii) the transverse momentum distribution of alpha fragments from the projectile nucleus.

Several emulsion chambers with different geometry and targets will be exposed to the ^{207}Pb beam. Each chamber will be irradiated with the beam of low density ^{207}Pb ions (several hundred per cm^2). Interactions with small impact parameter, characterized by high multiplicity and disruption of the projectile nucleus will be found with high efficiency. Measurements in the emulsion will include the number and emission angles of charged particles produced and the emission angles of alpha fragments from the projectile nucleus.

Prior and On-Going KLM Collaboration Research.

Since 1985, when the KLM Collaboration was formed, we have completed several irradiations of nuclear emulsions using relativistic ions as projectiles, namely: ^{16}O with energies 60 and 200 GeV/nucleon and ^{32}S with energy 200 GeV/nucleon (experiment EMU-07 at CERN). Also, at the same time the KLM Collaboration has been involved in the analysis of ^{16}O and ^{28}Si interactions at 14.6 GeV/nucleon (BNL experiment E808).

In all the analysed nucleus-nucleus interactions, irrespective of mass and energy of the projectile as well as the degree of centrality of collision, we have found [1,2] that the general properties of nucleus-nucleus collisions e.g. multiplicity distribution, its dispersion and pseudorapidity distribution are consistent with superposition models i.e. with the general assumption that a nucleus-nucleus collision can be viewed as a series of incoherent nucleon-nucleon collisions. On the other hand this point of view can be called in question by some observations. Among them we would like to emphasize the effect of non-statistical fluctuations of particle production.

Nuclear emulsion with its high spatial resolution ($\Delta\eta \leq 0.1$, $\Delta\phi \leq 5^\circ$, where η and ϕ denote pseudorapidity and azimuthal angle), essentially 100% efficiency for particle detection in a 4π angle is especially suitable for studying the fine structure of the angular distributions.

The KLM Collaboration has investigated the particle density fluctuations in η and ϕ by means of the factorial moment analysis [3]. Evidence for intermittency, i.e. power-like increase of the factorial moments with decreasing size of the phase space bin $\delta\eta$, $\delta\phi$ was found in one and two-dimensional η-ϕ phase space [4]. The phenomenon of intermittency was also observed in hadronic and leptonic collisions [5], but it seems that the mechanism responsible for intermittency in heavy ion reactions is not the same as for other, more elementary processes. Whether the intermittency effect in nuclear collisions is related to the production of Quark-Gluon-Plasma (QGP) [6] or other collective phenomena or alternatively can be explained by self-similar cascade mechanism is still an open question [7]. Hence further investigations in wide range of masses of colliding nuclei are needed. The high energy Pb beam at CERN as well as heavy ion beams up to gold at BNL (approved KLM experiment at BNL: E868) will offer such a possibility.

Research Goals.

Several years of extensive search for QGP have passed and still there is no convincing evidence of its anticipated creation in hot, dense nuclear matter, which presumably is formed in high energy nucleus-nucleus collision. Still after years the search for QGP represents one of the most fundamental problems not only of contemporary particle and nuclear physics, but also astrophysics and cosmology. From the many expected signatures for QGP formation we would like to emphasize one of them which we believe can be adequately searched for by means of the proposed experiment. Generally speaking, these are the nonstatistical fluctuations in particle production.

Our previous results for ^{16}O and ^{32}S collisions on Ag/Br nuclei at 200 GeV/nucleon and also $p\bar{p}$ data [8] showed that the intermittency exponents decrease with increasing particle density in pseudorapidity. However, at a given density the intermittency in heavy ion reactions is stronger than in hadron-hadron collisions. This can be interpreted as evidence for collective phenomena which occur in nucleus-nucleus collision. It is interesting to check whether this tendency holds for much higher densities which are expected in central lead-lead collisions.

Another research goal is related to the fragmentation processes of relativistic nuclei and concerns the transverse momentum distribution of alpha particles. It follows from our earlier analysis performed at lower energies and smaller projectile masses that this distribution seems to be inconsistent with predictions of statistical model of fragmentation [9]. We propose to perform similar analysis using lead projectiles, having in mind that the bigger the interacting nuclei and the higher their energies, the greater are the experimental possibilities for investigating the exotic processes that might occur in nuclear matter under extreme conditions of high energy and/or large nuclear densities. It is worthwhile to stress that nuclear emulsion permits very accurate small angle measurements and therefore is a prefarable tool for investigating the processes of projectile fragmentation.

Method and apparatus.

We plan to expose nuclear emulsion chambers of various geometry to the beam of 180 GeV/nucleon ^{207}Pb ions. Emulsion, copper and lead will be used as targets. Each chamber is a multi-layered sandwich of thin (not exceeding 50μm) emulsion films coated on both side of a plastic base, foil target and several air gaps (spacers) to enable the measurements on tracks emitted at relatively small angles. The cross-sectional area of the plates is 10x10 cm^2. The irradiation should be perpendicular to the upstream face of the chamber in at least four spots depending on the beam size. The incident ion density should be several hundred per cm^2.

Interactions in a given target will be found by area scanning of the plate placed just after the target. In some chambers low sensitivity plates will be put downstream of the target. We believe that comparison of the normal upstream and low sensitivity downstream plates should be a good trigger for selecting events with small impact parameter i.e. events characterized by lack of heavy fragments.

We would like to expose about 20 emulsion chambers with accumulated beam density about 400 ^{207}Pb ions per cm^2. This will give us about 200 central nucleus-nucleus collisions in each target used.

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