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Electromagnetic effects on strongly interacting QCD-matter

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We present a systematic analysis for the electromagnetic properties of QCD matter under extreme conditions of high temperature and density in finite magnetic and electric fields. The possible influences on hadron-quark phase transition(s) and QCD equations of state are determined from Polyakov linear sigma model (PLSM). We also calculate the electric conductivity and the viscous properties by means of Green-Kubo correlation and Boltzmann master equation with Chapman-Enskog expansion.

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developing new non-invasive biomarkers for liver fibrosis

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Liver diseases are a worldwide challenge. It is among the leading diseases that has high mortality and morbidity. There are many causes, however, the danger is that the liver becomes so damaged that it can no longer function adequately. Whether the insult is a viral infection, chemical injury, or immune-related, liver disease follows a slow and steady progression. Early stage liver disease is characterized by inflammation, which if left untreated, can cause scarring and fibrosis. A healthy liver is capable of repairing and regeneration, but when there are architectural changes to the tissue, the damage can no longer be reversed. Biopsies are routinely conducted to diagnose liver fibrosis and cirrhosis. Undergoing this invasive procedure involves significant abdominal pain along with the risk for complications and sampling error.
Therefore, many patients are reluctant to have a second biopsy even when it is medically advisable. The goal of this proposal is to develop a specific and sensitive biomarker(s) that is highly associated with liver fibrosis and giving predictions of
possible development of hepatocellular Carcinoma. Various techniques have been used including protein imaging, RNA sequencing and profiling.

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Characterization of Fatigue crack Response 3D Molecular dynamic simulation

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Fatigue crack response was evaluated using an 3D Molecular dynamic simulation in a structural mettalic nanowiers and alloys to study the elastic, elastic- plastic response of the nanowiers and alloys. Alternative resistance measures would be "steady state" fracture propagation energy, critical fracture strain and adoption of damage mechanisms. The presence of periodic thermal planar defects in the long-period nanostructure (combined thermal anti-phase boundaries) significantly affects the onset of plastic deformation. young's modulus, Yield stress, Yield strain and poisons ratio were studied for different size and temperature.This paper focuses on modeling approaches for crack propagation using damage mechanisms. The tension test is used to "calibrate" the damage model parameters and applied to the crack propagation in a 3-point bend specimen in mettalic nanowiers and alloys. The limitations and an approach to overcome the difficulties will be evaluated.

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Influence of the potential difference on the structural and conducting properties of Fe / Ni nanotubes

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Two-layered structure takes special place among the magnetic nanomaterials. Attention to them is attracted due to the discovery of their huge isotropic magnetoresistance effect. One possibility of increasing the amount of the magnetoresistive effect is producing a multilayer structure in the form of nanostructures in the form of hollow cylindrical tubes. For nanotubes the geometry of magnetoresistive effect is realized when an electrical current is perpendicular to the interfaces between layers, or the magnetic domains in two-component structures, that can not be implemented in multilayer films with a planar geometry. In case of nanostructures conduction electrons are forced to cross the magnetic layers with periodically antiparallel direction of magnetic moments generated by domain structures, which leads to an increase in scattering effect as compared with multilayer flat films. One of the most promising materials are iron / nickel alloy based nanotube because of their excellent magnetic properties and high magnetization.

In this paper we investigated the dependence of the phase composition on the applied potential difference Fe / Ni based nanotubes produced by template synthesis, as well as changes in the conducting properties on the elemental composition. PET track membranes of thickness of 12 microns, and pore density of 1.0E + 09 pore / cm2 and a diameter of 110 ± 5 nm were used as templates. The range of potential difference is from 1.0 V to 2.0 V, with a step of 0.2V. The control of the electrodeposition process was carried out by chronoamperograms, according to which the volume rate of deposition was calculated, which allows you to control the value of the geometric parameters of the growth of obtained Fe / Ni based nanotubes. With the increase in the current density by increasing the potential difference across the electrodes there were observed an adsorption on the cathode of hydrogen impurities, salt anions, hydroxide molecules, some of which precipitates on the surface of the membrane, whereas the rest part is included in the crystalline structure of nanotubes. Thus the inclusion of impurities affects the conductive properties due to the deformation of the crystal lattice. It has been shown that increasing of concentration of iron as well as impurities in the structure of the nanotubes results in decrease of conductivity.

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H-Utils package: set of libraries allowing simplification of program writing on the heterogeneous cluster HybriLIT

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The user own software development with the aim at carrying out massive computations that require different computational accelerators such as GPU, Xeon Phi and others is becoming more and more popular among the staff of JINR and of JINR Member-States. The H-Utils [1] package, which was recently developed in LIT for the HybriLIT [2] users, provides a useful tool enabling easier design of parallel applications by the users. Specifically, it allows the users to: dynamically set input parameters; generate logs; interact with the launched task. The package includes a number of libraries which facilitate the solution of difficulties that the developers are often faced while creating program complexes in the fields of physics, chemistry, biology, etc. on high performance computational platforms. The H-Utils package enables the user to solve the following tasks:
- to dynamically change input parameters that include the possibility to transfer data arrays of various types;
- to provide utilities to save data about events and errors in files (log file) with automatic indication of the current time and dynamic setting of the input log level;
- to control interactively with the launched task;
- to interact remotely with the launched task.
While the primary destination of the package is the work on the heterogeneous cluster HybriLIT, it can be used for work on other clusters that have common disk space.
H-UTILS package is available for use and it is included to JINRLIB [3].
[1] H-UTILS storage in Gitlab. URL: https://gitlab-hybrilit.jinr.ru/aleksand/h-utils
[2] HybriLIT Cluster. URL: http://hybrilit.jinr.ru/
[3] H-UTILS page in JINRLIB. URL: http://wwwinfo.jinr.ru/programs/jinrlib/h-utils/index.html

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NOνA test bench at JINR

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The main goal of the NOvA experiment is to study oscillation parameters in the neutrino and antineutrino beams: measurements of the mass hierarchy and CP-violation phase in the lepton sector. Two identical highly-segmented detectors based on PVC-tubes filled with a liquid scintillator to detect signals from muon and electron neutrinos were built. Masses of each are 300 and 1400 tons. Avalanche PhotoDiode is a core element of the detectors to measure signal response. Total amount in the large Far Detector is 344064. The NOvA test bench was made at JINR for studying native NOvA electronic responses through APD and FEB chain. The bench was used to perform investigations for physical signals in the detectors also. In this work we are presenting the NOvA-JINR bench results which show signal shaping studies, simulation of the electronic response on hypothetical magnetic monopole's signals and other required to do simulations and precise measurements of the events' energy.

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Studying of zonal characteristics of PMT

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The JUNO experiment requires a huge ammount of PMTs because required sensitivity may be achieved by maximazing collection efficiency. That's why the mass testing techniques have to be developped. The integral characteristics of PMT, which are made faster and easier, are less sensitive to variations in the zonal characteristics of the photocathode. The differential measurements may be used as a cross-check for the integral ones. The theoretical calculation of the number of photons absorbed in photocathode was made taking into account Fresnel coefficients between media with differing refractive indices.

