Twelfth All-Union School on "Nuclear Interactions at High and Ultrahigh Energies" (Bakuriani, Georgian SSR, January 15–23, 1987)

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The Twelfth All-Union School on Nuclear Interactions at High and Ultrahigh Energies was held in Bakuriani (Georgian SSR) from January 15 to January 23, 1987. Ninety-seven scientists from 15 institutes of the USSR Academy of Sciences, the Academes of Sciences of the Republic of the Union, the USSR State Committee on Applications of Atomic Energy, and the Ministry of Higher Education of the USSR participated in the school. Fifty-eight lectures and reports, including 19 at theoretical and experimental seminars, were presented at the school.

Nuclear interactions at high energies give rise to a wide range of problems—from the mechanism of elementary quark-parton interactions to the search for new phase states of intranuclear matter. Here the data from experiments performed on accelerators and in cosmic rays overlap. This determined the full and diverse program of the school. The schools and conferences in Bakuriani have for a long time been a unique source of information on work in high-energy physics performed during the previous year. Experiments in cosmic rays have given new experimental results on nuclear interactions. An extensive review of data from the Pamir experiment was given in reports by M. M. Roĭnishvili and G. B. Zhdanov. The investigations performed with the help of large-scale x-ray-emulsion chambers in the energy range 10^{15}–10^{16} eV showed that the cross section for particle production increases, scaling breaks down in the fragmentation region, the coefficient of inelasticity in interactions of hadrons with lead is large $k \approx 0.8$, and there are large fluctuations in the energy transferred through the π^0 mesons into the electron-photon component and into the hadron component (p, n, $\pi^{\pm}$, ...). Preliminary results obtained at energies above 10^{16} eV show that diffraction processes play a significant role, large amounts of energy are dissipated in interactions, multiaxial halos are aligned, and quark-gluon plasma can be observed. The data from the Pamir experiment and the results of a new analysis of the data from the Tskhra-Tskaro setup (D. M. Kotlyarevskiĭ, N. G. Dzhaoshvili, and I. V. Padiashvili) revealed the formation of semihard jets as a specific subprocess of interactions at high energies. According to the Pamir data, at energies of 10^{15}–10^{16} eV they equal about one-half the inelastic cross section and they determine the increase in this cross section, the increase in the average transverse momentum, and the breakdown of scaling both in p ionization and fragmentation regions. Comparison of these results with the UAI data, performed by N. N. Roĭnishvili, showed that the breakdown in KNO scaling, the correlation between the multiplicity and transverse momentum and other facts confirm the hypothesis of semihard jet formation.

The quantitative predictions of thereotical models were compared with the experimental data for interactions with nuclei by D. M. Kotlyarevskiĭ, M. G. Ryskin, and Yu. M. Shabel'skiĭ. Comparison of the distributions over the pseudorapidity obtained in the experiment at Tskhra-Tskaro in the energy range 0.1–5 TeV, with the predictions of the additive quark model (AQM), the active leader model (ALM), and the quark-gluon string model (QGSM) shows quite good agreement with AQM and QGSM in the fast part of the spectrum for energies above 0.4 TeV. In the region of p ionization the particle yield in the experiment was higher than predicted in the models. Preliminary results of the determination of the partial and full coefficients of inelasticity on different nuclei as a function of the interaction energy indicate that the rescattering of leading particles in the nucleus plays an appreciable role (D. M. Kotlyarevskiĭ). Comparison of the predictions of AQM and QGSM with the data from accelerator experiments on nuclei in the report by Yu. M. Shabel'skiĭ showed that the predictions of these models for a hydrogen target are indistinguishable, whereas for nuclei they sometimes disagree. Such studies are therefore important. For interactions of different hadrons with nuclei with momenta of tens of GeV/c electric charge transfer and baryon number transfer from one hemisphere into another plays a significant role. It is difficult to take these correlations into account in the models. The existence of such effects was predicted by L. N. Smirnova, whose report was devoted to the analysis of the characteristics of leading particles and correlations between regions of fragmentation for the example of $\bar{p}p$ interactions at a momentum of 32 GeV/c. Comparisons of hadron-nuclear interactions at 200 GeV/c show that additional cumulative nucleons, emerging from the nucleus, make a significant contribution.

