School on inelastic interactions at high energies and conference on multiple processes at high and ultrahigh energies (Bakuriani, Georgian SSR, 23–30 January 1983)

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The traditional All-Union School on inelastic interactions at high energies (the ninth in the series), organized by the Institute of Physics of the Georgian SSR, was held at Bakuriani on January 23–30, 1983. A conference on multiple processes at high and ultrahigh energies was held at the same time (January 26–28, 1983). A total of thirty lectures and papers was read. In addition, there were nine seminars. The school and conference were distinguished by the presence of specialists in cosmic-ray physics, experimental high-energy physics, and theoretical physics.

Problems in cosmic-ray physics and in adjacent areas occupied the centre of attention during the school and conference. D. M. Kotlyarevskiĭ reported on new experimental data obtained at the Tskhra-Tskaro high-altitude mountain installation which is unique in the sense that it is capable of measuring average multiplicities and inclusive spectra of secondary particles produced on pure nuclear targets at energies above 1 TeV. Such data are necessary in fundamental studies of inelastic hadron-nucleus interactions. In the second paper, D. M. Kotlyarevskiĭ reported on prospects for the modernization of the Tskhra-Tskara installation through the introduction of a system consisting of spark chambers, an ionization calorimeter, and a muon detector. A. D. Erlykin, spoke on behalf of the FIAN-ErFl collaboration and gave a detailed account of the ANI experimental project on the interaction of hadrons with cosmic-ray nuclei at energies in the range 10^3–10^6 TeV.

The results of the Pamir experiment were discussed in a number of papers. S. A. Slavatinskiĭ showed that these results can be regarded as evidence for a considerable violation of Feynman scaling: the fast secondary-particle multiplicity in the beam fragmentation region at about 10^4 TeV should be greater by a factor of ~5 than at ~1 TeV. N. N. Roĭnishvili pointed out that agreement between calculations and experiment can be achieved by assuming a substantial (by a factor of ~5) increase in multiplicity in the ionization region, a reduction in the fragmentation region, and an increase in σ_{pp}^{tot} up to ~10^4 TeV. Both papers emphasized the fact that the mean transverse momenta of secondary particles remain approximately constant (the increase is by a factor of not more than 1.5). G. B. Zhdanov reported on the effect of fluctuations in the development of the hadron-nuclear avalanche in the atmosphere on the properties of observed γ-families. The use of correlations between longitudinal and transverse avalanche parameters was suggested as a way of increasing the sensitivity of the experiment to model parameters.

Now that the results obtained on the SPS collider at CERN have become available, they can be compared with cosmic-ray data at comparable energies (~100 TeV). This comparison was reported by S. A. Slavatinskiĭ who showed that data on the distribution of γ-rays with respect to pseudovelocity, transverse momentum, and $\gamma\gamma$ effective mass, which were obtained by the Japan-Brazil collaboration, are in agreement with the SPS data. The only exception are the "centaur" type events that have not been observed on the SPS.

Experimental data obtained on accelerators were discussed in a number of papers. G. A. Leksin presented the results of a study of deep-inelastic reactions on nuclei. These processes are characterized by a "nuclear scaling" and a strong A-dependence (the yields are proportional to A^{α} where $\alpha \simeq 1.4$), whilst the longitudinal size of the emission region is much greater than the transverse size. In his paper, V. G. Grishin compared the various parameters of hadron jets created in hh, eN, and e^+e^- collisions. He showed that these jets are practically identical with respect to many of the parameters, but that secondary-particle correlations in pp collisions and e^+e^- annihilations are very different, A. D. Erlykin reported that the degree of violation of scaling in e^+e^- annihilation and in pp collisions is roughly the same. L. I. Sarycheva presented data on inclusive and semiinclusive creation of neutral strange particles in pp^- interactions at 32 GeV/c (Mirabel chamber). She showed that the probability of neutral-kaon production in annihilation processes is greater by a factor of about three than in nonannihilation events. L. I. Lapidus reported on the possible creation of gluonium in $np^- \to \varphi\varphi n$ reactions (data of the Lindenbaum group at 22 GeV/c). R. A. Kvatadze reviewed searches for exotic baryon resonances with isospin 5/2.

V. A. Nikitin presented a review of data on the creation of anomalous (secondary nuclear fragements whose mean range during the first ~10^{-10} s after creation has been reported by several workers as being smaller by ~10–30% than at other times). JINR (Dubna) proposed to develop new electronics for the investigation of this phenomenon. In another paper, V. A. Nikotin reported on a proposed new installation for the investigation of polarization phenomena in inelastic pp and pA collisions on the IFVE (Institute for High Energy Physics) accelerator.