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Self-similarity of cumulative particle production in proton-nuclear collisions at high energies

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Experiments at Relativistic Heavy Ion Collider (RHIC) have showed evidences of the new state of nuclear matter existence, which is close to perfect liquid by it's characteristics. One of the main
goal of physical programs at present (RHIC, LHC) and future (NICA, FAIR) colliders is to meet experimental criteria for obtaining this new state of matter investigate it and determine properties of the
system at high temperatures and baryonic densities. Scaling laws are widely used for description of processes near phase boundary. In scaling theories one assumes the system near respective critical
point should behave in a self similar manner: same laws at different scales. There are different scaling laws used in nuclear physics: Feynman scaling, P-KNO scaling, quark counting rules etc.
In present work method of z-scaling is used to describe charged hadron production in p+A collisions. This method is based on fundamental principles of locality, self-similarity and fractality of
constituent interaction. In this model momentum particle spectra are expressed with dimensionless function Ψ, dependant on one scaling variable z. This method is suggested to searching for phase
transitions in nuclear matter. Clear signatures of new phase would be fluctuations increase or discrepancy in fractal dimensions (parameters of the theory).
Experimental data in proton-nuclear collisions taken at FNAL and U70 accelerators with different kinematics were analyzed. Special interest was paid to cumulative processes which take part only in
kinematical area forbidden for free nucleon-nucleon collisions. Data taken at such processes were then compared with non-cumulative ones.

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Numerical Modelling of Eddy Current Non-Destructive Evaluation in Material Defects Detection Studies

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This paper proposes an approach to evaluate the detection possibility and characteristics of material defects using numerical modelling, together with characterizing the capability and reliability of using eddy current non-invasive inspections.
Eddy-Current (EC) inspection represents an essential method for the electromagnetic non-destructive detection/evaluation (NDE) of cracks in conductive materials, with its main applications being found in the examination of aircraft, particle accelerators, and other engineering constructions. The method is based on the detection of the magnetic field produced by eddy currents induced in the specimen being tested. The presence of a crack disturbs the flow of the eddy currents, thus producing a magnetic field perturbation dependent on the position and shape of the defect itself. Variations in the electrical conductivity and magnetic permeability of the test object material, and the presence of defects in the object causes a change in eddy current and a corresponding change in phase and amplitude that can be detected by measuring the impedance changes in the magnetic field generating coil, which is a telltale sign of the presence of defects.

The NDE methods are characterized in a statistical manner by probability of detection (POD) assessments. The result will be different when evaluating different materials, geometries, defect types and also by the specified procedure settings.
The nature of the method is complex and there is therefore a need for deeper understanding that may be gained from mathematical models. Such models can have several objectives as for example procedure and equipment optimization or understanding of the method capability and reliability.

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Algorithm and simulation of heat conduction process for design of a thin multilayer technical device

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A model of multi-layered cylindrical device with a non-trivial computational domain and nonlinear thermodynamic properties of materials at cryogenic temperatures is considered. This model describes so-called cryogenic cell designed for pulsing working gases into the multiply charged ion source chamber. The main requirement for operation mode of the cryogenic cell is the periodically opening and closing the valves for injecting gaseous substance in the millisecond range. A model implementation of the previously proposed idea of the temperature valves is realized, when the valve closing is ensured by freezing gaseous substance on the outer surface of the cell, and the opening of the valves is provided by heating of the surface of the cell to the desired temperature when the required vapor pressure achieved. The surface is heated by passing a pulsed electrical current through one of the conductive layer of the cell. The numerical algorithm for simulation of the thermal evolution with time-periodic source is developed, which was implemented in the OpenCL language for calculations on graphics processing unit. The algorithm makes possible the further optimization of the design of the cryogenic cell. The calculations were done on heterogenius cluster HybriLIT.

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Dosimetric Study on Ten Different Commercial Glass Objects Using ESR Technique

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Electron spin resonance, ESR, has been extensively used as an investigative tool for the study of radicals formed in solid materials, since these radicals typically produce an unpaired spin on the molecule from which an electron is removed. Study of the radicals produced by radiation gives information about the locations and mechanisms of radiation damage. Also, ESR has a great potential for radiation dosimetry. The study of stable paramagnetic centers created by radiation in solids has proven to be extremely useful for radiation dosimetry purposes. Dosimetric assesment is important at high dose level areas. For this purpose, commercial glass samples were investigated, widely used in everyday life, such as bottles of beverages, mirrors, window glasses, glass mugs, etc. Glass dosimeters are important dosimeters for high dose-levels e.g. in sterilisation of medical devices, food processing, nuclear power plants etc. In all these fields, it is vital to measure and control the radiation. In this study, ten different glass samples were used. Most of the samples were not totally transparent, but colored. All samples were gentle crushed and subsequently sieved. Coarse grains in the size fraction of 80-140 μm were selected. For all samples, mass was 7.5 mg. Structural state characterization was performed by applying X-ray diffraction (XRD). The corresponding g-values were identified. Linear dose response curves were yielded. Also fading study was performed. For this study, all samples were stored in the same conditions (in dark at room temperature) for 30 days. Promptly after irradiation and 30 days later, ESR signal changing was monitored.

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The scalar field potential distribution for a closed radially expanding null string with axial symmetry

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Study of dynamics of test null strings in the gravitational field of a closed null string with constant radius [1], carried out in [2] as well as in the gravitational field of a closed null string radially expanding or radially collapsing in the plane carried out in [3], allows to assume the possible existence of a number of fundamental interest from the cosmological point of view, properties of the null string gas.

For example, it was noted that the presence of the test null string only «narrow» field («interaction zone»), being in that test null string can communicate with null string generating the gravitational field can speak about the feasibility of «granular» structure of the space filled with null string gas. Available abnormal areas of the trajectory for every test null string caught in a «zone of interaction» on which the test null string for a very short period of time, or rapidly pushed to infinity, or rapidly attracted from infinity, confirmed, indirectly, by the hypothesis of the possible of string nature of mechanism of inflation of the Universe, proposed in [4]. Analysis of the solutions of the equations of test null string motion given in [1,2] also demonstrated the feasibility of sustainable polarized states (phases) of the null string gas, as well as the possibility of formation of the domain structure in a space filled with null string gas.

An important extension can be a study the influence of closed null string on the properties of its gravitational field, and it was given the task of finding a solution of Einstein's equations for a closed radially expanding null string with axial symmetry, where the symmetry axis (z-axis), in general, it may be a symmetry axis of order.

In a cylindrical coordinate system functions that determine the trajectory of (global surface) closed null string this problem, have the form

$t=\tau$, $\rho=\tau$, $\theta=\sigma$, $z=Z(\theta)$, $\tau \in [0,+\infty)$, $\sigma \in [0, 2\pi]$,

where τ and σ the parameters of the global surface of null string. Function $Z(\theta)$determines the shape of null string and satisfies a number of conditions related to the symmetry of the problem.

