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# PRELIMINARY RESULTS OF THE ANALYSIS OF THE CERN ISR DATA ON $p\alpha$- AND $\alpha\alpha$-INTERACTIONS WITHIN THE FRAME OF EIKONAL MODEL

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In the previous paper [1] a calculating procedure of different nucleus-nucleus inelastic reaction cross sections has been proposed. Using this procedure the cross sections for $^{4}He$-$^{4}He$ interactions were obtained [2] and one of the authors of this paper has tried to interpret CERN ISR data on $\alpha\alpha$-collisions. In the present paper we shall continue these efforts at a new level. It is characterized by:

a) exploitation of the Levchenko-Nikolaev model [3];

b) consideration of only non-diffractive processes.

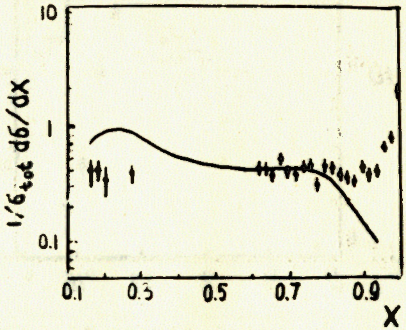
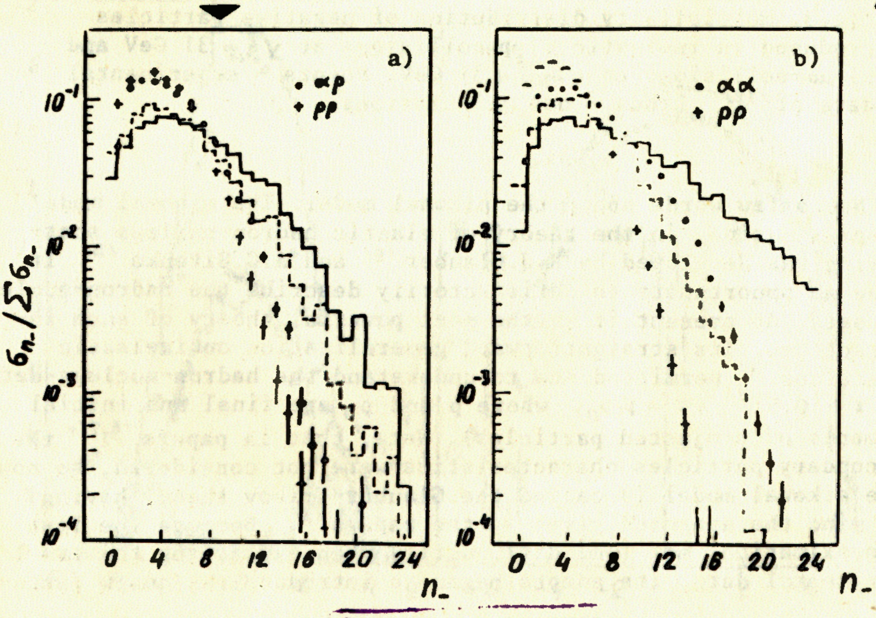



Fig.1. Proton spectra in pp -interactions. Points - experimental data. Solid line - our calculation result.

Fig.2. Multiplicity distributions of negative particles in $p\alpha$ (fig.a) and $\alpha\alpha$ (fig.b) compared with pp. Points - experimental data [11]. Lines - our calculations.



