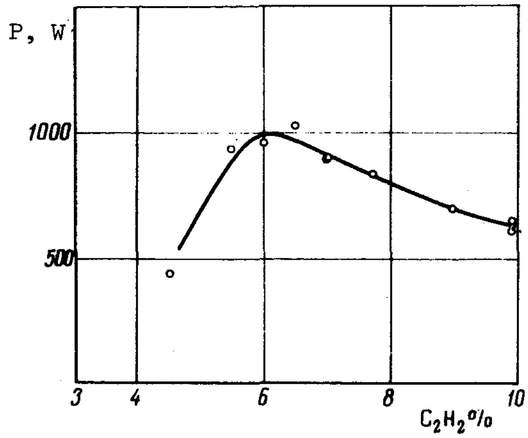

Fig. 3

in our experiments at an acetylene concentration of the order of 6% and amounted to 1.0 kW at a pulse duration 20 - 30 msec. With further increase of the acetylene concentration, to 10%, the power decreased gradually to 600 W. Such a variation of the generation power is connected with the behavior of the gain. Measurements have shown that the gain decreases when the acetylene concentration in the mixture rises above 6%, owing to the increased concentration of the water vapor in the combustion products and to the corresponding increase of the asymmetrical-mode deactivation rate, which leads to a decrease in the inversion. When the acetylene concentration drops below 6%, the gain also decreases, for in this case the combustion temperature and the inversion also decrease. Further increase of the power calls for the use of higher stagnation pressures and for an optimal geometry of the nozzle.

In conclusion, the authors thank A. E. Abaliev for great help with developing the appratus and with the experiments.

[1] N. G. Basov and A. N. Oraevskii, Zh. Eksp. Teor. Fiz. 44, 1742 (1963) [Sov. Phys.-JETP 17, 1171 (1963)].
[2] I. R. Hurle and A. Hertzberg, Phys. Fluids 8, 1601 (1965).
[3] V. K. Konyukhov and A. M. Prokhorov, Authors' Certificate (Patent) No. 223954, Priority 19 February 1966. Byull. Izobr. No. 25 (1968)].
[4] V. K. Konyukhov and A. M. Prokhorov, ZhETF Pis. Red. 3, 436 (1966) [JETP Lett. 3, 286 (1966)].
[4] V. K. Konyukhov, I. V. Matrosov, A. M. Prokhorov, D. T. Shalunov, and N. N. Shirokov, ibid. 10, 84 (1969) [10, 53 (1969)].
[6] D. M. Kuehn and D. I. Monson, Appl. Phys. Lett. 16, 48 (1970).
[7] E. T. Gerry, IEEE Spectrum 7, 51 (1971).
[8] M. S. Dzhidzhoev, V. V. Korolev, V. N. Markov, V. G. Platonenko, and R. V. Khokhlov, ZhETF Pis. Red. 13, 73 (1971) [JETP Lett. 13, 49 (1971)].
[9] I. Tulip and H. Seguin, Appl. Phys. Lett. 19, 8, 263 (1971).
[10] S. Yatsiv, E. Greenfield, F. Dothan-Deutsch, D. Chuchem, and E. Bin-Nun, ibid. 19, 65 (1971).

CERTAIN CHARACTERISTICS OF INELASTIC PROTON-NUCLEON INTERACTIONS AT 200 GeV/c

Z.V. Anzon, M.G. Antonova, E.G. Boos, A.A. Goryachikh, E.K. Kanygina, G.S. Kolyachkina, P.V. Morozova, N.N. Pavlova, Zh.S. Takibaev, A.V. Khomenskaya, I.Ya.Chasnikov, Ts.I. Shakhova, N.P. Bogachev[1], F.G. Lepekhin, B.B. Simonov, V.G. Bogdanov, N.A. Perfilov, Z.I. Solov'eva, M.I. Adamovich, N.A. Dobrotin, V.G. Larionova, M.I. Tret'yakova, S.P. Kharlamov, M.M. Chernyavskii, K.I. Alekseeva, S.A. Azimov, A.I. Bondarenko, K.G. Gulamov, V.V. Lavkov, B.Sh. Navotnyi, V.I. Petrov, T.T. Riskiev, T.P. Trofimova, L.P. Chernova, and G.M. Chernov
Alma-Ata - Leningrad - Moscow - Tashkent Collaboration
Submitted 14 May 1973
ZhETF Pis. Red. 17, No. 12, 655 - 658 (20 June 1973)

We separated 294 proton-proton and 337 proton-neutron quasifree inelastic collisions out of 4078 events of inelastic interaction of protons with momentum 200 GeV, found in 1438 m of proton tracks in nuclear emulsion. Analysis of the angular characteristics of the secondary charged relativistic particles shows that the showers are anisotropic up to maximum multiplicity and are inhomogeneous, probably as a result of the tendency of the particles to cluster.

