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New technique and results of cosmic ray investigations in the energy interval 10ˆ15 –10ˆ19 eV

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New technique of EAS investigations by means of the method of local muon density spectra (LMDS) is developed. Application of this method to investigations of inclined EAS allows exploration of CR energy interval from 10ˆ15 to 10ˆ19 eV by means of a relatively small detector with area ˜100 mˆ2 due to very strong dependence of EAS muon density on zenith angle. During 2002-2007, long-term NEVOD-DECOR experiment (about 20 thousand hours) was conducted and more than two million muon bundles in zenith angle interval 30 –88 degrees were registered. Comparison of experimental data with results of CORSIKA simulations showed that the new method is sensitive to all main peculiarities of CR energy spectrum: the knee, increase of the energy spectrum slope with energy, the second knee. But the observed progressive excess of muon bundles with increasing primary CR energy in comparison with simulations (even for pure iron composition) indicates the appearance of new processes of muon generation. This result, together with observations of numerous unusual events and phenomena in various CR experiments –halos, alignment, penetrating cascades, long-flying component, large transverse momenta, Centauros, excess of VHE (˜ 100 TeV) single and multiple muons, etc. –can be explained in frame of a single model if to suppose the production of blobs of quark-gluon plasma with large orbital momentum in nuclei collisions. This hypothesis drastically changes all cosmic ray physics at energies above the knee and interpretation of the results of all experiments at these energies. The correctness of this hypothesis can be checked both in LHC experiments and in CR investigations. At that, CR experiments have some advantages in comparison with LHC experiments, since the main signature of new processes are muons which will have energies ˜ 100 TeV in cosmic rays and about several tens GeV in LHC experiments. It is difficult to separate such muons from particles produced in usual processes. Preliminary results of CR muon energy spectrum measurements (BUST in Russia and IceCube in Antarctica) exhibit a noticeable excess of muons with energies > 100 TeV, which evidences in favor of the new model of hadron interaction. In this case, for correct investigations of EAS, the experimental arrays must be supplemented by detectors which can measure or evaluate the energy of muons.

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