The increase in the inclusive cross section in the central region necessitates changes in the rest of the spectrum (for $x \gtrsim 0.3$, for example). Scaling breaks down to the same degree in AQM and QGSM. Taking into account the increase in the average transverse momentum as a function of energy increases the extent of breakdown in scaling at the energies of experiments in cosmic rays (Yu. M. Shabel'skiĭ).

M. G. Ryskin showed that in experiments on the measurement of large transverse energies it is not so much the formation of jets but rather the intranuclear rescattering that is studied. The main question here is what is rescattered in the nucleus: the fast particle or slow partons. Comparison of calculations and experiment shows that both processes are observed.

B. Z. Kopeliovich studied the corrections due to inelastic scattering in nuclei. These corrections can make the nu-

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cleus both more and less transparent, depending on the specific interaction mechanism studied. The nucleus appears to be a "filter," transmitting hadronic flucutations of small size. As a proposal for UNK an experiment on coherent creation of hadrons with large $p_\perp$ was studied.

The current status of the search for a quark-gluon plasma (QGP) in collisions of heavy ions at high energies and in annihilation of antinucleons in heavy nuclei was examined in a report by L. V. Fil'kov. It was shown that spectrum of hadrons emitted from the QGP depends strongly on the method of hadronization of QGP. Under conditions of surface evaporation of hadrons s-quarks accumulate in the QGP drop. This changes the condition for the phase transition, and ultimately changes the spectrum of emitted particles. The proposed criterion for selecting strange and charmed baryons, emitted from the QGP, consists of vanishing of the polarization of these baryons in the corresponding fragmentation region.

Annihilation of an antinucleon in a nucleus can also be a source of hot matter with high baryonic density inside a heavy nucleus. O. D. Chernavskaya examined in her report the phase transition of QGP into a hadronic phase on the basis of the hydrodynamic theory of multiple particle production. It was concluded that the nonequilibrium mechanisms of hadronization, associted with supercooling, play the main role in the cooling of plasma that is not hot initially ($T_{in} \gtrsim T_c = 200$ MeV), which increases the average transverse momentum of secondary particles.

G. L. Vardenga showed that in separating central nucleus-nucleus interactions in an experiment the use of geometric models for evaluating the interval of realizable impact parameters in the search for QGP underestimates this interval, and the underestimation is all the larger the closer the mass of the colliding nuclei and the more stringent the criteria for "centrality" employed in the experiment.

It is impossible to construct a theory of the nucleus and nuclear forces based on the ideas of quarks and gluons without employing the results of experiments on deep-inelastic scattering by nuclei. The experimental status of the EMS effect and the results of the study of the nucleon structure function $F_2(x,Q^2)$ from deep-inelastic scattering of muons were discussed in lectures by I. A. Savin. The new measurements of the ratio of the values of F_2 for deuterium and iron targets in the kinematic region $0.06 \leqslant x \leqslant 0.70$ and 14 GeV$^2 \leqslant Q^2 \leqslant 70$ GeV^2 agree with previous measurements for $x > 0.3$. For $x < 0.2$ the measured ratio exceeds unity by approximately 5%. The results of the study of the nucleon structure function $F_2(x,Q_2)$ in the kinematic region $x \geqslant 0.25$ and $Q^2 > 25$ GeV^2 are based on $1.5 \cdot 10^6$ reconstructed events at energies of 120, 200, and 280 GeV. For diffeent beam energies $R = \sigma_L/\sigma_T = 0.015 \pm 0.013$ (random) ± 0.026 (systematic) irrespective of the value x in the region $0.25 < x < 0.7$ and 50 GeV$^2 \leqslant Q^2 \leqslant 150$ GeV^2. The kinematic region of these data is well suited for quantitative checks of quantum chromodynamics (QCD). For the case of the nonsinglet fit in second order the QCD scaling parameter $\Lambda_{MS} = 225 \pm 20$ (random) $^{+70}_{-60}$ (systematic) MeV.