We report here certain results of an analysis of the angular distributions of secondary

[1] Joint Institute for Nuclear Research, Dubna

particles in inelastic pp and pn collisions, observed in nuclear emulsion. Two emulsion stacks were bombarded with a beam of 200 GeV/c protons from the NAL accelerator in Batavia.

The experimental material analyzed below consists of 294 pp-collision events and 337 pn-collision events selected in accordance with the customary criteria [1] for the selection of quasinucleon interactions in emulsion. They were selected from a total of 4078 inelastic collisions obtained by scanning a total of 1438 m of track (the mean free path for inelastic interaction is 35.2 ± 0.6 cm). Coherent reactions with production of n_{ch} = 1, 3, and 5 charged particles were excluded (the procedure for selecting coherent reactions and their characteristics are reported separately [2]). The average multiplicity of the charged particles in the selected pp and pn interactions was 8.4 ± 0.4 and 7.9 ± 0.4, respectively.

The angular characteristic of the secondary particle is taken to be the quantity[1)] $x = \log \tan \theta$ (θ is the angle of emission relative to the primary particle in the l.s.).

Figure 1 shows the distributions of the secondary particles with respect to x for pp and nn collisions at different multiplicities (n_{ch} are even for pp and odd for pn). We excluded from the number of secondary particles the so-called "leaders" (particles with $\theta^{min} < 0.5°$), which represent protons that are fast in the l.s., and also the recoil protons with kinetic energy ≤ 400 MeV in the l.s.

Figure 2a shows the mean values $|\langle x\rangle/\log \gamma_c|$ and Fig. 2b shows the standard deviations $\sigma(x)$ of these distributions as functions of n_{ch}. An analysis of the data of Figs. 1 and 2 leads to the following conclusions: (a) At 200 GeV, as at lower energies [1], the summary x-distributions have no singularities whatever and are somewhat asymmetrical with respect to $-\log \gamma_c$, especially at small n_{ch}. This is connected with secondary particles that are slow in the c.m.s. and with an admixture of protons having $\theta^* > \pi/2$ in the c.m.s. (b) As is known, an angular distribution that is isotropic in the c.m.s. corresponds in the l.s. to a distribution that is very close to Gaussian with a standard deviation $\sigma_0 = 0.36$. It follows from the data of Fig. 2 that the angular distribution in the c.m.s. has a strong anisotropy that decreases with increasing n_{ch}. What is new in comparison with the analogous distribution at lower energies (see, for

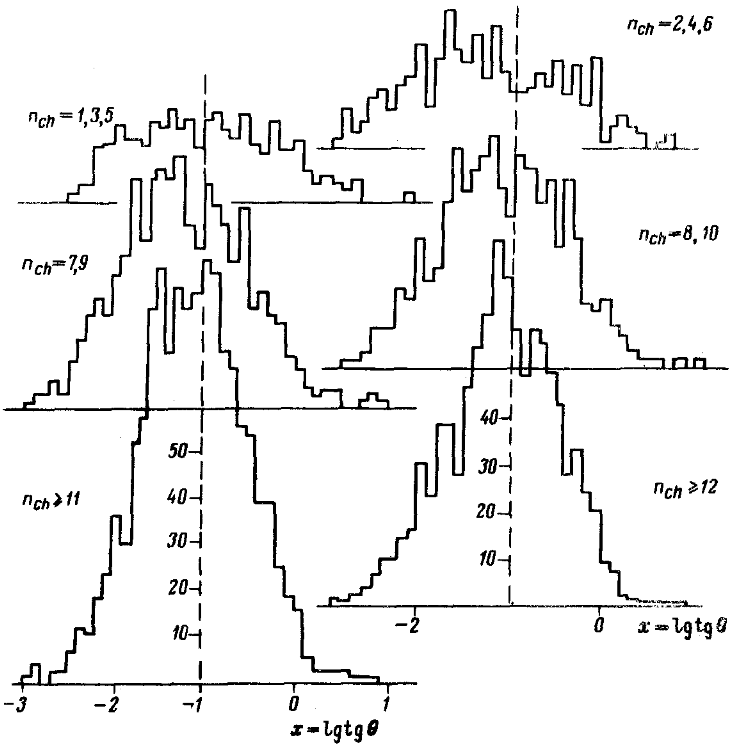

Fig. 1

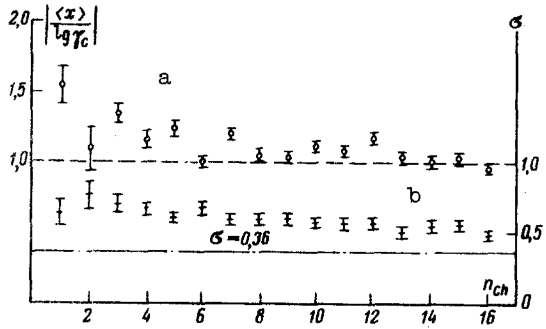

Fig. 2

Fig. 1. Summary distributions with respect to the quantity $x = \log \tan\theta$ in pn and pp collisions at different sets of multiplicities.

