E1-2001-68

A.S.Galoyan[1], E.N.Kladnitskaya, O.V.Rogachevski,
V.V.Uzhinskii[2]

APPLICATION OF **RQMD** AND **FRITIOF** MODELS FOR DESCRIPTION OF NUCLEUS-NUCLEUS INTERACTIONS AT ENERGY OF 3.36 GEV/NUCLEON

[1]Yerevan Physical Institute, Armenia
[2]E-mail: uzhi@cv.jinr.ru

The predictions of the Relativistic Quantum Molecular Dynamics model (RQMD) [1] are widely used for analysis of experimental data on collective flows of particles in high energy nucleus-nucleus interactions. It is explained by the following, the model takes into account the potential interactions of baryons, meson and baryon resonance creation, secondary particles cascading in nuclei, and so on. So, the model considers the main factors determined the collective flows. Though the demerits of the models manifested themselves at global characteristics description especially at moderate energies put doubts about the reliability of its predictions on the collective flows of the particles.

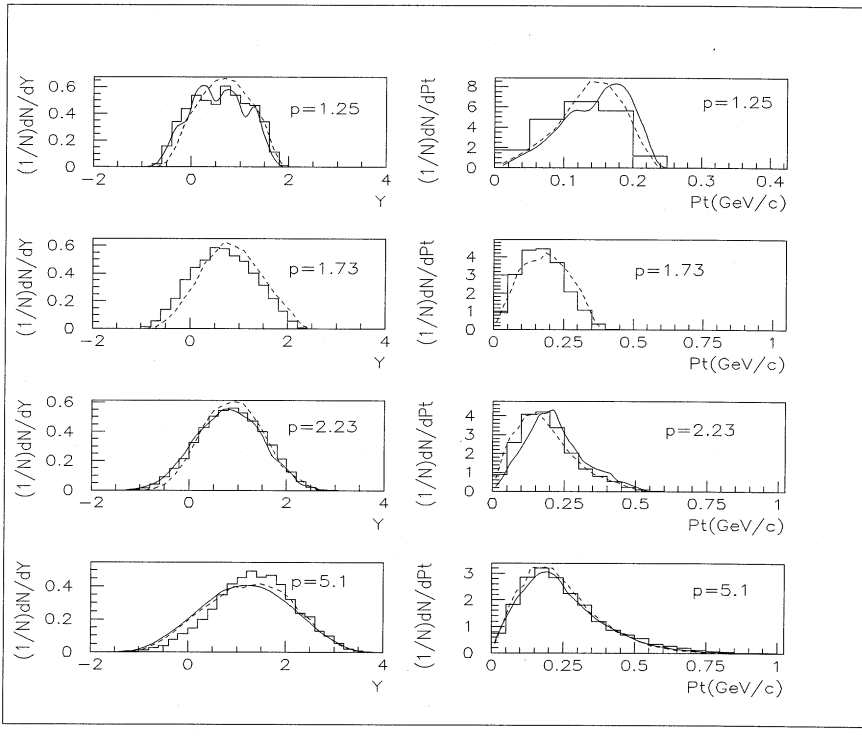

Figure 1: π^--meson rapidity and transverse momentum distributions in *np*-interactions. Histograms are the experimental data. Solid and dashed lines are RQMD and FRITIOF model calculations, respectively.

Fig. 1 presents experimental data on π^--meson rapidity distributions in neutron-proton (np) interactions at the neutron momentum of $P_n = 1.25$, 1.73, 2.23 and 5.1 GeV/c. The data were amiable given to the authors of

the paper by Yu.A. Troyan's group. The RQMD 2.4 model calculations are presented on fig. 1, too. As seen, the model predicts a strange structure in the distribution at $P_n = 1.25$ GeV/c. There is no π^--meson production in the model at $P_n = 1.73$ GeV/c. Agreement of the calculations with the experimental data at $P_n = 2.23$ and 5.1 GeV/c is satisfactory. For comparison, on fig. 1 we give the calculations performed with help of the FRITIOF model [2, 3]. The parameters of the FRITIOF model were changed [4] in order to reach an agreement with the experimental data. As seen, a good description of π^--meson characteristics can be obtained.