Nuclear interactions are inextricably linked with processes in cosmic rays. In the last few years measurements of muon and photon fluxes at high energies have been attracting a great deal of attention. In a report by B. I. Luchkov, the pulsed signal from Cygnus X-3 in high-energy muons was explained based on the calculation of the decay of pions formed by cosmic rays in the upper atmosphere. It was shown that the signal can be imitated by cosmic rays and can appear as a result of the rising and rarefaction of gas in the upper layer of the atmosphere induced by the pulsed radiation from the source. The required energy flux must be at least 10^3 times greater than the x-ray flux from the source.

A complex installation is planned for the high-altitude Aragats station, within the framework of the ANI experiment, for recording both diffuse and local fluxes of photons with energy of 10^{12}–10^{16} eV. As shown in a report by R. M. Martirosov, the high-altitude installations are more advantageous than sea-level installations for studying showers of photons with energy 10^{14}–10^{16} eV.

A. A. Petrukhin presented a new method for spectroscopy of muons (parameter) with energy exceeding 10^{12} eV that can be employed in experiments using accelerators and in cosmic rays. The method is based on estimating the energy of muons from the e^+e^- pairs formed by them. The relative measurement error at asymptotically high energies is $\delta = (137/T)^{1/2}$, where T is the thickness of the setup in radiation units. To realize the method it is sufficient to record e^+e^- pairs with energy exceeding $10^{-3} E_\mu$.

A series of reports was devoted to the construction of an acceleration-storage complex at the Institute of High-Energy Physics (Serpukhov), the experiments planned on them, and the software for them (E. P. Kistenev, A. K. Likhoded, V. A. Nikitin, Yu. F. Pirogov, Yu. A. Belokopytov). A report that elicited active discussion was presented by S. I. Aiekhin. It dealt with systematization of experimental data in particle physics at the Institute of High-Energy Physics, primarily, with questions regarding the technology of coupling communication systems with information systems and systematization groups from other organizations.

M. V. Danilov reported new data on B mesons, obtained by the ARGUS and CLEO group. It turned out that the relative probabilities of a number of exclusive decays are an order of magnitude lower than previously thought. There is an indication that the average number of charmed quarks in B-meson decays is less than expected in the case when the ratio of the Kobayashi-Maskawa matrix elements $|V_{bu}|/|V_{bc}|$ is negligibly small. It is possible, however, that this problem is not related with B mesons, since even in e^+e^- annihiltion in the continuum the cross section for the production of D^0 and D^+ mesons is less than half of that expected for charmed particles. Existing experimental data do not permit proving that $|V_{bu}| \ll |V_{bc}|$. A number of theoretical uncertainties were neglected when the previously presented restriction $|V_{bu}|/|V_{bc}| < 0.11$ was obtained.

A modification of Heisenberg's model, based on classical ideas regarding the region of interaction of hadrons at high energies, was examined in a report by O. P. Yushchenko. Starting from the equations of relativistic hydrodynamics an expression was derived for the energy density in comoving coordinate systems, and a physically motivated eikonal amplitude for elastic processes was constructed. A good description was obtained for the data on the total and elastic cross sections and the cone inclination in a wide energy range.

The reports by theoreticians, as always, were distinguished by great diversity. They can be tentatively divided into five large groups: 1) collisions of hadrons at high ener-

gies; 2) vacuum QCD and hadron spectroscopy; 3) supersymmetry, supergravitation, and superstrings; 4) astrophysics and the physics of elementary particles; and 5) general questions concerning quantum field theory and quantum mechanics.

