COLLECTIVE EFFECTS IN KAON PRODUCTION BY RELATIVISTIC NUCLEI COLLISIONS*

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A parton model analysis was made of the kaon production data at 3.65 GeV/nucleon for collision of deutrons and carbon ions with carbon and lead target. The enhancement of kaon production could be accounted for the collective correlations in the target nuclei.

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New experimental data on pion and kaon production by incident deutron and carbon collisions with nuclear targets measured on Dubna synchrophasotron at 3.65 GeV/nucleon using the KASPIY installation of INR, Moscow, were published recently [1].

The target mass dependence was resonably described by taking into account the absorption of pions and kaons in nuclear matter during their transportation after production. However for nucleus-nucleus collisions the enhanced kaon production was observed and could be expressed as the projectile mass dependence $\sigma \sim A_{\mathrm{proj}}^{\beta}$ with $\beta > 1$. For projectile mass dependence of pion production the value of $\beta = 0.69 \pm 0.2$ was found.

Several attempts were made to explain kaon production enhancement in the relativistic quantum molecular dynamic model [2], by reinteraction in the transport model [3], in thermodynamic models [4, 5]. The strangeness production enhancement is expected if quark-gluon plasma is formed during nucleus-nucleus collisions [6]. However recent results at higher energies reveal the kaon production enhancemend about of the same value at 14.5 GeV/nucleon [7] and at 200 GeV/nucleon [8].

The common character of the enhemcement phenomena for kaon production at different energies could qive a hint to some general production mechanism of pion and kaon due to the similar nuclear structure function.

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The scaling of pion and positive and negative kaon production was revealed in the frame of simple parton model.

In this model we assume that pions and kaons are produced in a similar manner by parton–parton interactions during the nucleus–nucleus collisions. Like in the deep inelastic lepton–nucleon scattering the probabiliby of the parton–parton interaction depends on the Bjorken scaling parameter, which represents the momentum of the parton in the units of nucleon momentum. However in order to get the equivalent expression of scaling parameter one has to introduce mass corrections and the possibility for particle production. This procedure was first developed by Stavinsky [9]. The determination of scaling parameters in the incident nucleus z and the target nucleus x can be easy obtained from the 4-momentum conservation equation:

$$(zP_1 + xP_2 - P)^2 = \left(z\frac{M_1}{A_1} + x\frac{M_2}{A_2} + m_i\right)^2 , \tag{1}$$

where P_1, P_2 and P — the 4-momenta of nucleons in the incident and target nuclei and of a pion or kaon, M_1 and M_2 — masses of incident and target nuclei, $m_i = 0$ for pion production, $m_i = m_\Lambda - m_N$ the mass difference of Λ-particle and nucleon for K^+ production, $m_i = m_K$ for K^- production.

As it will be seen the parton-parton interaction probability is an exponentially decreasing function of the scaling parameters. Therefore the equation (1) is used for the determination of the smallest possible scaling parameters, corresponding to the production process with the smallest energy in the centre of mass, *i.e.* the minimum values of scaling parameters are determined appropriate to the threshold for a particle production with given kinematical parameters.

However the equation (1) gives only the relative dependence of two scaling parton parameters in the incident and target nuclei. Some additional assumption on the values of scaling parameters should be made to solve the equation. For the experiments of particle production in target fragmentation region the scaling of many experimental data on x parameter was obtained with $z = 1$ [10].

We detrmine the scaling parameters from the experimental data taking into account the assumption that all production data available should represent the universal scaling dependence of parton-parton interaction. Since the experimental data on pion and kaon production are above the threshold for nucleon–nucleon reactions, at least one of the scaling parameters should be less than unity. It was found numerically that for the production processes considered according to the equation (1) we have very week dependence of parameter x on P. Therefore x could be fixed, and the scaling on parameter z could be studied. The value of x should be chosen to give the best scaling of all experimental data.

In Fig. 1a. and Fig. 1b. the experimental cross sections for pion and kaon production in C+Pb, d+Pb and C+C, d+C collisions at 3.65 GeV/nucleon [1] are plotted against z scaling parameter. By neglecting small corrections due to different absorption of pions and kaons we assume that target A-dependence calculated from the experimental data is determined by the geometrical and second order effects on the nucleon level. Therefore it should be applied also to not enhanced part of incident nucleus A-dependence. To take into account these effects the experimental production cross sections should be divided by $(A_1A_2)^{0.7}$.

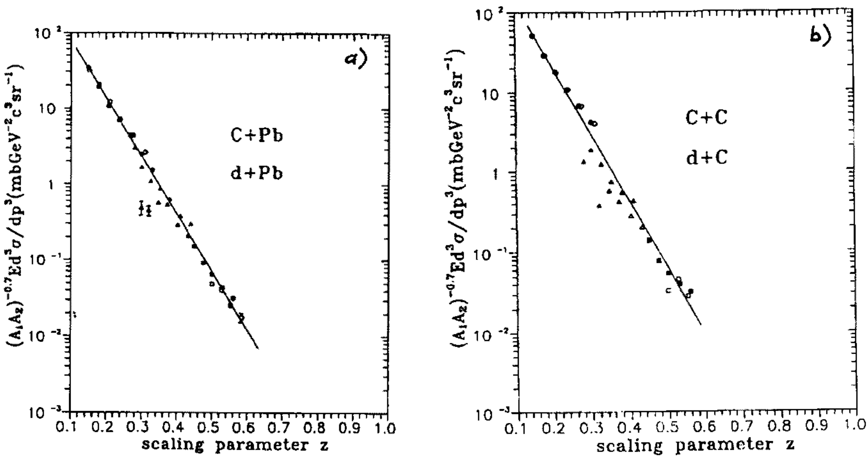

Fig. 1. Nuclear structure functions deduced from deutron and carbon ion collisions with a) lead and b) carbon target; • , o - positive and negative pion production, △ - K^+ production, □ - K^- production.

To obtain the best universal scaling curve for C+Pb production data $x = 2$ was chosen, for d+Pb, $x = 1.5$. Then all data points exept of two points at very low kaon momenta belong to a universal scaling curve. The plot for C+C and d+C with the same x-parameters is also reasonable, but the trend is to some reduction of fixed x-parameters. These results could be interpreted as the indication for the collective effects in pion and kaon production in nucleus–nucleus collisions at the parton level. It gives also the explanation of the enhanced K^+ and K^- production for carbon ions in comparision with deutron ions on carbon and lead target nuclei.

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