Fig. 2. a) Dependence of the parameter $|\langle x\rangle/\log\gamma_c|$ on the multiplicity n_{ch}. b) Multiplicity dependence of the standard deviation in the summary distribution with respect to x.

1) At large p_0 the value of x is approximately proportional to the speed y, which equals $\frac{1}{2}\ln(E + p_{\parallel})/(E - p_{\parallel})$ in the l.s. At p_0 = 200 GeV/c, this is satisfied for most relativistic secondary particles.

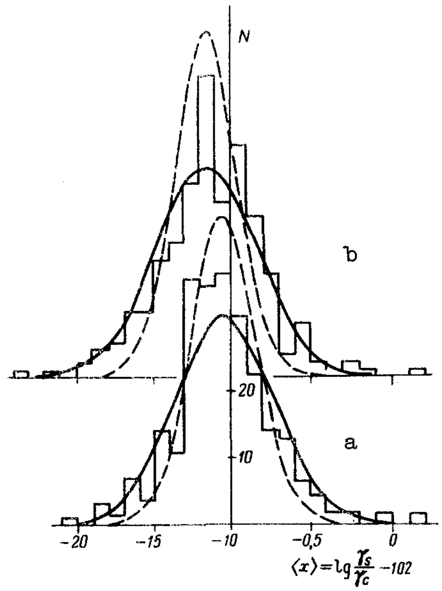

Fig. 3. a) Distribution with respect to <x> in individual showers from pp collisions. b) Distribution with respect to <x> in individual showers from pn collisions. The solid line shows an approximation of the distributions in individual showers by a Gaussian distribution, and the dashed line shows a Gaussian distribution with standard deviation $\sigma(x)/\sqrt{n-1}$, where $\sigma(x)$ is the standard deviation of the summary distribution with respect to x, and n is the volume of the sample.

example, [1]) is that the anisotropy remains appreciable up to the maximum possible multiplicities. (c) At small multiplicities ($n_{ch} < \langle n_{ch}\rangle$)m the pn collisions are somwhat more asymmetric "forward" than the pp collisions. This may be connected with a tendency to "remember" the charge in peripheral pn collisions, and should be verified with momentum measurements.

To study the properties of the angular distributions in individual acts of pp and pn collision, we calculated the values of $\langle x\rangle_i$ and σ_i in individual events for $n_{ch} \geq 3$. Figure 3 shows the distributions with respect to $\langle x\rangle = \log(\gamma_s/\gamma_c) - 1.02$ for pp and pn collisions, while the table lists the empirical standard deviations $\sigma(\langle x\rangle)$ of these distributions for all n_{ch}. If it is assumed that the x-distributions are homogeneous in individual showers, then the standard deviations of these distributions should be equal to $\sigma(x)/\sqrt{n-1}$, where $\sigma(x)$ is the standard deviation of the summary x-distribution (Fig. 2), and n is the number of particles in an individual sample (event) from this distribution. The data of the table and of Fig. 3 show that the angular distributions are not homogeneous in individual inelastic-interaction acts at 200 GeV energy. The physical reason for this inhomogeneity is apparently the tendency of the particles to cluster. It is also important to note the fact that a similar analysis at p_0 = 67 GeV leads to the conclusion that the distributions of the individual showers are homogeneous.

A more detailed analysis of the causes of the inhomogeneity observed at 200 GeV/c will be performed by us later. The work on the analysis of the obtained data is continuing.

The authors are deeply grateful to the Division of Nuclear Physics of the USSR Academy of Sciences and the staff of NAL (Batavia, Ill), as well as to V. A. Nikitin, for collaboration in the experiment. They also thank the members of the group headed by S. I. Lyubomilov (High-Energy Laboratory, JINR), for developing the emulsions. The authors are indebted also to the

n_{ch}	$\sigma(\langle x\rangle)$	$\sigma(x)/\sqrt{n-1}$	n_{ch}	$\sigma(\langle x\rangle)$	$\sigma(x)/\sqrt{n-1}$
4	0.49 ± 0.06	0.38 ± 0.04	3	0.50 ± 0.08	0.50 ± 0.03
6	0.41 ± 0.04	0.30 ± 0.01	5	0.34 ± 0.04	0.30 ± 0.01
8	0.31 ± 0.03	0.23 ± 0.01	7	0.40 ± 0.03	0.24 ± 0.01
10	0.21 ± 0.02	0.20 ± 0.01	9	0.21 ± 0.02	0.22 ± 0.01
12	0.19 ± 0.02	0.17 ± 0.01	11	0.27 ± 0.03	0.18 ± 0.01
14	0.17 ± 0.03	0.16 ± 0.01	13	0.22 ± 0.03	0.15 ± 0.01
≥ 16	0.17 ± 0.03	0.12 ± 0.01	≥ 15	0.18 ± 0.02	0.15 ± 0.01
pp	0.29 ± 0.01	0.21 ± 0.01	pn	0.31 ± 0.01	0.20 ± 0.01

laboratory staff for emulsion scanning and measurements.