The largest number of reports was devoted to a subject that is traditional for this school: collison of hadrons at high energies.

K. A. Ter-Martirosyan showed in his report entitled "Equality of the growing parts of the total across sections for the interaction of hadrons and nuclei" that in the theory of the supercritical pomeron the total cross sections approach the Froissart limit $\sigma^{\text{tot}} = 2\pi a^2 \ln^2(s/m^2) + \ldots$ and the coefficient $2\pi a^2$ in the growing part is a universal constant; i.e., it is independent of the type of colliding particles. Numerical estimates give $2\pi a^2 \approx 0.5 \sim 0.6$ mb for $s^{1/2} \geqslant 10^3$ GeV. At ultrahigh energies, when the growing radius of the hadron $R = a \ln(s/m^2)$ is greater than the radius of the nucleus, the total cross sections for scattering of hadrons by the nucleus and nuclei by nuclei approach the same value $2\pi a^2 \ln^2(s/m^2)$.

L. A. Ponomarev studied the diffraction scattering of hadrons at high energies within the framework of the theory of the supercritical pomeron. It was shown that the theory contains a small parameter that enables calculation of the cross section of any diffraction process with preassigned accuracy. A description was obtained of the existing experimental data, and predictions were given for the energies attainable in cosmic rays and future accelerators.

Sh. S. Eremyan gave a review entitled "The critical pomeron," in which he made a comparative analysis of hadron-hadron interactions in theories with critical and supercritical pomerons. He showed that the basic chracteristics of binary interactions in both theories are vitually identical with one another in the entire range of achievable energies. In addition, hadron-hadron interactions were analyzed within the framework of the reggeon field theory with critical and supercritical pomerons and the theory of multiple scattering.

L. L. Enkovskiĭ proposed in his report entitled "Mechanisms for growth of hadronic cross sections" that a bare pomeron in the form of a double pole, located to the right of unity, with a nonlinear trajectory determined by the dual model, be employed. In the asymptotic regime, which is reached at energies $s^{1/2} > 10^{13}$ GeV, this model leads to universal growth of the total cross sections at the maximum rate. The contribution of the C-odd of the odderon pomeron partner to the total cross sections and the quark-gluon interpretation of the observed growth in the cross sections were also discussed.

B. Z. Kopeliovich gave a detailed review of the problem of calculating the inelastic corrections to the Glauber-Sitenko approximation for hadron-nuclear interactions. It was shown that for most nuclear reactions the corrections are large and the computational results are strongly model-dependent. Analysis of the experimental data leads to the conclusion that screening of color inside hadrons is observed and demonstrates an inconsistency with the orthodox model of quark components. In his second report B. Z. Kopeliovich analyzed the mechanisms of $\bar{p}p$ interactions at low and high energies.

M. G. Ryskin's lecture was devoted to the study of hadron interactions at high energies from the viewpoint of quantum chromodynamics. He demonstrated that the QCD perturbation theory makes it possible to explain all the basic features of hadron interactions at high energies—the growth of the total cross sections as $\sigma_{\text{tot}} \sim \ln^2 s$, growth of the interaction radius as $R \sim \ln s$, etc. It was emphasized that the multiplicity and average transverse momentum of partons grow according to the law $n \sim q_1^2 \sim \Lambda^2 \exp(2.5 \ln^{1/2} s)$ which justifies the applicability of QCD perturbation theory. In his report entitled "Events with large E_t on nuclei inclusive spectra of fast particles in hadron-nuclear interactions were discussed within the framework of perturbation theory. It was shown that the experimental data on the cross sections of events with a large transverse energy $d\sigma/dE_t$ in pPb collisions at 800 GeV and 200 GeV can be described well.