The study presents a general view of the distribution of scalar fields "smeared" closed radially expanding null string with axial symmetry. The conditions under which in the limit compression of the scalar field in one-dimensional object, the components of energy-momentum tensor of the scalar field asymptotically coincide with the components of the energy-momentum tensor of a closed null string moving along the same trajectory. An example of the distribution of the scalar field satisfying the conditions found. The next stage of the proposed work will be the integration of the Einstein equations found for the distribution of the scalar field and the analysis of the influence of closed null string on the properties of its gravitational field.

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Development of methods for scintillation counters calibration in the HyperNIS project

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The trigger system of HyperNIS project is built on scintillation counters. Methods based on LED sources are used to evaluate the trigger efficiency and the counters calibration.

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Determination of distribution coefficients (Kd) of Ge-68 on ion exchange resin

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Distribution coefficients of Ge-68 were obtained on Dowex 1x8 resin, 200-400 mesh, Cl- -form. The elution solutions were mixtures of different concentrations of oxalic acid and hydrochloric acid

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Analyzing power of inverse diproton photodisintegration at intermediate energies

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The reaction $ \gamma + \{pp\}_{s}\rightarrow p+p$, where diproton $\{pp\}_{s}$ is a proton pair in $^{1}S_{0}$ state, is a spin-isospin partner of the fundamental reaction of deuteron photodisintegration. The inverse reaction, the hard bremsstrahlung $p+p\rightarrow \gamma + \{pp\}_{s}$, has been observed with the ANKE spectometer at COSY-J\"{u}lich. It's vector analyzing power has been measured at forward angles at several energies in the region of $\Delta(1232)$ isobar exictation. Together with the differential cross section measured earlier, it would allow to better estimate various multipoles contributions.

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Status of the Time Projection Chamber for the MPD/NICA projec

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Within the framework of the JINR scientific program on study of hot and dense baryonic matter a new accelerator complex the Nuclotron-based Ion Collider Facility (NICA) is under realization. It will operate at luminosity up to 1027 cm-2 s-1 for Au79+ ions. Two interaction points are foreseen at the NICA for two detectors which will operate simultaneously. One of these detectors, the Multi-Purpose Detector (MPD), is optimized for investigations of heavy- ion collisions. The Time-Projection Chamber (TPC) is the main tracking detector and charged particles identification of the MPD central barrel. The TPC/MPD will provide:
- The overall acceptance of |η|<1.2.
- The momentum resolution for charge particles under 3% in the transverse momentum range 0.1<pt<1GeV/c.
- Two-track resolution of about 1 cm.
- Hadron and lepton identification by dE/dx measurements with a resolution higher than 8%. These requirements must be satisfied at the NICA design luminosity, charged particle multiplicity ~ 1000 in central collisions and the event rate about 7 kHz.
The TPC design and structure are similar to those of the TPCs used in the STAR, ALICE and NA49 experiments.
The TPC being a large but conceptually simple detector must be constructed with very high precision to reduce nonlinear systematic effects. High stability of the mechanical structure and uniformity of the drift field, the temperature, the drift gas purity and the gas gain have to be provided to get precise track reconstruction and energy-loss measurements.
The structure of the MPD/NICA and of the TPC, the basic design parameters of the TPC and the basic TPC configuration are presented. Developed design tools for the TPC assembling and part of the TPC cooling system are provided. The pad plane and the scheme of TPC readout chamber, and the TPC gas system are shown.

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JINR LIT Computing Resources for NOvA Experiment

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This talk represents some application use-cases of JINR LIT computing resources for NOvA experiment. Running NOvA Art framework (used by the experiment) on cloud service and batch system is shown. It also depicts some pros and cons of these two approaches as well as performance comparison.

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Numerical Approach and Parallel Computer Code for Analysis of the Long Josephson Junctions Model

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Investigation of superconductive processes of long Josephson junctions (LJJ) is important because of wide range of applications in modern nonoelectonics. We consider a model of N stacked LJJs with inductive and capacitive couplings. The phase dynamics of this stack is described by a system of 2N nonlinear partial differential equations with respect of the phase differences and voltages of each JJ in the stack. Our numerical approach is based on the standard three-point finite-difference approximation in spatial coordinate along the length of JJ and on the utilizing the fourth order Runge-Kutta algorithm for solution of the resulting system of ordinary differential equations. Numerical simulation of such system in wide range of physical parameters takes a lot of computer time. We elaborated parallel algorithm and computer code on the basis of MPI technology which provide a 5-7 times speedup of calculations. The results of numerical simulations on multi-processor cluster CICC and heterogeneous claster HybriLIT (LIT JINR, Dubna) are presented.
This work was supported by RFBR (grant №15-29-01217).

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Electron-Electron Interactions in Highly Doped Heterojunctions

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Electron-electron interactions in a single highly doped semiconductor heterojunction are considered taking both intra- and intersubband transitions. Characteristic features of 2D electron systems, such as the amplitude-frequency modulation, beatings and sharp bends in the oscillation amplitude magnetic field dependence make the description of Landau quantization damping in terms of the Dingle temperature rather problematic [1]. Another point to be pointed out is the fact that in the magnetic field range where a strong amplitude-frequency modulation take place the perturbed – subband electrons are in the state closed to the quantum limit and one can speak of the oscillations period in a rather limited sense [2,3].
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Towards a new quark-nuclear matter EoS for applications in astrophysics and heavy-ion collisions

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The aim of our work is to develop a unified equation of state (EoS) for nuclear and quark matter for a wide range in temperature, density and isospin so that it becomes applicable for heavy-ion collisions as well as for the astrophysics of neutron stars, their mergers and supernova explosions. As a first step, we use improved EoS for the hadronic and quark matter phases and join them via Maxwell construction [1]. We discuss the limitations of a 2-phase description and outline steps beyond it, towards the formulation of a unified quark-nuclear matter EoS on a more fundamental level by a cluster virial expansion [2,3].

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Feasibility of femtoscopy studies at the NICA energies

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The correlation femtoscopy allows for measuring of space-time characteristics of particle production processes due to effects of quantum statistics (QS) and final state interactions (FSI). The main features of femtoscopy measurements in heavy-ion collisions at high energies are revealed as a manifestation of the strong collective flow and interpreted well within hydrodynamic models with a crossover phase transition. Femtoscopy at lower energies was intensively studied at AGS, SPS and STAR, also. A possibility to observe a transition from the first order phase transition expected at low energies to the crossover one at high energies with the femtoscopy observables using cascade and hybrid models is considered.

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The propagation of surface polariton during electromagnetic wave diffraction on planar structure

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The process of electromagnetic wave diffraction at the interface vacuum-metal-semiconductor with the excitation of a surface wave. In the framework of the theory was developed the mode method of calculation of the interaction of radiation with a structure that allows to count for a fixed stream of energy of disturbance the streams of energies that arise in the process of diffraction.
The processes of redistribution of energy as a result of diffraction of electromagnetic radiation in dielectric medium represent one of the major tasks of integrated optics. The main problem lies in the great mathematical difficulties associated with the solution of Maxwell's equations in media where the interface between the media are not parallel to the plane. Terms of continuity together with Maxwell's equations for such tasks are connected with the solution of complex integral differential equations that have analytic solution only for certain geometries.