[1] Alma-Ata - Cracow - Dubna - Leningrad - Moscow - Tashkent - Ulan-Bator Collaboration, Phys. Lett. 39B, 282 (1972). JINR Report R1-6504, Dubna, 1972.
[2] Alma-Ata - Leningrad - Moscow - Tashkent Collaboration, FIAN Preprint No. 67, 1973; ZhETF Pis. Red. 18, No. 1 (in press).

AZIMUTHAL CORRECTIONS FOR pp COLLISIONS AT 20 - 70 GeV AND THE MULTIPERIPHERAL MODEL

S. A. Azimov, A. I. Bondarenko, K. G. Gulamov, V. I. Petrov, T. T. Riskiev, T. P. Trofimova, L. P. Chernova, and G. M. Chernov
Physico-technical Institute, Uzbek Academy of Sciences
Submitted 16 May 1973
ZhETF Pis. Red. 17, No. 12, 659 - 662 (20 June 1973)

The distributions of the angles between the transverse momenta of secondary particles from pp collisions were investigated as functions of p_0 (21, 50 and 67 GeV/c), the multiplicity, and the difference of the longitudinal momenta. The data contradict qualitatively the multiperipheral model.

Since the single-particle distributions are not critical enough to choose between the different models of multiple generation, great interest attaches to the study of the multiparticle distributions and correlations. One of the simplest types of two-particle correlations is the distribution with respect to the angle between the transverse momenta of the secondary particles

$$\phi = \arc\cos(p_{\perp i} p_{\perp j} / |p_{\perp i}| |p_{\perp j}|), \qquad 0 \leqslant \phi \leqslant \pi .$$

If the particles are emitted independently, the ϕ-distribution is uniform in the interval $[0,\pi]$. The transverse-momentum conservation law leads to an excess of angles ϕ that are close to π, and makes the distribution asymmetrical with an asymmetry angle $\alpha = (n_2 - n_1)/n > 0$ ($n_{1,2}$ are the number of particle pairs with $\phi = 0 - \pi/2$ and $\pi/2 - \pi$, respectively, $n = n_1 + n_2$).

Highly characteristic dynamic correlations with respect to ϕ are observed in the multiperipheral model (MPM) at small numbers (1 - 2) of particles in the node of the multiperipheral chain (diagram of the "comb" type). Owing to the local conservation of the transverse momentum in the nodes of the diagram, strong correlations arise in the MPM (a tendency towards $\phi \sim \pi$) for particles from one or neighboring nodes (i.e., particle with close longitudinal momenta); these correlations weaken rapidly when the number of intermediate nodes between the chosen pair of particles or the difference between their longitudinal momenta increases [1 - 3]. This behavior should be observed for all p_0 and n_{ch} (multiplicity), since the distributions with respect to the subenergies s_i and the 4-momentum transfers t_i are fixed along the chain.

Other multiple-generation models do not give such definite predictions with respect to the ϕ-distribution. However, if the particle production comes from one or several "massive" centers (the pionization, fireball, or diffraction models), one should expect a weak dependence of the ϕ-distribution on the difference of the longitudinal momenta, i.e., the presence of the so-called long-range correlations even at large (but finite) p_0 and n_{ch}.

We have investigated the ϕ-distributions in pp collisions at p_0 = 21, 50, and 67 GeV/c as functions of p_0, n_{ch}, $\Delta\lambda \equiv \Delta \log \tan\theta \simeq 2.3\,\Delta y$ (θ is the lateral angle and y is the speed in the l.s.) and of the difference between the serial numbers of the particles when they are arranged in order of $\lambda \sim y$. The experimental material consisted respectively of 455, 537, and 645 events with $n_{ch} \geq 2$ at the indicated p_0. The selection criteria and several general characteristics of the events were described in [5 - 7].

Figure 1 shows by way of example[1)] the summary ϕ-distributions for n_{ch} = 4 and the curves calculated by the Monte Carlo method using a simplified phase-space model with allowance for the conservation of the transverse momentum. It was assumed in the calculations that the probability of appearance of unobservable (neutral) particles is 1/3. It turned out that the summary

[1)] Since the number of considered histograms reached 1000, Figs. 1 - 3 show only a small fraction of the data, pertaining to the most "representative" n_{ch} (n_{ch} = 4 and 6).