The theoretical description of multiple-creation processes was discussed in a number of papers. It was shown by K. A. Ter-Martirosyan and by A. B. Kaĭdalov

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that the quark-gluon model of soft hadronic interactions can be used to describe mean multiplicities, the multiplicity distribution of charged particles, the growth of spectra in the central region in pp (p^-) collisions, and the spectra of positive pions. Violation of KNO scaling and weak violation of Feynman scaling in the fragmentation region was predicted. The paper by E. V. Shuryak was devoted to the role of instantons in the formation of constituent (dressed) quarks in hadrons. V. V. Anisovich and Yu. M. Shabel'skiĭ showed that the hypothesis of constituent quarks and the rules of quark statistics lead to a quantitative description of inclusive spectra of different secondary mesons and baryons in hadron-nucleon and hadron-nucleus collisions. It was predicted that violation of Feynman scaling in the fragmentation region should occur with increasing initial energy (as the energy increases from about 1 TeV to about 100 TeV, the multiplicity should fall by ~10% in pp collisions and by a factor of ~1.5 in pPb collisions). V. R. Zoller discussed the dependence of the correlation coefficient for relativistic particles created in hadron-nucleus collisions on the degree of nuclear excitation, and gave a comparison with the predictions of different models.

P. E. Volkovitskiĭ discussed the quark-gluon model which, in principle, is capable of providing a description of inclusive channels of multiple creation. I. D. Mandzhavidze considered processes with asymptotically high multiplicites ($n \gg \langle n \rangle$), their origin, and their characteristic features.

I. M. Dremin examined the connection between the ratio of real to imaginary parts of the elastic amplitude and the different types of increase in the total pp cross section with energy. A. K. Likhoded discussed the possibility of a substantial increase in the range of nuclear showers in dense materials due to the creation of charmed particles. I. I. Roĭzen showed that there is a natural mechanism for the creation of hadron jets with high p_t, namely, double diffractive dissociation. This can explain a number of phenomena observed in cosmic rays and in the SPS collider. E. M. Levin presented calculations concerned with the creation of particles with high transverse momenta due to the emission of gluon jets.

V. Ya. Fainberg, L. V. Fil'kov, and V. A. Tsarev showed that calculations performed within the framework of QCD suggest the formation of quark-gluon plasma at a temperature of ~200 MeV. The plasma state can be produced in nucleus-nucleus collisions at energies of a few tens of GeV per nucleon. The experimental implications of this were examined.

Problems in the spectroscopy of toponium (the bound state of t and $\bar{t}$ quarks) were discussed by I. M. Dremin who showed that comparison of energy-level calculations for different potentials with experimental data should enable one to distinguish asymptotically free potentials from all others. This was followed by a discussion of the rest mass of the free quark in which K. A. Ter-Martirosyan, A. A. Ansel'm, Dzh. L. Chkareuli, Z. G. Berezhiani, and G. M. Asatryan participated. Different estimates yield values for m_t in the range 20–180 GeV.

As on previous occasions, considerable attention was devoted to problems in field theory. D. V. Shirkov discussed the relatively complex connection between observed quantities and the basic parameters of QCD theory (such as invariant charge and the cut-off parameter Λ). In particular, he showed that Λ should change as the energy passes through the threshold for the creation of a new quark. The paper by M. I. Vysotskiĭ was devoted to a discussion of realistic supersymmetric theories of elementary particles. A. I. Vaĭnshteĭn considered possible supersymmetry breaking due to the instanton contribution. Dzh. L. Chkareuli pointed out in his paper the strong ν_μ-ν_τ neutrino oscillation predicted by the SU(5) model with horizontal SU(3) symmetry. Papers by G. K. Savvidi and by G. M. Asatryan were devoted to classical Mills-Yang mechanics. A. G. Ushveridze discussed a nonstandard convergent perturbation theory for field theory. E. V. Shuryak presented the results of a solution of quantum-mechanical problems by the grid method.

I. L. Rozental' discussed the connection between the numerical value of certain constants (ratio of the electron mass to the neutron-proton mass difference, etc.) and different stages in the evolution of the Universe. B. I. Luchkov reported on the present state of gamma-astronomy and its possible future development.

The seminars were run in parallel with a working conference on the mutual calibration of x-ray emulsion chambers and the ionization calorimeter, and the investigation of the muon spectrum, performed under the auspices of the Institute of Physics of the Academy of Sciences of the Georgian SSR and the Tbilissi State University.

The organizing committee for the school and conference, headed by D. M. Kotlyarevskii, deserves great praise for their excellent work. They succeeded in finding sufficient time for the examination and discussion of all controversial topics. The conference participants produced a written statement pointing out the importance of such meetings and putting forward suggestions for the future.

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