Report on the project «Theory of Hadronic Matter under extreme conditions»

The project is devoted to theoretical studies of QCD under extreme conditions. Many groups around the world are working in this direction. This is an important subject for the theoretical research in view of current and future heavy ion collisions experiments at RHIC, LHC, NICA, FAIR as well as astrophysical observations. It is believed that the quark-gluon matter created in these collisions is described by QCD at finite temperature, finite baryon density, affected by strong external magnetic field and subjected to relativistic rotation.

Numerical simulations of Lattice QCD are recognized as the most powerful approach to studies of the nonperturbative properties of QCD using first principles of the quantum field theory. It is worth to mention one relevant result of Lattice QCD: the chiral transition (crossover) temperature at zero baryon density is 156(2) MeV. This powerful approach is used in the proposed project to accomplish the formulated tasks.

The studies are planned in a few directions, some of them are completely new and very promising. It is known that a strong external magnetic field significantly changes the properties of QCD. In particular, the chiral transition temperature value is changed. It is planned to compute the QCD equation of state in N_f=3 Lattice QCD at nonzero baryon density and nonzero external magnetic field. The infamous 'sign' problem of Lattice QCD simulations at nonzero baryon density will be bypassed by employing simulations at imaginary chemical potential with subsequent analytical continuation to real chemical potential values.

Another direction of the proposed research is investigation of the the influence of rotation on the properties of the quark-gluon matter. The group has obtained recently the very first results in this direction of research and extension of this research to more realistic case (e.g., smaller quark masses) is proposed. The effects of the rotation on the equation of state, the chiral and deconfinement transitons temperatures will be estimated.

It should be emphasized that the group has completed very successful work on simulations of Lattice QCD in the last few years and the proposed project is a continuation of this successful work. The cooperation with other groups in Russia and Italy is planned which is also very important for the success.

In conclusion, I strongly recommend to support the proposed project.

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