

## Workshop on the EHR experiment

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During 15–22 October 1984 a workshop on the program for the preparation of EHR experiment ("Earth-based Hadron Research") took place in the village of Nor-Amberd (on the slopes of Aragats mountain). In addition to representatives from the institutes—participants of the future experiment (ErFI and FIAN) (Erevan Physics Institute and Physics Institute of the Academy of Sciences) physicists from ITEF, MGU, MIFI, LIYaF, OIYaI, KhGU (Institute for Theoretical and Experimental Physics, Moscow State University, Moscow Engineering Physics Institute, Leningrad Institute for Nuclear Physics, Joint Institute for Nuclear Research, Khar'kov State University) also participated in the workshop. The principal items on the agenda were:

- 1) Questions of organization and methodology;
- 2) New experimental data;
- 3) New theoretical results.

É. A. Mamidzhanyan (ErFI) made some introductory remarks concerning the aims of the workshop.

The workshop began with the report by the director of ErFI, A. Ts. Amatuni. He reported on the tasks for the coming year (in particular, concerning the construction of a model EHR installation with an area of 250 m<sup>2</sup>), and on the plans for completing the construction work and putting the entire installation into operation (1990). After a detailed review of the situation on the construction in different countries of accelerators for superhigh energies the principal physics (including astrophysics) problems were enumerated which it is proposed to solve using the EHR installation under the conditions of intense "competition" with accelerators.

The principal characteristics of the EHR model being constructed were further discussed on the basis of a paper of V. A. Romakhin (FIAN).

The results of studying the reverse current in the ionization calorimeter (according to the data of the Aragats installation "Pion") were presented by V. V. Avakyan (ErFI). V. D. Volovik (KhGU) proposed a new form of a hadron calorimeter based on detection of neutrons. A proposal to construct a muon spectrometer (~100 m<sup>2</sup>) based on multiwire proportional chambers, recording e<sup>+</sup>e<sup>-</sup>-pairs from muons, was discussed by R. P. Kokoulin (MIFI). É. A. Mnatsakanian (ErFI) discussed the characteristics of the future magnetic muon spectrometer for the EHR with a working area of 40 m<sup>2</sup> and a maximum measurable momentum up to 3 TeV/c, and also discussed the basis of an original method of measuring the integral over the field of the magnet with the aid also of a muon telescope.

Data on the spectrum of primary cosmic radiation (taking the chemical composition into account) which are very

important for the future experiment were given by S. I. Nikol'skiĭ (FIAN). A formula of the form

$$F(\geq E) = 0,16E^{-1,61} [B_p (1 + 5 \cdot 10^{-4}E)^{-0,4} + \sum_A B_A (1 + 10^{-2}A^{-1}E)^{-0,4}] m^{-2} s^{-1} sr^{-1}$$

( $E$  — in TeV) approximates these data quite well.

In a different report S. I. Nikol'skiĭ presented preliminary data on the analysis of young extensive atmospheric showers (EAS) by measuring the flux density of the particles accompanying a hadron of a given energy. A conclusion was made concerning the "steepening" of the secondary hadron spectrum in the region  $x > 0.5$  ( $x$  is the Feynman variable) with an increase in the primary particle energy in the range  $10^{13}$ – $10^{14}$  eV.

S. A. Slavatinskiĭ (FIAN) gave a summary of the latest results of the "Pamir" experiment.

Interesting physical and methodological results within the program of the same Pamir experiment were given in the papers by L. E. Genina and L. G. Melkumyan (ErFI). In particular, Genina described in detail the amazing phenomenon of the "lining-up" of the cores of halos (spots of complete blackening of the film), while Melkumyan presented results of modelling of overlapping spots from  $\gamma$ -quanta in high energy families, which is important in introducing energy corrections.

V. I. Yakovlev (FIAN) discussed long-range avalanches observed in the large ionization calorimeter on Tyan'-Shan'. Calculations using kinetic equations (I. M. Dremine *et al.*) show that these showers can be explained by a noticeable formation of charmed particles (cross sections around 5 mb at collider energies).