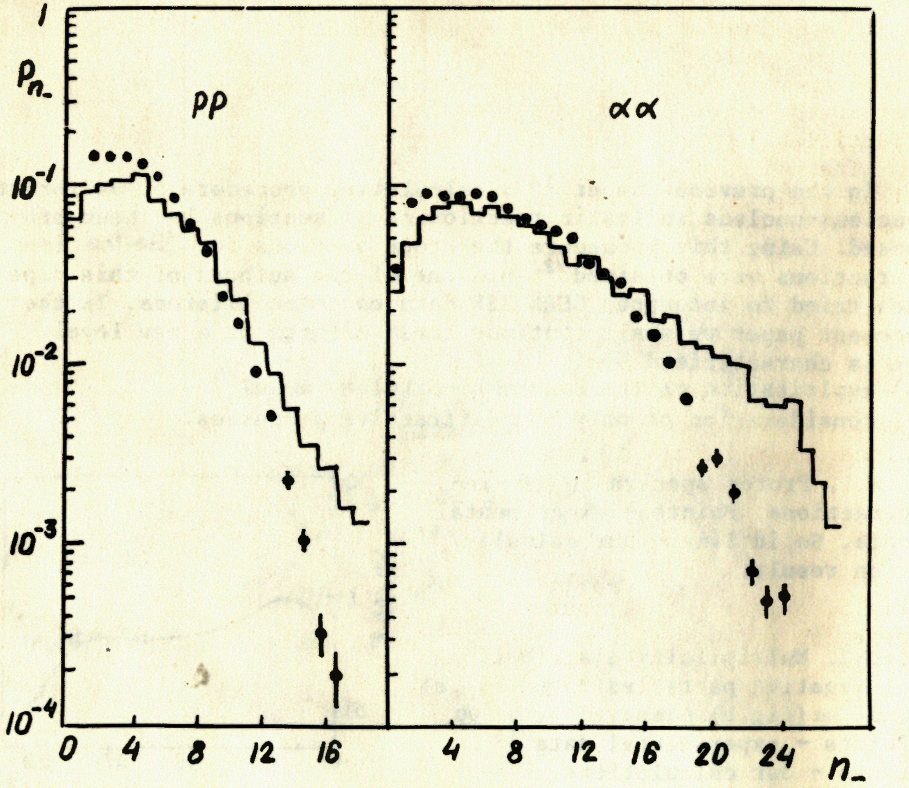



Fig.3. Multiplicity distribution of negative particles produced in inelastic a) pp-collisions at $\sqrt{s}$ = 31 GeV and b) $\alpha\alpha$-collisions at $\sqrt{s_{NN}}$ = 31 GeV. Points - experimental data of [12]. Lines - our calculations.

Now a few words about the eikonal model. The eikonal model (approximation) in the theory of elastic hadron-nucleus scattering was developed by R.J.Glauber [4] and A.G.Sitenko [5]. It gave an opportunity to satisfactorily describe the hadron-nucleus data. At present it is the most powerful theory of such interactions. Its straightforward generalization on inelastic reactions [6] permitted one to understand the hadron-nucleus data at $x > 0.5$ [7] ($x = p/p_0$, where p and $p_0$ are final and initial momenta of projected particles). Note, that in papers [6,7] the secondary particles characteristics were not considered, so now the eikonal model is called the Glauber-Gribov theory having in mind the approach given in the papers [8]. Because the last approximation met some difficulties when explaining the experimental data, its adepts began to introduce the quark featu-



res into their schemes. But the ordinary eikonal model gives reasonable results [9]. So we stick to the point of view of the standard eikonal model, and assume that in hadron-nucleus interactions a cascade of incident particles takes place and all produced particles leave the nucleus without interactions.

The main ideas of such approximation in the theory of nucleus-nucleus interactions were formulated in papers [1,2], and we follow them. According to them we assume that in typical nuc-

Fig.4. Relative number of events vs multiplicity, normalized to unity, for pp, p$\alpha$ and $\alpha\alpha$ data in the cm pseudorapidity range $|\eta| < 0.8$. Points - data of [13]. Lines - our calculations.

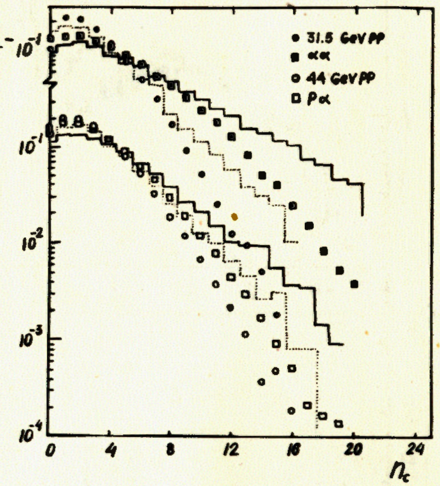
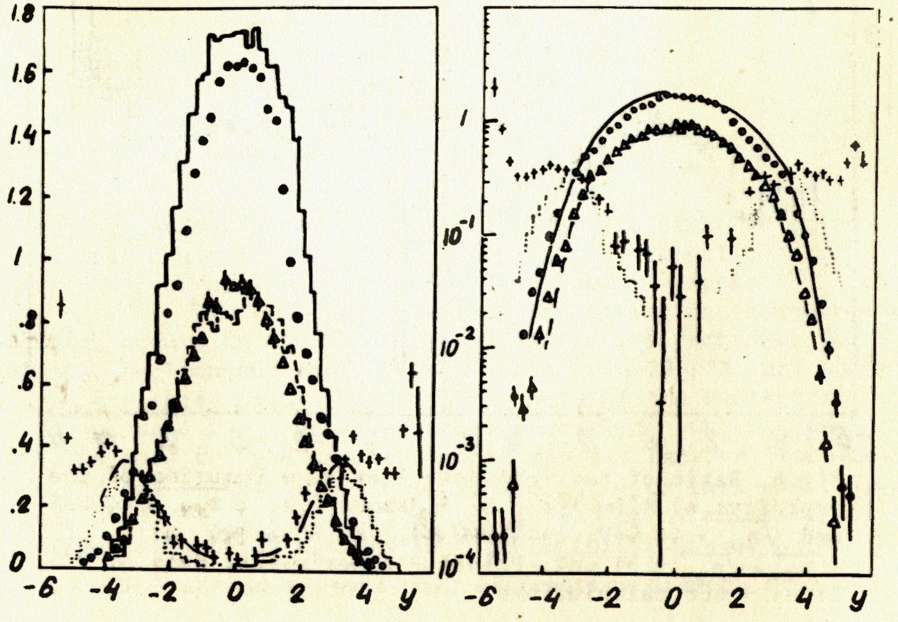