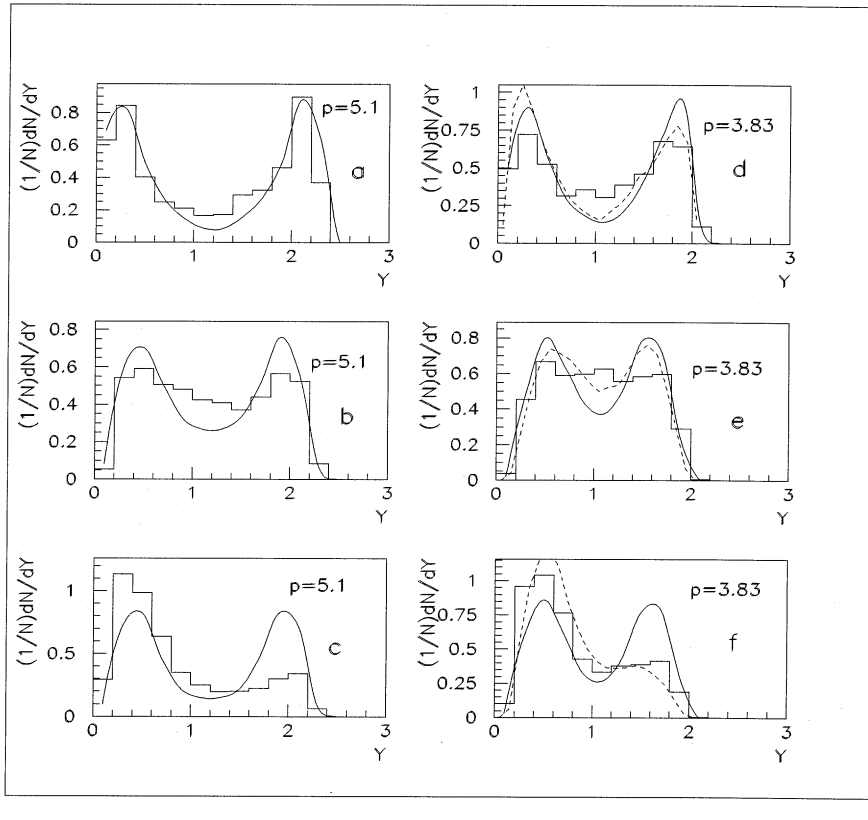

Figure 2: Proton rapidity distributions in np-interactions. Histograms are the experimental data. Solid and dashed lines are RQMD and FRITIOF model calculations, respectively.

Fig. 2 gives experimental and model distributions of protons on rapidity in np-interactions in the reactions $np \to pp\pi^-$ (fig. 2a, 2d), $np \to pp\pi^-\pi^0$ (fig. 2b, 2e), $np \to np\pi^+\pi^-$ (fig. 2c, 2f) at $P_n = 3.83$ and 5.1 GeV/c. As

seen, it is too hard to say about an agreement between the experimental data and the RQMD model calculations. The model assumes too strong charge transfer from the backward semi-sphere to the forward semi-sphere in the np-interaction center-of-mass system. The FRITIOF model calculations are in agreement with the experimental data.

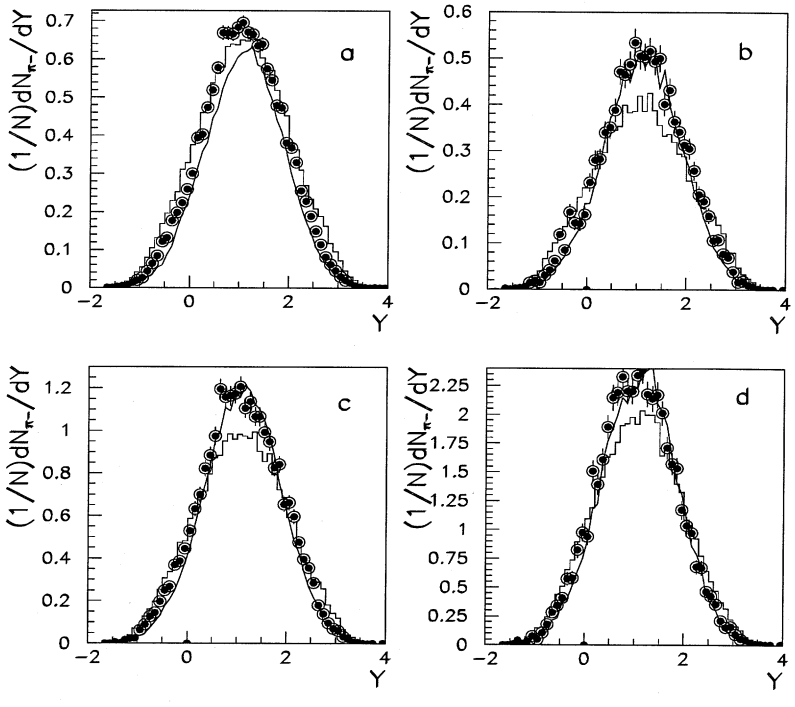

Figure 3: π^--meson rapidity distributions in *CC*-interactions. Points are the experimental data. Histograms and solid lines are RQMD and FRITIOF model calculations, respectively.

