Seventh All-Union Workshop on Inelastic Interactions at High Energies, Bakuriani, Georgian SSR, (17–26 January 1980)

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After a one-year hiatus, the regular Seventh All-Union Workshop on Inelastic Interactions at High Energies was held at Bakuriani from January 17 through January 16, 1980. The workshop was organized by the Physics Institute of the Georgian Academy of Sciences at the Bakuriani base of the Tskhra-Tskaro Mountain Cosmic Ray Station. The Bakuriani workshop is unique among a number of others, being the only national workshop at which cosmic-ray and accelerator physicists meet. Cosmic-ray physics has not been rendered less important by the progressive increase in accelerator energies, and the opportunity to discuss shared problems and prospects for the development of inelastic-process physics makes the Bakuriani workshop equally interesting to the "cosmic people" and the physicists from the accelerator centers.

The Bakuriani workshop has traditionally had broad representation from all of the main scientific centers and scientific schools: The Georgian Academy of Science Physics Institute, Tbilisi University, the USSR Academy of Sciences Physics Institute (FIAN), the Institute of Theoretical and Experimental Physics (ITÉF), Institute of High-Energy Physics (IFVÉ), the Joint Institute of Nuclear Research (JINR), the Leningrad Nuclear Physics Institute of the USSR Academy of Sciences (LIYaF AN SSSR), the Nuclear Physics Institute of the USSR Academy of Sciences Siberian Division (IYaF SO AN SSSR), the Landau Institute of Theoretical Physics of the USSR Academy of Sciences (ITF im. Landau AN SSSR), the Physico-technical Institute of the Uzbekh Academy of Sciences (FTI AN UzbSSR), the Erevan Physics Institute (ErFI), and several other scientific establishments.

The workshop heard a total of 28 lectures and held seven theoretical seminars and 10 seminars in experimental physics.

Consistent with its subject area, the workshop concentrated its attention on hadron interactions at high energies. Traditionally, however, the range of problems open to discussion at the workshop has been very broad. Several lectures and many seminars were devoted to the physics of weak interactions, quantum mechanics and quantum field theory, dual models, nuclear physics and the physics of nucleus-nucleus collisions, and problems of experimental methods for accelerators and in cosmic-ray physics, astrophysics, and cosmology.

The hadron physics of extremely high energies was represented at the workshop by lectures on experiments in cosmic rays (G.V. Zhdanov, N.N. Roĭnishvili, D.M. Kotlyarevskiĭ). Roĭnishvili reported on the results of the "Pamir" experiment. The properties of extensive (EAS) and young (YAS) air showers were studied. The basic conclusion from analysis of the data: the standard scaling picture of the final states cannot be applied to hadron-nucleus interactions at energies above 10^{15} eV. That is, a) EAS develop in the atmosphere much more rapidly than scaling models would indicate; b) there are many more muons and far fewer hadrons at a given number N_e of electrons than are given by scaling-model calculations. Possible explanations: a) the cosmic rays are richer in heavy nuclei in this energy range; b) the total cross sections increase more rapidly than would be expected from extrapolation of accelerator data; c) the rate of energy dissipation into secondary particles is higher than that given by scaling estimates—the leading-particle effect vanishes and the height of the central plateau increases. Another indication of violation of scaling is the increase in the transverse momenta of the secondary particles; this was discussed in Zhdanov's paper on the structure of γ families based on data for the "Pamir" installation.

Kotlyarevskiĭ's lecture gave a detailed review of the physics of interaction of high-energy cosmic rays with nuclei. It must be stressed that the most complete set of data at above-accelerator energies has been obtained by none other than the Georgian physicists working at the Tskhra-Tskaro installation. Among the most interesting results, we note constancy or even a slow decrease of the normalized multiplicity $R_A = \langle n_S \rangle_A / \langle n_S \rangle_N$ with increasing energy. Also obtained were indications that the total cross sections of the interactions with heavy nuclei remain constant as the cross sections for the light nuclei increase.

Two theoretical lectures were also devoted to the interactions of high energy particles with nuclei (Yu.M. Shabel'skiĭ and N.N. Nikolaev). The main conclusion is

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that multiple processes on nuclei give important indications of additive behavior of the quark components in inelastic interactions. I.M. Dremin reported on a possible mechanism of Cerenkov radiation of pions in nuclear matter. If it exists, the effect cannot be the dominant pion-production process, since it leads to large pion transverse momenta. A lively discussion followed this presentation. G.A. Leksin presented a detailed review of data on the fragmentation of nuclei. The results of the first experiments with nucleus-nucleus collisions at the JINR were discussed at a seminar held by G.A. Vardenga. The data obtained thus far on multiple pion production can be described by independent nucleon collisions.