Fig.5. Rapidity distribution of negative and positive excess particles in inelastic $\alpha\alpha$ and pp collisions. Points - data of [12]. Lines - our calculations.



leus-nucleus reactions nucleons suffer many collisions, while the produced particles do not undergo collisions at all.

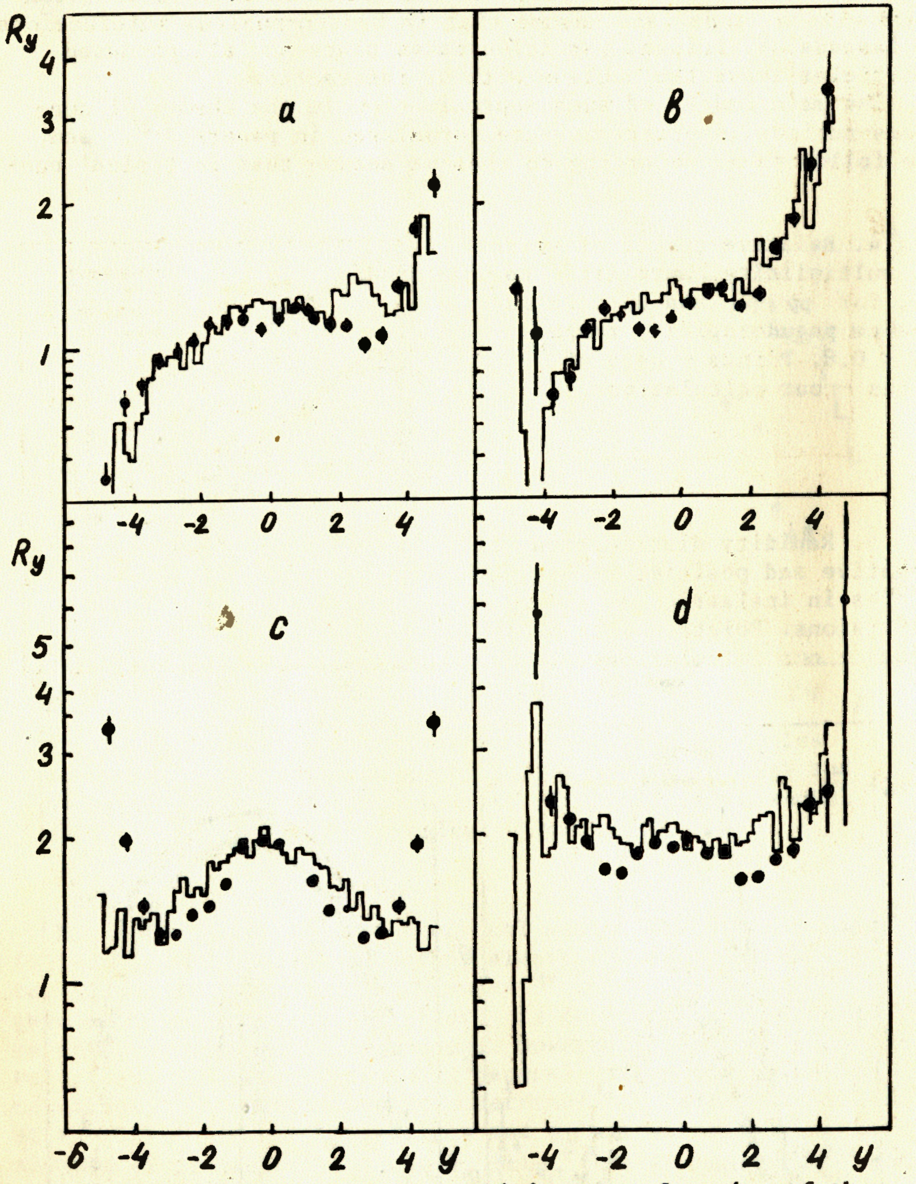



Fig.6. Ratio of particle densities as a function of the rapidity: a) $R_y^+(\alpha p/pp)$, b) $R_y^-(\alpha p/pp)$ at $\sqrt{s_{NN}}$ = 44 GeV and $\sqrt{s_{pp}}$ = 44 GeV, c) $R_y^+(\alpha\alpha/pp)$, d) $R_y^-(\alpha\alpha/pp)$ at $\sqrt{s_{NN}}=\sqrt{s_{pp}}$ = 31 GeV. Points - experimental data of [11]. Lines - our calculations.



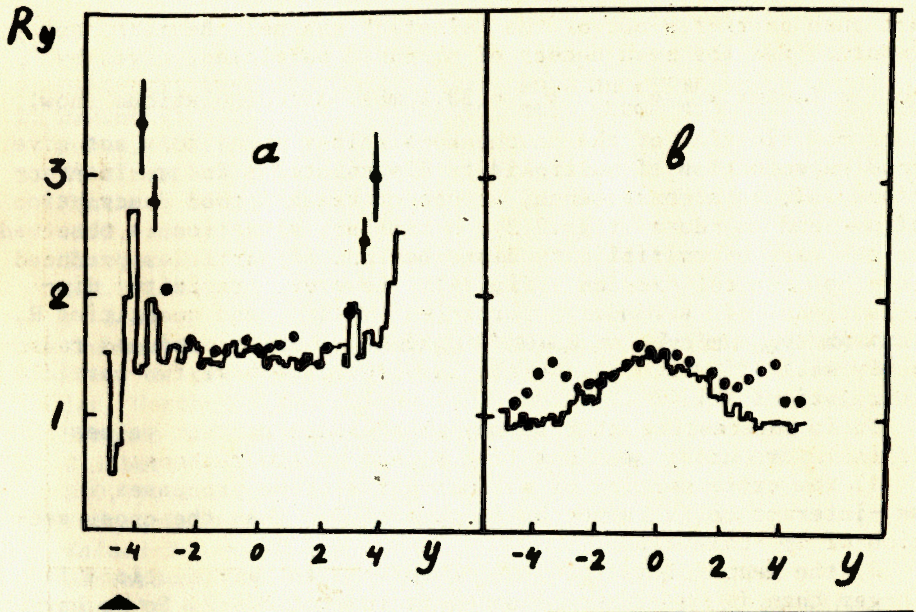



Fig.7. The same as in fig.6, but experimental data are from [14]. Lines - our calculation results multiplied by 0.75.

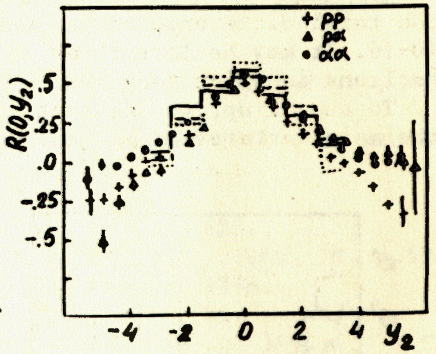



Fig.8. Two-body correlation function for pp, αp and αα inelastic interactions. Points - data of [14]. Lines - our calculations.

We have estimated the cross sections of different reactions by the method given in ref.[1], based on the eikonal theory of elastic nucleus-nucleus scattering developed in papers[10]. It shows that in $^4He$-$^4He$ interactions one inelastic nucleon-nucleon collision occurs in 45-50% of all inelastic interactions. Two inelastic nucleon-nucleon collisions occur