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Poster abstract	Remarks

1. Solving the Optimization Problem for Designing the Pulse Cryogenic Cell

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Solving the optimization problem for the characteristics of the thermal source of a cryogenic cell, i.e. a multilayer cylindrical sandwich-type configuration designed for a pulsed dosed injection of the working substance into the ionization chamber of the source of multiply charged ions, is considered. To solve the optimization problem, we have developed the MPI+OpenMP hybrid parallel calculation algorithm based on the brute force method to search for the maximum of the integral of proportionality to the volume of gas evaporated from the cell surface. The algorithm leads to multiple solutions of the initial boundary value problem for the heat equation, which is solved numerically by the alternating direction implicit method (ADI). A method of simple iterations with an adaptive time step is implemented to solve nonlinear difference equations. The solution of the optimization problem for a specific cell configuration on the GOVORUN supercomputer has demonstrated a ten- to hundredfold acceleration of the calculations.

2. Parallel simulation of the magnetization reversal phenomenon in the φ_0-Josephson junction

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A model of the φ_0-Josephson junction in a system “superconductor – ferromagnetic – superconductor” with direct coupling between the magnetic moment and the Josephson current is studied by using the implicit two-stage Gauss-Legendre algorithm for the numerical solution of the respective system of equations. In this framework, the effect of the full magnetization reversal is investigated in a wide range of parameters of the model. With this aim, a parallel MPI/C++ computer code has been developed. Its efficiency is confirmed by the calculations, which have been carried out at the Heterogeneous Platform “HybriLIT” of the Multifunctional Information and Computer Complex of the Laboratory of Information Technologies, JINR (Dubna).

3. Investigations of polystyrene-fullerene nanocomposites thin films by neutron and X-ray reflectometry

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Thin polymer films have numerous technological applications in various industrial and biomedical sectors related to protective and functional coatings, non-fouling biosurfaces, biocompatibility of medical implants, separations, advanced membranes, microfluidics, sensors, devices, adhesion, lubrication and friction modification [1]. In many cases, the films can be of complex composition with different types of polymers with complex architecture and other components such as nanoparticles. Polymers in thin films and nanocomposite structures can exhibit unusual physical properties due to the geometric constraints imposed by the presence of surfaces and interfaces. Polystyrene-fullerene films present a suitable model system for investigation of these properties. Neutron reflectometry has proved to be an effective method for studying PS/C_{60}, allowing evaluating the structural peculiarities of nanoparticles ordering in the polymer matrix [2].

We report the reflectometry investigations of structural organization and glass transition of thin films of polymer nanocomposites. Neutron reflectometry was performed at the GRAINS instrument of the IBR-2 reactor (Dubna). X-ray reflectometry was also performed in Dubna. First, we model the neutron reflectometry experiments on a thin film of polymer-fullerene nanocomposite [3]. Several physically based models of structural organization of the nanoparticles in polymer matrix are considered – a uniform distribution, a dense substrate layer, a layer on the surface of a polymer. The calculations show that it is possible to apply reflectometry for clarifying the structural organization of nanoparticles in the nanocomposites with the mass concentration of fullerenes exceeding 1%. Next, a series of films witch fullerenes C_{60}/C_{70} concentration of 1%, 3% and 5% were investigated experimentally. After fitting the data by different models of inner films structure, we compare the organization of spherical fullerenes C_{60} and ellipsoidal fullerenes C_{70} in similar films.

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4. Distributed information and computing environment of JINR Member State organizations

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The integration of JINR Member State organizations' resources in a unified distributed information and computing environment is an important and topical task, the solution of which would significantly accelerate scientific research. This paper describes the distributed cloud infrastructure deployed on the basis of the resources of the Laboratory of Information Technologies of the Joint Institute for Nuclear Research (JINR) and some JINR Member State organizations, explains the motivation of this work, the approach it is based on, gives outline plans for using the created infrastructure.

5. Describing quantumness of qubits and qutrits by the Wigner function's negativity

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According to modern views, the Wigner quasiprobability distribution, or simply the Wigner function, provides a qualitative information on many quantum phenomena occurring in diverse physical systems [1].

The Wigner function has all the properties of statistical distributions except one: taking negative values for some quantum states, the Wigner function turns to be not a proper distribution, and hence it indicates the existence of truly quantum features which cannot be described within the classical statistical paradigm. The deviation of the Wigner quasiprobability distribution from a proper statistical distribution of a physical system is interpreted as an evidence of non-classicality, or quantumness. In our report, based on the recently elaborated method of construction of the Wigner function of a finite dimensional system [2, 3], we will discuss the following measures/indicators for quantification of non-classicality of a finite-dimensional system:

1. The negativity probability defined for an arbitrary ensemble of a random quantum state as the ratio of the number of states with negative Wigner functions to the total number of generated states.
2. KZ-indicator introduced by A. Kenfack and K. Zyczkowski [4] and defined as an integral over the phase-space manifold of the absolute value of the Wigner function.
3. Global indicator of non-classicality defined as the ratio of the volume of orbit space of a state space with the non-negative Wigner function to the volume of total orbit space. It is assumed that the volume is calculated with respect to the Riemannian metric induced by mapping of a state space to the orbit space.

All the above mentioned non-classicality measures will be exemplified by considering the Hilbert-Schmidt ensemble of qubits and qutrits.

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6. Data management system of the UNECE ICP Vegetation Program

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The aim of the UNECE International Cooperative Program (ICP) Vegetation in the framework of the United Nations Convention on Long-Range Transboundary Air Pollution (CLRTAP) is to identify main polluted areas of Europe, create regional maps and further develop the understanding of the long-range transboundary pollution. The Data Management System (DMS) of the UNECE ICP Vegetation consists of a set of interconnected services and tools deployed and hosted at the Joint Institute of Nuclear Research (JINR) cloud infrastructure. DMS is intended to provide its participants with a modern unified system of collecting, analyzing and processing of biological monitoring data. The general information about DMS and its abilities are presented.

7. Multifunctional platform for plant disease detection

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The increasing number of smartphones and advances in the deep learning field open new opportunities in the crop disease detection. The aim of our research is to develop a multifunctional platform that uses modern organization and deep learning technologies to provide a new level of service to the agricultural community. As a product, we are going to develop a mobile application allowing users to send photos and a text description of sick plants and get the cause of the illness and its treatment. We have collected a special database of grape and wheat leaves consisting of ten image sets. We have reached 93% accuracy in the disease detection with a deep siamese convolution network. We have developed a web portal with a basic detection functionality and provided an opportunity to download our self-collected image database. The general information about the platform and its abilities are presented.