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Investigation of the effect of finite interval of integration in the processing of resonances for elemental and isotopic analysis of samples by neutron spectroscopy

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One of the applications of neutron spectroscopy for applied purposes is a nondestructive determination of the isotopic composition of samples under study. The method is based on the registration of neutron resonances and measurement of the yield of reaction products in the resonance. The determination of isotope quantity is carried out by using the relative measurements with a standard and investigated sample. In processing of experimental data the area method is applied. The isotope mass is gotten from the value of resonance area under the transmission curve which depends on the resonance parameters and the isotope concentration. It uses the theoretical calculation of the transmission curve. However, these calculations are carried out for isolated resonances. In practice, it often happens that one has to take a rather narrow area on the resonance curve. The investigation of the effect of finite interval of integration on the final result is presented in this work.

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Nanostructured manganites: neutron diffraction studies at high pressure in wide temperature range

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Apart from potential application, the complex manganites are attractive for great number of scientific research. The knowledge of relationship between magnetic and crystal structure of nanostructured manganites La1-xSrxMnO3, which can be obtained from high-pressure investigations, is very essential for understanding the nature and mechanism of physical phenomena observed in these nanostructured compounds.
Also recently it has been discovered that nanostructured manganites La1-xSrxMnO3 (near x ~ 0.33) have a rhombohedral structure both in the corresponding bulk samples. However, the magnetic state of these compounds, in contrast to powder samples that exhibit ferromagnetic metallic state, characterized by coexistence of ferromagnetic (FM) and antiferromagnetic (AFM) phase A-type.
The crystal and magnetic structure of nanostructured manganites La1-xSrxMnO3 with doping level x= 0,28 и 0,37 has been studied by means of a neutron diffraction method on diffractometer DN-6 of IBR-2 high-flux pulsed reactor (Frank Laboratory of Neutron Physics, JINR, Dubna) using high pressure chambers with sapphire anvils under pressure up to 5,7 GPa.
In both samples the FM ordering is formed close the room temperature and at cooling below T<270 K the ferromagnetic FM phase coexists with an A-type antiferromagnetic AFM phase. At high pressures the volume fraction of AFM phase increases while FM is gradually suppressed. The structural aspects of the magnetic phase separation and pressure effects on the studied nanostructured manganites are discussed.
Pressure dependences of unit cell parameters and volume, magnetic moments of ferromagnetic (FM) phase and antiferromagnetic (AFM) phase, Curie and Neel temperature were calculated.

The work was supported by the RFBR grant No. 15-32-20358-mol-a-ved.

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Diffusion Constant with higher order gravity corrections in the Soft-Wall Model

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We study the Renormalization Group (RG) flow of transport properties by holographic QCD. Diffusion constant and shear viscosity at the cut-off have been calculated in the soft wall model including the Gauss-Bonnet coupling in the gravity. An explicit relation between the two has been presented at the cut-off for the Einstein-Maxwell system in the soft wall model and then after including the Gauss-Bonnet corrections the results have been shown.As our main motivation is to establish a relation between diffusion constant and Gauss Bonnet coupling in soft wall model.Charge dependence of susceptibility has also been plotted using the famous Einstein relation.

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General formulation of process noise matrix for track fitting with Kalman filter

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While using the Kalman filter for track fitting in high energy physics experiments, one often needs to extrapolate the Kalman state vector (which contains all the information e.g. charge, momentum and direction etc. about the particle) and propagate the corresponding errors, repeatedly, in small tracking steps, between two active planes with measurements. This makes the filter sensitive to the possible internal variations in the materials, magnetic field etc. in thick scatterers. This operation mixes up the random uncertainties due to multiple scattering, energy loss straggling etc. with systematic uncertainties due to magnetic field etc. As a result, the effective forms of the random noise matrix, to be used in case of a thick scatterer, are modified. Rainer Mankel dealt with this problem in the context of development of the HERA-B pattern recognition package, ranger. But in that work, a very simple form of Kalman propagator matrix was used and the error propagation of signed inverse momentum (q/p) was kept out of the consideration. But in many experiments, including INO-ICAL, the Kalman propagator matrix is not at all trivial. In fact, all 25 elements of the matrix are non-zero in general. Therefore, the simple form of the random noise matrix, derived by Mankel, is not valid in such a scenario. Specifically, it is seen that the 15 independent elements of the random noise covariance matrix are the solutions of a set of 15 coupled linear ODEs. The solutions need to be such that the diagonal elements of the random noise matrix are positive. In this paper, we describe the mathematical formulation of the problem and present the methods to obtain the solutions. We also obtain the track fitting results for INO-ICAL and quantify the degree of deviation we observed from Mankel's work.

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The two-species annihilation reaction: Effect of finite correlation time and compressibility

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The two-species annihilation reaction $A + B \longrightarrow \emptyset$ with equal diffusion constants DA=DB is studied in the presence of a velocity fluctuation. The velocity fluctuations are generated by a self-similar Gaussian ensemble. The special emphasize is put on the effect of finite correlation time and compressibility of the environment. Using the perturbative renormalization group the long-time behaviour of the model near its critical dimension is analyzed using a three-parameter expansion in ε, Δ and η, where ε is the deviation from the Kolmogorov scaling, Δ is the deviation from the (critical) space dimension $d_c = 2$, and η is the deviation from the parabolic dispersion law. We summarize the possible asymptotic regimes corresponding to infrared fixed points of the renormalization group calculated up to the leading order in the perturbation theory.

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Reactive oxygen species induction in V79 cells after gamma irradiation

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The radiation can damage living organisms and their DNA, which is believed to be the critical target, in direct or indirect manner. The reactive oxygen species (ROS) are considered to be one of the most damaging agents causing the indirect effects of radiation (especially the hydroxyl radicals, but also peroxyl radicals, superoxide radicals, etc.). It is speculated that the long-term elevated levels of ROS can cause unexpected irregularities in DNA and some hypothesize it could be a source of the inherited genomic instability.

The work was conducted on the mammalian cell line of Chinese hamster (V79). The cells were exposed to gamma radiation of Co-60 at the Rokus-M unit of Dzhelepov Laboratory of Nuclear Problems. Applied doses were from 0.5 up to 10 Gy. Changes in the levels of ROS after irradiation were measured with the use of general oxidative stress indicator (CM--H2DCFDA) with fluorescent dye. This study is particularly aimed on the comparison of measurements in the cell suspension and in the adhered cells. Intensity of fluorescent light corresponding to the concentration of ROS in suspension of cells was measured on fluorometer Qubit 2.0 (Invitrogen). The fluorescent signal of cells adhered to the 96-well microplate was measured using the Multi-mode microplate reader Synergy H1 (Biotek) and the same fluorescent kit. Both approaches have their advantages and disadvantages which are discussed.

There are still many uncertainties connected to the effects and persistency of the ROS in mammalian cells and a further research is essential.