I. I. Roĭzen's report was devoted to exclusive structure functions of hadron constituents. He showed that if the independence of the valence constituents in a hadron is constrained only by the conservation of total energy, then an exact solution expressing the exclusive structure functions in terms of the inclusive structure functions of quarks and antiquarks in the meson and quarks and diquarks in baryons can be obtained.

I. M. Dremin proposed in his lecture entitled "Intermittency and fractality in multiple particle production" proposed a novel approach to hadron collisions at high energies. The main attention was devoted to clarifying the mathematical concepts of intermittency and fractality, which are not very familiar to particle physicists. Arguments were given supporting the fact that the high peaks observed in the distribution over the rapidities of secondary particles formed in hadron interactions at high energy are associated with the property of inermittency in the system. The fractality of the random walk of partons in this system is determined from the experimental data on the average multiplicity and inclination of the diffraction cone. It turns out to be quite high, and this supports the statistical-thermodynamic models.

The second group of reports was devoted to a less traditional subject—hadron spectroscopy and quantum chromodynamics. É. V. Shchuryak discussed the progress in the theory of the instanton vacuum of quantum chromodynamics.

The results of numerical experiments with an ensemble of instantons, including exchange of light quarks, were reported. It was shown that if the instanton density is high enough, a "polymer" phase with a nonzero quark condensate forms; if the density is low, a first-order phase transition into a "molecular" phase occurs.

L. V. Laperashvili examined in her interesting report entitled "strings and QCD bags" a model of a relativistic string as the limiting case of a stretched QCD bag. The mass spectrum of hadronic resonances with high spins was studied, taking into account the deformation of the surface of the stretched bags. It was shown that taking surface tension into account improves the agreement between the predictions of the model and the experimental data.

A. B. Kaĭdalov reviewed in a detailed report entitled "Physics of hadronic resonances" the present status of hadron spectroscopy. Several problems were examined. A new method for determining the quark and gluon composition of the resonances in two-particle decays of J/ψ was discussed. The classification of the existing resonances on the basis of

the quark model was examined. It was shown that the boson and baryon resonances lie on linear Regge trajectories, which are accompanied by daughter trajectories, and that for hadrons with masses $M > 1$ GeV there is some similarity to supersymmetry. The predictions of the model of quark-gluon strings for masses and widths of resonances consisting of heavy and light quarks were discussed. It was shown that many D^* and B^* states must be very narrow. The predictions of this model were examined for resonances consisting of diquarks and antidiquarks. It was shown that many resonances in $N\bar{N}$, $\Lambda\bar{\Lambda}$, and other systems lie on the corresponding $2q\text{-}2\bar{q}$ Regge trajectories.

I. M. Dremin examined in his report "Quarkonia and superatoms" the behavior of levels in atom-like systems with a sharp jump of the potential. Arguments were presented supporting the fact that such systems could be useful for understanding the properties of quarkonia and superatoms.

In his report entitled "Scalar two-quark mesons" E. P. Shabalin tried to calculate, with the help of the chiral effective Lagrangian for scalar and pseudoscalar fields with broken $U(3)\times U(3)$ symmetry, the mass spectrum of two-quark scalar mesons in terms of the masses of pseudoscalar mesons and the constants f_K and f_π. Arguments were presented supporting the fact that the $\sigma(980)$ meson is a two-quark isovector meson.

Sh. S. Eremyan and A. É. Nazaryan presented a report entitled "Quark-gluon mixing in pseudoscalar, scalar, and tensor mesons," in which they examined the model of mixing of $q\bar{q}$ and gluon states in η, η', and $\Upsilon(1440)$ (0^-) mesons; S^*, ε, $s^{*\prime}(1730)$ (0^+) mesons; and, f, f', $\theta(1690)$ (2^-) mesons. They obtained predictions for 110 two-particle decays with the participation of these particles. It was asserted in the report that 80% of $\Upsilon(1440)$ consists of gluonium, while $\theta(1690)$ and s^* are purely gluon states. The decays $J/\psi \to$ v, p, s, and T mesons were also studied.

