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#### Report on the new theme

"Theory of Complex Systems and Advanced Materials"(2019 – 2023)

Leaders: V.A. Osipov and A.M. Povolotsky

The scientific program of the proposed theme aims at the further development of analytical and numerical methods for studying complex many-body systems that are of great practical importance. It addresses also the development of mathematical methods for investigation of models of advanced materials. A significant part of the planned research has an interdisciplinary nature, being at the intersection point of modern condensed matter physics and statistical mechanics with the physics of atoms and nuclei, biophysics and quantum computation. I think it is promising also to continue the study of high-temperature superconductivity in cuprates by using the non-perturbative Green functions method, as well as the quantum Monte Carlo simulations, which are developed in the BLTP.

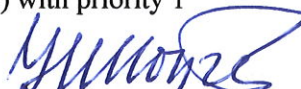
With big satisfaction I note the study of low-dimensional nanostructures and nanomaterials. We, in Bulgaria, develop similar projects on the synthesis, experimental and theoretical studies of graphene nanostructures. Thus, an important area for our cooperation opens, the significance of which is due not only to the fundamental nature of the physical properties of such systems, but also to the practical need for the creation of advanced electronic devices for storage, processing and transmission of information, for sensors and biosensors. A special attention is paid to the sensors based on graphene with attached biological molecules which increase the selectivity and sensitivity of the sensor.

Remarkably, the achievements of the Bogoliubov scientific school in statistical mechanics will be actively used and enriched with methods for rigorous solution of new problems in both equilibrium and non-equilibrium statistical physics. In the field of nonlinear many-body theory, investigations of stochastic models of non-equilibrium driven lattice gases, exclusion processes with generalized interactions, zero-range and avalanche processes are planned. The fluctuations and correlations in the arising low-dimensional particle flows often reveal universal properties. In addition to the studies of models, a major attention will be paid to the development of mathematical methods related to the theory of integrable systems, theory of phase transitions and conformal field theories. The structure properties of quantum matrix algebras will be investigated, the differential geometry of quantum matrix groups will be developed. The results in that direction will contribute to the disclosure of universal laws governing the behavior of complex systems.

A favorable feature of the proposed theme is that a substantial part of the research will be carried out in collaboration with the Laboratories of Neutron Physics and Information Technologies of JINR, the Institute of Semiconductor Physics of the SB RAS, as well as with collaborators from the member countries. In general, the proposed plan of investigations can be highly appreciated. The main team of researchers from the BLTP is highly qualified, well known to the scientific community by their reports at international conferences and publications in leading scientific journals.

In conclusion, I strongly recommend the approval of the proposed theme "Theory of Complex Systems and Advanced Materials" for the next five years (2019 – 2023) with priority 1

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/N.S. Tonchev, Prof., D.Sc./