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Ex-situ and in-operando neutron diffraction study of doped LiNi1/2Mn3/2O4 cathode materials

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Ex-situ and in-operando neutron diffraction study of doped LiNi1/4Mn3/4O4 cathode materials
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In this report results of new ex-situ and in-operando neutron diffraction study of doped spinel cathode materials LiNi0.5-xMn1.5-yMx+yO4 (M = Co, Cr,Ti, Mg; x+y=0.05) are presented. The samples were prepared by mechanochemically assisted solid state synthesis using a high energy AGO-2 planetary mill and have promised electrochemical properties as cathode materials for Li-ion batteries [1]. Neutron diffraction study can reveal some structural information about crystals which are not possible to reveal by other diffraction methods: redistribution of cations with close atomic number, position and occupation of light elements (Li, O, ...), to obtain information about crystal- and micro- structure evolution during electrochemical cycling. The experiments have been made on the High Resolution Fourier Diffractometer (HRFD) and Real-time Diffractometer (RTD) at the IBR-2 pulsed reactor in JINR (Dubna). For in-operando neutron diffraction studying new electrochemical cells designed and produced in Frank Laboratory of Neutron Physics were used.
The research was financially supported by Russian Foundation for Basic Research (project #14-02-31506).

1. N. V. Kosova, I.A. Bobrikov, O.A. Podgornova, A.M. Balagurov, A.K. Gutakovskii Perculiarities of structure, morphology, and electrochemistry of the doped 5-V spinel cathode materials LiNi0.5-xMn1.5-yMx+yO4 (M=Co, Cr, Ti; x+y = 0.05) prepared by mechanochemical way. Journal of Solid State Electrochemistry (2015) DOI: 10.1007/s10008-015-3015-4

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The monitoring network connections using the RFID technology in the Slow Control system

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In modern large experiments it can be distinguished two data processing systems: the acquisition data and the control-measuring system. The control and the measurement systems responsible for controlling the experiment and the control parameters, using the existing Ethernet communications infrastructure. This type of solution requires identifying each sensor not only by IP address, but also the physical connection. The aim of the speech is the presentation of the ideology of the Slow Control system in the NICA experiment and comparison to commercial solutions type IoT. In addition, there will be presented the solution of the problem of connections' identification based on the wireless technology to recognize the plugs – RFID.

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Phase transitions and ordering in the frustrated Ising model on the antiferromagnetically stacked triangular lattice in the field

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Ising antiferromagnet on the stacked triangular lattice is one of the classical examples of a three dimensional frustrated system. The case with a ferromagnetic interlayer interaction has been studied for over a three decades and provided a good understanding of the phenomena observed in the compound Ca_3Co_2O_6. We would like to expand this topic by considering antiferromagnetic interaction between adjacent layers which corresponds to the material CsCoX_3 where X = Cl and Br. Without an external magnetic field the behaviour of this system is similar to the previously studied case where degenerate Wannier-like ordering is observed in the ground state but spin chains that lies perpendicular to the layers are ordered antiferromagnetically. This phase persists for the fields h/|J_1| < -2J_2/|J_1|. For larger fields (up to h/|J_1| = 6 - 2J_2/|J_1|) the layers exhibits ferrimagnetic ordering. However, the infinite degeneracy shifts from layers to the spin chains with one third of couplings to be ferromagnetic. We also employ histogram reweighting technique and finite-size scaling analysis to determine universality class of the high-temperature phase transitions for a few selected field values in the ordered region.

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Vacuum and cryogenic tests of a new cryocooler - based facility for experiments with superconducting solenoids

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The new stand facility for experiments with superconducting solenoids, based on use of a cryocooler (Sumitomo Inc, Japan) to maintain cryogenic environment is under construction in Veksler and Baldin Laboratory of High Energy Physics. First results of vacuum and cooling tests down to 3.13 K (at the coldest point) with use of the elaborated cryogenic thermometric system will be presented and discussed. It is planned to use this stand facility as a cryo-vacuum system of a new source of multicharged ions Krion-T (with tubular geometry of e-beam).

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γ-ray induction and repair of DNA double-strand breaks in rat hippocampus and cerebellum cells.

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Radiation protection both on Earth and in space is based on the principles of risk justification and limitation. The contemporary concept of the radiation risk of manned interplanetary flights incorporates the influence of space radiation on the CNS functions. It is expected that possible space radiation risks for the CNS, like altered cognitive functions (including in short-term memory disorders), reduced motor functions, and behavioral changes are connected with damage on the molecular and cellular levels. These CNS changes can also originate in the radiation-induced DNA damage arising in neuronal and non-neuronal cells of specific brain areas. DNA double-strand break (DSB) is the most harmful damage for the cell. To protect the DNA molecule from such changes there are mechanisms of DNA repair which maintain genome integrity in an intact state. Investigation of DNA DSB induction and repair is of special interest in cells of the hippocampus and cerebellum. The hippocampus is the brain area performs the function of the production of new neurons by neurogenesis and has been associated with radiation-induced cognitive decline in spatial learning and memory. The cerebellum is involved in the coordination of voluntary motor movement and contains roughly half of the brain's neurons. For the analysis of the induction and repair of DNA DSBs, Spraque Dawley rat heads were irradiated with 1, 3, and 5 Gy 60Co γ-rays. DNA DSBs were visualized by immunohistochemical staining of paraffin-embedded rat brain tissues. Tissue slices were processed by the standard procedure of immunostaining with fluorescent antibodies for the phosphorylated histone H2AX (γ-H2AX) and repair protein 53BP1 – DSBs markers. Quantification of colocalized γH2AX/53BP1 foci allows evaluation of the quantity and quality of DNA DSB and their repair in hippocampus and cerebellum cells. Fluorescent images hippocampus sections with visualized γH2AX foci in were obtained.

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Stability of atoms in spaces with compactified extra dimensions

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We investigate the consequences of one extra spatial dimension for the stability and energy spectrum of the non-relativistic hydrogen atom with the potential defined by Gauss' law, i.e. proportional to 1/|x|^2 . The additional spatial dimension is considered to be either infinite or curled-up in a circle of radius R. In both cases, the energy spectrum is bounded from below for charges smaller than the same critical value and unbounded from below otherwise. As a consequence of compactification, negative energy eigenstates appear: if R is smaller than a quarter of the Bohr radius, the corresponding Hamiltonian possesses an infinite number of bound states with minimal energy extending at least to the ground state of the hydrogen atom. We present numerical calculations of the energy spectrum by using Hamiltonian diagonalization techniques.

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Beam-Plasma Reactors for the Hydrocarbons Treatment

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Nowadays the plasma treatment of liquid and gaseous hydrocarbons is considered as promising approach to improve the crude oil quality and to produce valuable materials and compounds. Being highly effective and environmental friendly plasma technologies are competitive with conventional technologies of hydrocarbon chemistry and petroleum processing.