In order to evaluate the possibilities and the problems of the future EHR experiment information is very important concerning the anomalous events with high transverse momenta observed at the Sp $\bar{p}$ S accelerator-collider at CERN, a review of which was given by A. Yu. Khodzhamiryan (ErFI). Also the purely theoretical approaches are important to the prediction of new types of particles of high mass (in particular, the Higgs bosons) on the basis of supersymmetric theories discussed in the review by V. A. Khoze (LIYaF).

Among the theoretical papers I would like to note the results of the LIYaF group (Ya. A. Azimov, Yu. L. Dokshitser, V. A. Khoze) reported by Dokshitser. Within the framework of QCD expressions have been obtained (without arbitrary parameters) for the spectra of hadrons born as the result of jets in the processes of e<sup>+</sup>e<sup>-</sup>-annihilation. These results agree well with the latest experiments at DESY (Hamburg).

New results were successfully obtained within the framework of QCD on the multiple production of particles by hadrons (including production on nuclei) in so called "semihard" jet processes with moderate transverse momenta ( $p_T \sim 1 \text{ GeV}/c$ ) as reported in the papers by E. M. Levin and M. G. Ryskin (LIYaF). It turned out, in particular, that this type of process can determine (at energies of  $\sim 10^{16} \text{ eV}$ ) the greater part of the inelastic inclusive cross section.

The phenomenological model of multiple production of particles by hadrons on light nuclei presented by B. L. Kan-evskii (NIIYaF MGU) turns out to be capable of describing approximately a number of "key" data obtained by different groups in studying EAS and at the same time does not contradict the predictions of the QCD-theory of semihard processes mentioned above.

The approach to the quantitative description of multiple production in hadron-hadron and hadron-nuclear collisions with small transverse momenta on the basis of concepts of a supercritical pomeron was presented in the papers by A. V. Kaĭdalov (ITEF) and Yu. V. Shabel'skii (LIYaF). In the presence of a relatively small ( $\sim 4$ ) number of "adjustable" parameters this model gives a good description and enables one to extrapolate up to super high energies ( $\sim 10^{16}-10^{17} \text{ eV}$ ) both the total and the inelastic interaction cross sections, and also the spectra of all the produced particles.

The proposals based on a brief review of the latest theoretical papers concerning a search for processes of formation of a quark-gluon plasma were presented by G. B. Zhdanov (FIAN).

A number of papers were devoted to calculations of nuclear-cascade processes in the atmosphere. In particular, A. P. Garyaka discussed the methodology of calculations developed by him with collaborators in ErFI and the first results on the spectra of hadrons and muons. A. M. Dun-

aevskii (FIAN) together with S. V. Pashkov carried out calculations of cascades taking into account the formation of QCD-jets including in the discussion the principal characteristics of  $\gamma$ -families obtained in the "Pamir" experiment.

A verification of the model of a supercritical pomeron (in particular, predictions concerning the degree of violation of scaling in secondary spectra) by means of calculations and comparison with experiment on the spectra of the electron-photon component (in the region of 5–10 TeV) was described in the paper by A. D. Erlykin (FIAN).

M. Z. Zazyan (ErFI) together with A. A. Chilingaryan gave a paper on the successful utilization of statistical methods of identifying images for a comparison with the data of x-ray emulsion cameras of the different models of nuclear-electron cascades in the atmosphere.

Finally, in the paper of R. A. Agaronyan (ErFI) a number of aspects of  $\gamma$ -astronomy were touched upon. The author presented his ideas on the verification of general concepts of contemporary models of the expanding Universe using observations of the spectra of  $\gamma$ -quanta of high energy (up to  $10^{15} \text{ eV}$ ) using installations of the type of EHR which give a detailed picture of the composition of EAS, and which enable one to distinguish EAS from  $\gamma$ -quanta associated with discrete sources, in particular those of an extragalactic nature.

According to the unanimous opinion of the members of the workshop a regular carrying out of such enterprises (of the type of autumn schools) in subsequent years will produce very useful results in order to increase the efficiency of preparation and realization of such a large scale project as the EHR.

Translated by G. M. Volkoff