Our data of CC-interactions at $P = 4.2$ GeV/c/nucleon obtained with help of the propan bubble chamber are presented in Fig. 3, 4. A method of receiving and developing data is described in Ref. [5]. Fig. 3 gives the π^--meson rapidity distributions in all interactions (fig. 3a) and in the interactions with different multiplicities of the π^--mesons ($n_{\pi^-} = 1$ fig. 3b, $n_{\pi^-} = 2 \div 3$ fig. 3c, $n_{\pi^-} > 3$ fig. 3d). According to Fig. 3a, the RQMD model overestimates the π^--meson yields in the nuclear fragmentation regions at $y = -0.5 \div 0.5$ and $y = 2 \div 3$. At the same time, the unsaficient

yield of the π^--meson is observed in the central region The underestimation of the π^--meson yield in the central region is more visualize in Figs. 3a – 3d.

The modified FRITIOF model reproduces correctly the experimental distributions at different multiplicities of the π^--meson. The summered distribution of Fig. 3a is determined by the distributions at different n_{π^-} and by the meson multiplicity distribution. Since the RQMD model describes unsatisfactory the distributions at different n_{π^-}, but reproduces the summered distribution, one can assume that the agreement between the experimental data of Fig. 3a and the calculations is enplaned by an incorrect distribution on the meson multiplicity in the model. Unfortunately, the methodical peculiarities of the propan bubble chamber does not allow us to check up the hypothesis directly.

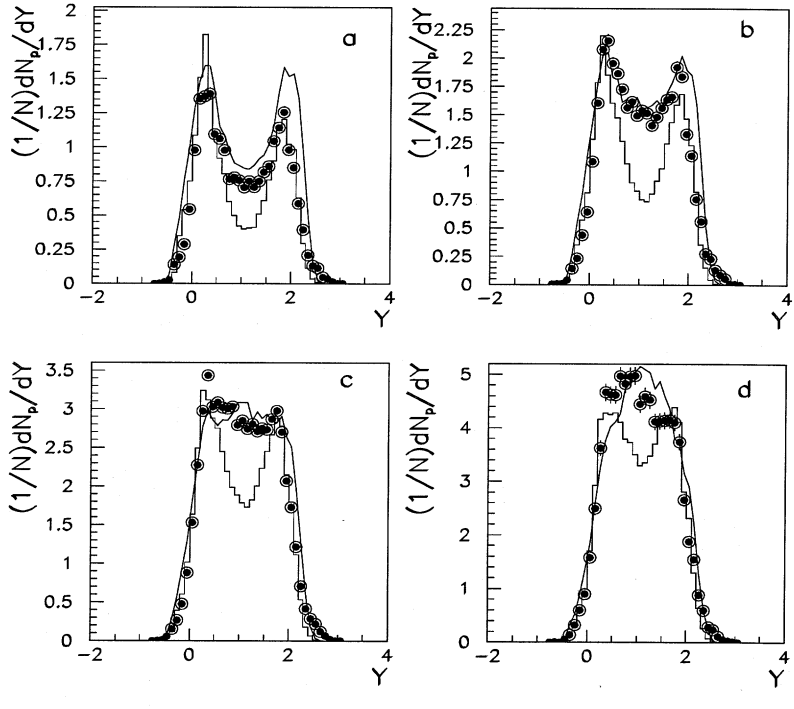

Figure 4: Proton rapidity distributions in CC-interactions. Histograms are experimental data. Solid and dashed lines are RQMD and FRITIOF model calculations, respectively.

The rapidity distributions of participating protons in the events with

different multiplicities of the π^--meson in the CC-interactions are presented in Fig. 4. Protons with the momentum larger than 300 MeV/c which do not include spectator protons with $p > 3$ GeV/c and $\theta < 4^o$, were considered as participating protons. As seen from the figure, the bimodal structure of the distributions assumed by the RQMD model for the np-interactions, is observed in the CC-interactions, too. In addition, the model underestimates significantly the proton yields. The FRITIOF model describes satisfactory the experimental data.