The present study is devoted to the development of experimental techniques for studying of processes stimulated by non-equilibrium plasmas in liquid and gaseous hydrocarbons. Two types of experimental setups were developed, namely:

1) Plasma chemical reactor in which the low-temperature non equilibrium plasma is generated by the electron beam injection in a neutral dense gas;

2)Plasma chemical reactor based on the combined action of two ionizers on a gas (so-called the reactor of hybrid type).

In latter case the plasma was generated by continuous or intermittent injection of the electron beam into the plasma volume preliminary excited by the radio-frequency (RF) glow discharge.

Both reactors were tested in experiments with natural crude oils of Siberia oil fields and some gaseous hydrocarbons such as methane, propane and acetylene. The mixtures of above hydrocarbons with oxygen and noble gases were also used as plasma generating media. Total pressure and partial pressures of the mixture components as well as beam parameters (beam current, electrons energy) were varied in wide ranges to find the stable modes of the reactor operation and to develop methods of the reactor control. In case of the hybrid reactor the RF power was adjusted to the electron beam parameters to obtain the best compatibility of the beam and gas discharge under various conditions of the plasma generation including the plasma generation in presence of liquid phase (liquid oil) in the reaction zone.

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STUDY OF VASOTROPIC PROPETIES ITU-1 IN THE MODEL OF SEVERE HEMORRHAGIC SHOCK AND THE MODEL OF ACUTE SEPTIC SHOCK

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All over the world research related to the search for new and effective agents for the treatment of acute and chronic diseases of the cardiovascular system, including a shock are actively conducted. Septic and hemorrhagic shock are accompanied with profound hypotension induced by drop in blood pressure (BP). The most common cause of death in these patients is a lack of effectiveness of render assistance in the pre-hospital period. The effective vasoconstrictors must be crucial on these stages of pre-hospital therapy.

It is known that nitric oxide (NO) plays an important role in the regulation of vascular tone. We have found that the compound ITU-1 from the chemical class of izothiourea, synthesized by the laboratory of radiation pharmacology in A. Tsyb MRRC is able to selectively and reversibly inhibit the NO synthases (NOS). We proposed that ITU-1 can cause some vasopressor action.

Objective: experimental study of the potential antishock drug ITU-1 on the model of severe hemorrhagic shock and the model of acute septic shock, as well as its comparison with adrenoreceptor agonist - Phenylephrine.

Materials and methods. We used male Wistar rats weighing 300-350 g (6-8 animals per group). Each rat was anesthetized with thiopental sodium (60 mg/kg ip). The parameters of respiratory rate (RR), heart rate (HR), blood pressure: systolic blood pressure (SBP) and diastolic blood pressure (DBP); and indicators of the electrocardiogram in indirect leads (ECG) were recorded using Polygraph RM-6000 (Nihon Kohden, Japan), Cardiofax (Nihon Kohden, Japan).

For creating: a) severe hemorrhagic shock the carotid arteria blood was collected in a volume of 2-2.5 ml per 100 g body weight (50% of the total blood volume); b) acute septic shock - in the jugular vein were administered E. coli LPS at a dose of 18 mg/kg. After ascertaining the state of shock ITU-1 (10 mg/kg ip) was administered and the registration parameters were carried. The period of monitoring was of 90-120 minutes. Phenylephrine (0,5 mg/kg ip) was used as a comparison drug.

Results. In the model of hemorrhagic shock blood pressure decreased to 30-40% of the initial value due to the decrease in circulating blood volume to 50%, caused by massive blood loss. In the control group that did not receive treatment, there was 45% mortality of the animals during the first hour.

Compound ITU-1 in the model of severe hemorrhagic shock showed stable and significant vasoconstrictor effect (BP for 80-90% of the original value). All hemodynamic parameters remained within the physiologically normal state and no deaths were observed during the period of monitoring (more than 2 hours). The administration of Phenylephrine also caused a rapid development of the vasoconstrictor effect. However, during the all period of monitoring the BP parameters didn't increased more than 53% of the initial value and didn't differed significantly from the corresponding time of the model blood loss. Moreover in this group 50% of the animals died during the first hour after the Phenylephrine injection.

In the model of acute septic shock, blood pressure of animals dropped to 40-45% of the initial value due to the vasodilation caused by a toxin. After administration of the ITU-1 we registered the stable and statistically significant increase in blood pressure up to 82-88% of the initial value. The effect persisted during the all period of monitoring - 90 min. Phenylephrine caused in the experimental animals in a state of septic shock the short-time hypertensive effect. A statistically significant increase in blood pressure was observed only within 10 minutes.

This way, compound ITU-1 in the models of severe hemorrhagic shock and acute septic shock showed strong and prolonged vasopressor effect, that exceeds the effect of adrenoceptor agonists. This gives the basis for its further studies as antishock drug.

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Spectrometer of Charged Particles on the EG-5 FLNP, JINR

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The modernization of the equipment on the channel №5 EG-5 FLNP, JINR for the study of reactions induced by fast neutrons (neutron, charged particle) was carried out. To obtain fast neutrons based on the reactions Li (p, n) and D (d, n) new two targets were created; gas-state and solid-state. A new detector that includes 5 helium counter tubes for neutron beam monitoring was developed. A special ionization chamber with five pairs of exchangeable samples is being used as a detector [1, 2]. Two new data acquisition systems were elaborated. The first one is based on CAMAC standard using the Kmax controller (Sparrow Corp., USA). The second one is based on PXI standard and uses the high-speed digitizers PIXIE-4 (XIA, USA). The paper presents detailed characteristic of the setup.

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SCALE FORMATION AND METHODS OF STRUGGLE WITH THE DEPOSITION IN THE COOLING APPARATUS.

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The main requirements to the quality of the cooling water are: temperature, which is able to provide normal cooling of the heat exchange equipment; absence of mineral and biological deposits in the cooling system, as well as corrosion of metal equipment. In the result of heating water passing through heat exchangers, occur releasing of carbon dioxide and decay of calcium and magnesium bicarbonate, which are converted into slow-soluble in water CaCO3 and Mg(OH)2 or MgCO3. Salts, which drops out of the water deposited on cooled surfaces around washed tract. Calcium, magnesium chlorides, magnesium, sodium and potassium sulfates, and also sodium and potassium hydrocarbonates and carbonates that present in water are very soluble and in the case of passing water through the heat exchangers do not precipitate. Therefore, the main cause of the formation of scale and mineral deposits is a carbonate hardness of water.

In this work presented methods for the analysis of EGRES-1 water cooling reservoir.

Calculation of mineralization average values in the water intake and discharge showed the following. It is noted as increase in mineralization (in average 11.2 mg /l) in the discharged water, and decrease in mineralization (in average 6.1 mg /l). In other words, water in the case of passing through the cooling system is enriched with mineral salts and impoverished them in view of the prevailing physical and chemical conditions at the moment. pH varies between 8,00- 8,46. Moreover, in most cases pH value in deep water samples more for 0.1- 0.12 units than in surface (error determination of value is 0.02 units.). This is because of continuing receive materials with alkaline nature from sediment to the water. Vertical stratification of pH values do not observe. Comparing data on various types of hardness: common, uncarbonate, carbonate and maximum allowable carbonate.