Supersymmetry and superstrings were not as widely represented as at the previous school. Nonetheless the reports were very informative. In a lecture entitled "Current status of low-energy superstring supergravitation" K. A. Ter-Martirosyan reviewed the scaleless supergravitation (developed previously at CERN), following from the model of superstrings. Difficulties with the theory, associated with the idea of breaking of supersymmetry owing to the nonzero mass of gaugeons—suerpartners of gauge fields—were pointed out.

G. M. Dvali and Dzh. L. Chkarevli gave in a lecture entitled "Supersymmetry and generations of quarks and leptons" supersymmetric extension of the horizontal symmetry of generations—$Su(3)_H$. A superpotential was proposed for horizontal fields, which leads in a fully natural manner to the mass matrices of Fritzsch, for the top and bottom quarks with the experimentally observed hierarchy between their elements.

The remaining three reports were devoted to a more abstract subject—superinstantons. In a lecture entitled "superinstantons" M. A. Shifman explained, with great pedagogical skill (he received the prize for the best lecture at the school), using the simplest example of a field theory—the two-dimensional $O(3)$-σ model—what an instanton and its supersymmetric generalization—the superinstanton—are how to construct the superfield formalism, and what physical results can be obtained, in principle, with the help of this formalism.

V. A. Novikov explained in a report entitled "Superinstantons in an arbitrary Lie group" how one can construct the superspace of parameters of a superinstanton in supersymmetric gauge theories with matter. It was shown that the action of the superconformal group on this superspace and the invariant measure can be found. The supersymmetric models, in which superinstantons lead to full dynamic breaking of gauge symmetry and thereby give a nontrivial example of a field theory in the weak-coupling regime, were discussed in detail.

Ya. I. Kogan discussed in a report entitled "String superinstantons" nonperturbation effects in two-dimensional conformal field theory, describing the motion of a string in background fields. It was shown that instanton effects lead to effects that are nonanalytic in the tension parameter of the string α'. This is manifested, in particular, in the absence of full equivalence between the string theory and field theory. Instantons in the tree approximation of string theory were studied. It was shown how they can lead to generation of Yukawa vertices and effective potentials.

General questions concerning quantum field theory and quantum mechanics were discussed in several reports. D. D. Shirkov summarized in a lecture entitled "Renormalization group in different areas of physics" the proceedings of the "Renormalization group-86" conference held in the summer of 1986 in Dubna. The ideology and the method of the renormalization group in modern theoretical physics were discussed. A general viewpoint, employing a new concept of functional self-similarity, was developed based on a functional formulation of the group transformations. Based on it the different formulations of the renormalization group, employed in quantum field theory, the physics of critical phenomena, the theory of turbulence polymer physics, theory of radiation transfer and in other areas of physics were compared. Based on functional formulation of the group transformations

S. I. Sokolov presented a lecture entitled "Characteristics of the motion of particles in the front form of two-dimensional relativistic dynamics and constraints on the stiffness of a relativistic string." This study was performed together with A. A. Maĭorov and V. I. Tretyak. The motion of classical particles, bound by a direct relativistic interaction was discussed within the framework of Lagrangian dynamics in the front form and its Hamiltonian analog. It was shown that as the coupling constants increase, pathologies of the trajectory breaking type arise in the theory, tachyon regions appear, etc. The Hamiltonian formalism appears to be better suited for describing nonpathological systems. It was shown within the framework of the Lagrangian formalism that in the theory of a relavisivistic string there are constraints on the string stiffness, following from the condition that the velocity of sound in the string must be less than the velocity of light.

Two other reports were devoted to quantum machanics. A. V. Turbiner demonstrated that smooth variational trial functions giving high accuracy in the energy can lead to strong deviations in other quantities, in particular, in $\psi(0)$. He also proposed a simple criterion for constructing trial functions, which are close to the exact functions.