in 23-27%, and so on. To simulate these collisions with the help of the Monte-Carlo method, we used the Levchenko-Nikolaev model [3], which, we think, is good for the description of non-diffractive processes. Since the proton spectra calculated according to this model have no bump at $x \sim 1$ (fig.1), therefore, in our calculations of different reaction cross ections in $^4He$-$^4He$ collisions we used $\sigma_{pp}^{n.dif.}$ = 26.2 mb and assumed that diffraction dissociation did not push particles out of the "elastic" channel. Besides, we renormalized the mean number of produced particles, given by [8], to the factor $\sigma_{pp}^{in}/\sigma_{pp}^{n.dif.}$ ($\sigma_{pp}^{in}$ = 33.4 mb). As calculations show, such modification of the Levchenko-Nikolaev model does not give good reproduction of multiplicity distributions in pp -interactions and, as a consequence, we cannot reach a good description of $p\alpha$- and $\alpha\alpha$ -data (figs.2,3). A similar, situation is observed in the case of multiplicity distributions of particles produced in the central region (fig. 4). However, rapidity distributions of secondary particles (dn/dy) and quantities $R_y$ ($R_y = (dn/dy)_{\alpha\alpha}/(dn/dy)_{pp}$ or $R_y = (dn/dy)_{p\alpha}/(dn/dy)_{pp}$) are reproduced reasonably well (figs.5,6,7). On the same level we have two-particle correlations (fig.8).