Predictions analogous to that of the RQMD model were obtained with the help of the intra-nuclear cascade model [6]. The first variant of the cascade model took into account π-mesons and nucleons interactions only. So, it assumed fast resonance decays. Here, a good description of the proton multiplicity and overestimated meson yield was reached. The cascade model with meson and baryon resonance production [7] allowed one to describe the meson multiplicity, but underestimated the proton multiplicity. Here, the reproduction of the proton rapidity distributions was better than in the RQMD model.

Summing up, one can conclude that the introduction of the resonance production in the framework of the cascade model with (RQMD) and without taking into account the nuclear mean field effects does not allow one to reproduce the meson and proton multiplicities in the nucleus-nucleus interactions at the same time. The modified FRITIOF model that uses the reggeon nuclear destruction model [8], allows one to reach good results.

Turning to the question about the collective flows, it is obvious that it is too hard to believe in the reality of the RQMD model predictions without a correct description of the particle distributions in the phase space. Moreover, one can assume that the strong concentration of the baryon in the nuclear fragmentation regions which contradicts the experiment, leads to the strong collective flow effects predicted by the RQMD model.

The authors of the paper are grateful to Yu.A. Troyan group for providing us with their experimental data. One of the authors (V.V.U.) thanks RFBR (grand No. 00-01-00307) for its particular financial support.

References

[1] H. Sorge// Phys. Rev., 1995, V. **C52**, P. 3291.

[2] B. Andersson et al.// Nucl. Phys., 1987, V. **281B**, P. 289.

[3] B. Nilsson-Almquist and E. Stenlund// Comp. Phys. Comm., 1987, V. **43**, P. 387.

[4] B. Ganhuyag, V.V. Uzhinskii// JINR Commun., 1997, **P1-97-315**, Dubna; JINR Commun., 1997, **P2-97-397**, Dubna.

[5] A.I. Bondarenko et al.// JINR Commun., 1998, **P2-98-292**, Dubna.

[6] V.S. Barashenkov, F.G. Geregy, Zh.Zh. Musulmanbekov// JINR Commun., 1983, **P2-83-117**, Dubna.

[7] G. Musulmanbekov, B. Khurelbaatar// JINR Commun., 1999, **P2-99-59**, Dubna.
A.I. Bondarenko et al.// JINR Commun., 1998, **P1-98-155**, Dubna; Yad. Fiz. 1998.

[8] Kh.El-Waged, V.V.Uzhinskii// Yad. Fiz., 1997, V. **60**, P. 925; Phys. Atom. Nucl., 1997, V. **60**, P. 828.

Received by Publishing Department
on April 11, 2001.

Галоян А.С. и др. E1-2001-68
Применение моделей RQMD и FRITIOF для описания
ядро-ядерных взаимодействий при энергии 3,36 ГэВ/нуклон

Представлены экспериментальные данные о распределениях протонов и π^--мезонов по быстротам в *CC*-взаимодействиях с различной множественностью π^--мезонов при энергии 3,36 ГэВ/нуклон. Проведено сравнение данных с предсказаниями моделей RQMD и FRITIOF. Показано, что модель RQMD удовлетворительно воспроизводит распределения π^--мезонов, но неудовлетворительно описывает характеристики протонов. В модели FRITIOF при подборе свободных параметров удается достичь хороших результатов.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна, 2001

Galoyan A.S. et al. E1-2001-68
Application of RQMD and FRITIOF Models for Description
of Nucleus-Nucleus Interactions at Energy of 3.36 GeV/nucleon

Experimental data on proton and π^--meson rapidity distributions in *CC*-interactions at 3.36 GeV/nucleon in the events with different multiplicities of produced π^--mesons are presented. The data are compared with predictions of RQMD and FRITIOF models. It is shown that the RQMD model reproduces satisfactorily the π^--meson distributions, but unsatisfactorily describes the protons characteristics. The FRITIOF model gives good results at tuning the free parameters of the model.

The investigation has been performed at the Laboratory of High Energies, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna, 2001

Макет Т.Е.Попеко

Подписано в печать 04.06.2001
Формат 60 × 90/16. Офсетная печать. Уч.-изд. листов 1,04
Тираж 375. Заказ 52684. Цена 1 р. 25 к.

Издательский отдел Объединенного института ядерных исследований
Дубна Московской области