The quark model, and especially a very recent elaboration related to quantum chromodynamics, were widely discussed at the workshop. P.É. Volkovitskiĭ reviewed traditional applications of the additive quark model to peripheral hadron-hadron collisions. V.V. Anisovich gave a lecture on the implications of quark combinational analysis for multiple-production processes. Experimental confirmation of the predicted dominance of secondary-particle production via vector resonance is a major triumph of the model. A.B. Kaĭdalov showed in his lecture that secondary-particle production by a mechanism that extinguishes the color states that arise on gluon exchange results in the same final-state structure as that given by the dual topological expansion. The natural hypotheses as to the decoloring mechanism result in factorization in the s channel. For linear trajectories, these factorization relations give numerous sum rules for the particle masses that are very well satisfied indeed in experiment. Generalization of this picture of the interaction to hard processes and its relation to chromodynamic perturbation theory were also discussed. E.G. Gurvich's seminar discussed a concrete mechanism for decoloring and hadron production. Dremin's lecture examined modifications of the evolution equations of hard jets that simulate pionization effects—the production of slow particles on disintegration of the colored objects.

G.S. Iroshnikov's lecture and a seminar held by M.V. Ioffe were concerned with finding a more abstract approach to the relation between dual-string theory and quantum chromodynamics. The equations for the contours in quantum thermodynamics are found to be similar to the equations for dual strings, with the parameters of the chromodynamic vacuum admitting of a relation to the slopes of the Regge trajectories. Kaĭdalov's lecture on exotic baryons aroused great interest. The existence of resonances with isospin I equal to the spin J and larger than $5/2$ follows from the superconverging sum rules for scattering of reggeons by particles. Experiments were described that have indicated, albeit faintly, that such resonances exist.

A.I. Vaĭnshteĭn, who discussed mainly e^+e^- annihilation, and Ryskin lectured on traditional applications of quantum chromodynamics to hard processes. It is no longer doubted that quantum chromodynamics can be used to describe the production of particles with very large $p_t < 6$ GeV/sec. Still great difficulties remain when it comes to quantitative description of the range $p_t < 6$ GeV/sec, where it is very likely that corrections to the Born approximation will be important. Indications that the corrections will be large have been obtained, for example, in CERN experiments with production of heavy lepton pairs. The production of heavy particles in hadron reactions was discussed in a lecture by A. K. Likhoded. The production of heavy particles is also a hard process, and quantum chromodynamics can be used to estimate the cross sections.

The physics of multiple processes was discussed in lectures by I.D. Mandzhavidze, V.R. Garsevanishvili, and I.I. Roĭzen and at the seminars chaired by A.I. Golokhvastov and G.A. Vardenga. Mandzhavidze lectured on processes with extremely high multiplicities and possibilities for choosing between the usual multiperipheral and hard parton mechanisms of these processes.

A new approach to the problem of the spectrum in nonrelativistic quantum mechanics, in which it is not necessary to know the entire spectrum of the unperturbed problem in order to find the correction to a given level, was discussed at A.V. Turbiner's seminar. Lectures by S.M. Vilen'kiĭ (the theoretical aspect) and I.S. Tsukerman (review of experimental data on neutral currents) demonstrated that the basics of the Weinberg-Salam model have been fully borne out by experiment and that this model can indeed be regarded as the standard theory of the single electrically weak interaction. I.B. Khriplovich presented a paper describing a study of parity-violation effects in heavy atoms, which led to the discovery of a weak electron-nucleon interaction at Novosibirsk.

The various mechanisms of CP-invariance violation and their possible manifestations were discussed in a paper presented by E.P. Shabalin. Measurement of the electrical dipole moment of the neutron (e.d.m.) with accuracy better than 10^{-25} e·cm enables us to answer the question as to whether CP violation occurs as a result of spontaneous violation of symmetry in the Higgs-field sector (e.d.m. $\sim (1-3)\cdot 10^{-25}$ e·cm) or due to the Kobayaski-Maskawa mechanism (e.d.m. $\sim 10^{-34}$ e·cm).

A.A. Ansel'm lectured on various limitations on the masses to today's "truly elementary" particles. He stressed that the masses of as yet undiscovered intermediate bosons can now be predicted accurately: $M_W = 80$ GeV, $M_Z = 90$ GeV, and indicated a possible mechanism of spontaneous symmetry violation in weak interactions that involves strong interaction of quarks. If this mechanism is valid, the mass of the heaviest quark is $M_q = 50$–60 GeV.

Several lectures were devoted to astrophysical and cosmological problems. E.M. Alekseev reported on work done at the Baksan Notch neutrino observatory. On the gravitational collapse of a star, there is a short (~20 sec) but intense burst of neutrino radiation. It is estimated that the Baksan observatory should be able to register such bursts about once every 5 years. In his paper, A.D. Dolgov discussed limits on the properties of elementary particles as inferred from contemporary astronomical observations. For example, the mass of a stable neutral lepton is either <40 eV or >3 GeV, and

there are no more than four different types of neutrinos. Greater familiarity with these problems can be obtained by perusing the review that Dolgov and Ya.B. Zel'dovich published in this journal (Usp. Fiz. Nauk **130**, 559 (1980) [Rev. Mod. Phys. **53**, 1 (1981)].

V.V. Burdyuzh lectured on spectral features of the x-ray emission of neutron stars.

Note should be taken of the excellent organization of the workshop and, more to the point, of the extremely warm, open, and friendly atmosphere that traditionally prevails at Bakuriani. It enables the workshop's participants to discuss their newest projects and ideas without diffidence, even if they are still "in the rough."

Unfortunately, the presenters at the last workshop sometimes overworked this unique and valuable opportunity, fatiguing their listeners unnecessarily.

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