A. V. Turbiner and A. G. Ushveridze showed in their report entitled "Analytical structure of the coupling con-

stant plane" that for exactly solvable problems the coupling constant plane contains systems with branching points of the root type. Their appearance is associated with the crossing of different energy levels. The concept of quasiexactly solvable problems, in which a finite number of levels, crossing one another and not crossing other levels, are known, was introduced. The structure of singularities for nonlinear Schroedinger equation was studied. It was shown that in any N-particle sector there exist branching points of the root type in the coupling constant.

The high altitude of the school apparently explains the persistent interest of the participants in problems of astrophysics. A. D. Dolgov demonstrated in a report entitled "Island model of the universe" how one can understand astronomical data indicating that the distribution of baryonic matter in the observed part of the universe is spatially bounded. A model was proposed for such a universe, based on the hypothesis of spontaneous violation of C and CP invariance. The phase transition from the charge-even state to the charge-odd state occurs during the exponential inflation of the universe. Bubbles of the C-odd phase formed at this time expand up to dimensions of $\sim 10^{10}$ years. Ultimately baryon and antibaryon islands, separated by a sea of invisible matter, form.

M. Yu. Khlopov reminded us once again in a report entitled "Astrophysical methods for checking the theory of elementary particles" that astrophysical observations of the present day universe provide a unique possibility for studying physical phenomena occurring at the very early stages of the evolution of the universe and are inaccessible to investigation under laboratory conditions.

Less global, but no less interesting problems were discussed in the report by Z. G. Berezhiani and M. K. Vysotskiĭ entitled "Neutrino decay in matter." It was shown that the presence of dense matter can induce decay of a neutrino into an antineutrino and a majoranon α: $\nu \to \bar{\nu} + \alpha$. Off-diagonal transitions are also induced, in principle, together with diagonal transitions. The probabilities of such decays depend in a nonstandard fashion on the neutrino energy. The consequences of the transmission of neutrino beams from an accelerator through the earth were discussed.

Several reports do not fit into the proposed classification.

A. B. Kaĭdalov discussed the basic results presented at the Twelfth International Conference on High-Energy Physics, of which he was a participant. The following questions were examined:

1. The Darmstadt effect and the existence of the axion.
2. Experimental indication of $B^0 - \overline{B}^0$ mixing.
3. The physics of the neutrino and neutrino oscillations in the sun.
4. New data on W and Z bosons and $\sin^2\theta_W$.
5. Restrictions on the number of generations and masses of new particles.
6. Hard processes and QCD. New data on minijets.
7. EMS effect.
8. Superstrings.

A. A. Tyapkin's report was devoted to the history of physics. Information on attempts to explain the high probability of the time-irreversible transition from a nonequilibrium starting state to an equilibrium state for a statistical ensemble of systems consisting of many identical particles, whose motion strictly obeys the reversible laws of classical mechanics, was presented. It was shown based on the approaches of M. Smoluchowski and N. S. Krylov that at the microscopic level of a statistical description the probabilities for the forward and backward processes are always equal and that the asymmetry of probabilities arises in the macroscopic description only because of the indistinguishability of many microstates owing to the fact that the constituent particles of the system are identical, and not as a result of the rougher description of the spatial and momentum characteristics of the system.

There was general interest in a report by D. S. Chernavskiĭ on the problems of the appearance of life, biological evolution, and combinatorics. We did not succeed in fitting the content of this report into a brief review.

Unfortunately we were not able to mention all the reports and presentations given at the excellent school in Bakuriani, but the foregoing brief list of problems examined there shows that the work of the school proceeded in an intensive, busy rhythm. This is an undoubted credit to the organization committee of the school, which was able to tie together harmoniously a wide spectrum of reports, to make it possible for most participants of the school to be heard, and to maintain the traditional friendly and unconstrained atmosphere both at conferences and during the free time. All participants of the school are grateful to the organizers for the wonderful days granted to them by the school.

Translated by M. E. Alferieff