It is interesting that we may also obtain correct values of inclusive cross sections (fig.9) due to two reasons:

1) the cross section of all non-diffractive processes in $\alpha\alpha$ -interaction is larger by factors of 7-8 than the cross section of pp -collisions;

2) the mean multiplicity of $\pi^0$ -mesons in $\alpha\alpha$-reactions is larger than in pp-interaction by factors of 1.5-2. So we have the total difference of inclusive cross sections by factors of 10-16. It may be larger due to multiscattering processes of nucleons in which they receive large transversal momenta.

To sum it up, we see that the eikonal model can reproduce the main features of $p\alpha$- and $\alpha\alpha$-interactions at high energies.

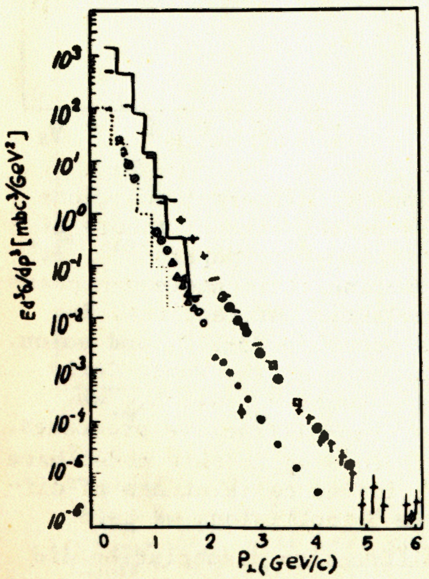



Fig.9. Inclusive invariant cross section for $\pi^0$ production in $\alpha\alpha$ - and pp -collisions as a function of the transverse momentum $p_T$. Points - data from [15]. Lines - calculation results of $\frac{1}{10}\frac{d\sigma}{p_T dp_T}$.



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Ужинский В.В., Омбоо З. E2-83-254

Предварительные результаты анализа данных CERN ISR по $p\alpha$- и $\alpha\alpha$-взаимодействиям в рамках эйкональной модели

Представлены результаты выполненных в рамках эйкональной модели расчетов различных характеристик $p\alpha$- и $\alpha\alpha$-взаимодействий таких, как распределения по множественности, быстротные распределения, двухчастичные корреляционные функции и инклюзивные сечения. Получено удовлетворительное согласие теории и экспериментальных данных. Расчеты были выполнены в предположении о том, что все вторичные частицы покидают область взаимодействия, не перерассеиваясь. Только барионы испытывают многократные перерассеяния. Сечения различных неупругих реакций определялись с помощью эйконального подхода. При моделировании неупругих барион-барионных соударений использовалась модель Левченко-Николаева. Все расчеты проведены с использованием метода Монте-Карло.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1983

Uzhinskii V.V., Omboo Z. E2-83-254

Preliminary Results of the Analysis of the CERN ISR Data on $p\alpha$- and $\alpha\alpha$-Interactions within the Frame of Eikonal Model

The results of a calculation of different characteristics of $p\alpha$- and $\alpha\alpha$-interactions, such as multiplicity distributions, rapidity distributions, two-particle correlation functions, and inclusive cross sections, performed in the frame of eikonal model, are reported. The reasonable agreement of the theory and the experimental data is obtained. The calculations were performed under the assumption that all secondary particles leave the interaction region without rescattering and that only baryons suffer multiple scattering. The cross-sections of different inelastic reactions were determined with the help of the eikonal approach. At simulation of inelastic baryon-baryon interactions, the Levchenko-Nikolaev model was used. All calculations were performed using the Monte-Carlo method.

The investigation has been performed at the Laboratory of Nuclear Problems, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna 1983