In the result of received data, analysis of EGRES-1 water cooling reservoir, created all prerequisites for calcium carbonate salt precipitation from water, as well as carbonate salt deposits in the cooling system (condenser tube).

In reviewing of main methods to struggle with scale formation in our view, most optimal is a mechanical method. Represented mechanical method based on mechanical removal of sediment from the inner surface of condenser tubes by rubber balls.

These results have important practical significance. They were taken into account by EGRES-1 administration in the supply regulation and outflow of cooling water in the technical system.

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Model F of critical dynamics: Superfluid phase transition with activated velocity fluctuations

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On the base of the quantum field description of Bose-condensed systems and the stochastic Navier-Stokes equation we propose a model that generalizes the model F of critical dynamics. It describes influence of the velocity fluctuations on the phase transition to the superfluid state. The corresponding action is constructed using the Martin Siggia-Rose formalism. The regime of equilibrium fluctuations is analyzed within perturbative renormalization group method. The double (ϵ, δ)-expansion scheme is employed, where ϵ is a deviation from space dimension 4 and δ describes scaling of velocity fluctuations. The calculation of the renormalization constants, renormalization group functions, regions of stability and critical dimensions was accomplished to the leading order (one-loop approximation). We show that critical exponents are drastically changed as a result of the turbulent background and critical fluctuations are in fact destroyed by the developed turbulence fluctuations. The scaling exponent of effective viscosity is calculated and agrees with expected value $4/3$.

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EFFECT OF ELECTRIC FIELD ON NANOFABRICATION OF THE CARBON NANOFIBERS FOR 3D PRINTING

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We offer a new method, which includes a process of nanofibers fabrication by electroforming under an electric field of high voltage and 3D technology. The main problem of using electroforming is internal instability electrified nanojets that “feel” mutual Coulomb repulsion. In our method, we solve this problem by using different types of electrodes, which are modification of "H-shaped" electrode as well as two parallel "II" form of the electrode. This approach makes it possible to change the direction of the electric field lines, which in turn is necessary for the production of oriented nanofibers. The proposed method makes it possible to stack strictly aimed nanofibers of PMMA-polymer with diameters of 50 to 500 nm, building of these "nanowalls. The applying of different types of electrodes allows us to vary the size of nanofibres, for example, for "H-shaped" electrode fibers with average size of 250 nm, and for "II" form of the electrode 100 nm were obtained. Oriented polymer nanofibers were used for building bioscaffolds for biological cells implementation; we also obtained carbonized films and add to the electrodes in supercapacitors that two times decreased their resistance.

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Features of magnetic disorder in Mn0.89Cr0.11NiGe due to the interaction of the magnetic and structural order parameters.

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Materials with magnetostructural phase transition in which the crystal and magnetic structure are changed simultaneously attract considerable attention not only because of their importance to fundamental science, but also due to the wide possibilities of their practical application in magnetocalorics. The study of magnetic and structural characteristics of Mn1-xCrxNiGe alloys shown that their essential feature is the ability to change the nature of magnetic disordering of the phase transition from the paramagnetic (PM) to the ferromagnetic (FM) state from the isostructural (symmetry group Pnma) transition of the second order (for the slowly cooled samples) to the first order magnetostructural phase transition PM(P63/mmc)-FM(Pnma) (implemented in the samples quenched from 850°C in water). In our opinion this is due to the increased interaction between the magnetic and structural order parameters under the influence of solid-hardening, which brings the temperature of the magnetic characteristic (TC) and structural (Tt) transitions.

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Emergence of jams in the generalized totally asymmetric simple exclusion process

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The generalized totally asymmetric exclusion process (TASEP) [J. Stat. Mech. P05014 (2012)] is an integrable generalization of the TASEP equipped with an interaction, which enhances the clustering of particles. The process interpolates between two extremal cases: the TASEP with parallel update and the process with all particles irreversibly merging into a single cluster moving as an isolated particle. We are interested in the large time behavior of this process on a ring in the whole range of the parameter λ controlling the interaction. We study the stationary state correlations, the cluster size distribution and the large-time fluctuations of integrated particle current. When λ is finite, we find the usual TASEP-like behavior: The correlation length is finite; there are only clusters of finite size in the stationary state and current fluctuations belong to the Kardar-Parisi-Zhang universality class. When λ grows with the system size so does the correlation length. We find a nontrivial transition regime with clusters of all sizes on the lattice. We identify a crossover parameter and derive the large deviation function for particle current, which interpolates between the case considered by Derrida-Lebowitz and a single particle diffusion.

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METHODS AND ALGORITHMS FOR J/ψ→e+e- DECAYS RECONSTRUCTION IN THE CBM EXPERIMENT

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The technique of J/ψ reconstruction in its dielectron decay channel was developed within CBM experiment. It includes a chain of methods that are developed for the trajectories and momentum reconstruction of the charged particles by the STS, their identification with the help of RICH, TRD and TOF detectors, the formation of the J/ψ-mesons candidates and determination of their parameters using a KFParticle package. In order to select the signal events from a dominant background, specific selection criteria have been developed. Development methods and special selection criteria show that CBM setup can gather quite a high J/ψ→e+e statistics. The analysis of time-consuming of the used algorithms allows estimate the possibility of acceleration of the data processing with the help of high performance computing.

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Study of crystal structure of Co-nanotubes

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In today's world, the future of humanity depends on the development of new technologies, many of which are related to the use and preparation of nanostructure and preparation of nanostructured materials. The simplest definition of such materials is associated with the geometric dimensions of several nanometers to several tens of nanometers. Properties, as well as the functional and operational characteristics of these materials depend on the size and arrangement of structural elements. This property allows us to use nanomaterials in almost all known areas ranging from medicine and finishing with utilities. Nowadays, a large number of techniques developed, which makes it possible to obtain a great variety of species with different properties. Formation of nanoscale structures can occur during processes such as phasetransformations, chemical interactions, recrystallization, amorphization, high mechanical loads, biological synthesis, hydrochemical synthesis, energetic explosion of conductors, thermal evaporation and many others. The most universal method of producing nanostructures of various shapes is a template synthesis method, which is based on the use of porous matrix template for the formation of the geometry of the nanostructures. In this paper we consider obtaining nanostructures in the form of Co based hollow cylinders in the pores of PET based template matrix with diameters from 180 to 280 nm. The morphology and crystal structure were studied using the methods of SEM, TEM, XRD. The X-ray diffractometry studies have shown that the obtained samples are biphasic, possess metastable fcc (β-Co) phase and stable GP (α-Co) phase, that is typical to cobalt structures obtained at room temperature, with lattice parameters different from the reference value (PDF 01-1277 and PDF 15-0806). Increasing the contribution of metastable EGC phase into the crystal structure causes additional defects hindering the movement of electrons and thus reducing conductive properties.

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Synthesis and characterization of spider silk calcite composite

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Biomineralization is a process in which living organisms form minerals from organic and inorganic components. By its mechanical properties biominerals surpass minerals that spontaneously form without presence of organic molecules. Biomineralization inspired scientists to create new materials via combination of biomolecules and inorganic molecules. There is a growing interest in mimicking biomineralization as a potential route in synthesis building block for bone replacement materials. Spider silk posses excellent mechanical properties,tenacity and elasticity and it has been used as a template for calcite mineralization to improve load bearing strength of osteoconductive calcite. The samples were obtained by mimicking biomineralization for five days in order to follow formation and growth of calcite on the surface of spider silk. XRD and FTIR spectroscopy were used to observe formation of crystal phase. Microstructure, crystal size and its morphology were studied by means of FESEM.

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Analysis of Organophosphorus in pesticides treated citrus fruits of Fort Beaufort farms in the Eastern Cape, South Africa.

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Analysis of Organophosphorus in pesticides treated citrus fruits of Fort Beaufort farms in the Eastern Cape.

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Keywords: Pesticides residues, citrus fruits (mandarins, clementine, navels etc), Solid Phase Extraction, Gas chromatography.

The aim of this study is to determine the residues of Organophosphorus compounds in pesticides treated citrus fruits. Pesticides were developed to kill, control, destroy, or reduce the behavior of pests that interfere with the growth of crops, shrubs, trees, timber and other vegetation desired for humans to make lives easier and safer. However, they also have a potential to harm humans related to the types and concentrations of chemicals in each products. Citrus fruits (oranges, lemons, mandarins, grapefruit, navels etc) were selected for the purpose of this study. These samples were taken directly from seven farms of the Fort Beaufort to the laboratory at University of Fort Hare. Solid-phase extraction (SPE) was used for further clean-up coupled with GC-ECD and GC-MS for analysis. Organophophorus compounds such as carbopheothion, ethion, malathion and paranthion in pesticides citrus fruits (mandarins, lemons, limes, grapefruit, navels and clementines) were sought in mandarins, lemons and clementines all residues were detected in different concentrations .In grapefruit and navels only two were detected malathion and. In limes only carbopheothion was detected, they were concentration ranges of 0.13 mg/kg and < 0.01 mg/kg. This is a matter of major current concern due to the fact the monitoring of pesticides does not only assists in the country's food security but also it provides a check on compliance with good agricultural practice in the use of pesticides. Therefore, there is a need to continuity of investigation and monitoring on pesticides residues in agricultural products in order to prevent the contaminating materials and secure human safety.

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A study of the wave packets approach to the neutrino oscillations based on Daya Bay and KamLAND data.

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The talk represents an analysis of data from two reactor neutrino oscillation experiments (Daya Bay and KamLAND) using the wave packet approach. This approach eliminates inconsistencies of the usual plane-wave approach. The wave packets theory predicts new effects that suppress neutrino oscillations (decoherence effects). In this work we obtain constraints on the parameter characterizing decoherence effects using data of Daya Bay and KamLAND experiments.

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Mott-□□hadron resonance gas and lattice QCD thermodynamics

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We present an effective model for the generic behavior of hadron masses and phase shifts at finite temperature which shares basic features with recent developments within the PNJL model for correlations in quark matter. On this basis we obtain the transition between a hadron resonance gas phase and the quark gluon plasma in the spirit of the generalized Beth-Uhlenbeck approach where the Mott dissociation of hadrons is encoded in the hadronic phase shifts.
We find that the restriction to low-lying hadronic channels is justified by the rather low chiral transition temperature found in recent lattice QCD thermodynamics results.

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Development of applications to gather information about the grants with the participation of JINR.

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The information system JINR Document Server (JDS) used in JINR is a repository of open access articles, preprints and other materials, reflecting and promoting research by JINR. JDS functionality, provided by the software Invenio, covers all the aspects of modern digital library management. JDS, as well as any other information system, requires careful and systematic work on its filling. Collections of authoritative records - People, Institutes, Journals, Subjects, Themes & Projects, Experiments, Grants - are created (on the test server) to improve the quality of content at the present time. The goal of this activity is the maximal automation of the information system filling. In particular, it's need to update and support the information about the grants involving JINR. All necessary information on grants is presented on the official website of JINR.
This work is dedicated to development of the application for data acquisition about the grants from the official website of the JINR based by Web-Scraping – the technology for data retrieving from web pages. The developed application generates XML-files from the collected data that is fully ready to be loaded into the JDS system in the batch mode.
Thus, implementation of such application will reduce the time spent on the support of the collections of authoritative records, particularly, Grants.

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CRYSTALLINE STRUCTURE of Cu NANOTUBES

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In recent years, many efforts were directed to the preparation of micro- and nanostructures in hollow tubes form, because of their specific structure and unique properties. These properties are different from properties of rods [1], wires and widespread applications as potential photonic crystals, catalysts, sensors, drug delivery bearers, biomedical agents and chemical reactors.
In this paper considers the method of producing hollow Cu - nanotubes using template synthesis, as well as characterize their morphological and electrical properties. Deposition of Cu is performed by electrochemical method at different potentials. Characteristic structural features is carried out by scanning electron microscopy (SEM), energy dispersive analysis (EDA) and X-ray diffraction (XRD), and indirectly in the study of the electrical conductivity.
The atomic ratio of Cu in the nanotubes was 100% for all of the samples, without oxide impurities. According to the diffractograms, samples of Cu - nanotubes possess FCC - structure with a cell parameter differs from the reference (3.6130 E). Research of current - voltage characteristics of the Cu - nanotubes showed that with a change in the area of the conductive surface as well as the predominance of the preferred direction (111) in the crystalline texture of the obtained samples, value of the conductivity is increased by 1.7% for the samples deposited at 1.25V, and by 2.3% for 1.5 V. Thus, by varying the conditions of nanostructures synthesis can modify the crystalline structure of nanotubes, thus increasing the conductivity and reducing the resistance of nanotubes.

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Copper – YBCO Tape Low Resistivity Junctions

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This paper presents results of the experimental studies for optimizing junctions between normal conduction metal (copper) and High Temperature Superconductor (HTS) tape, YBCO type. Of great importance are as well the junctions HTS- HTS which are also studied in the low temperature range.
This study concerning junctions between superconducting tapes YBCO type, which helps a better understanding of the influence of a junction or a series of junctions on the thermal stbility of a HTS coil. The sample junctions are concerned with the latest industrial produced superconducting materials: 2nd generation High Temperature Superconductors of YBCO type, with transition temperature of 92 K. The YBCO tapes are preffered due to high values for Jc and high values of Bc.
The electrical resistivity of these junctions is one of the most important parameter when performing terminals for the superconducting coils, or HTS current leads, or when joining together two sections of the same coil.The influence of the junction is established by measuring the voltage drop on the junction by ranging the current between 0 – 300 A and keeping the temperature constant around 77 K.
Due to high values of the current densities (~104 A/cm2) these terminals must have a very low resistance (~10-8 ohms) in order to have negligible contribution to the heat loss. To perform such joints, are studied several soldering materials and the execution conditions of the joints.
The sample is powered by a programmable DC current source with high stability(10-4). No external magnetic fields are applied to the sample.

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«On factorization of Hermitian operator characteristic polynomial»

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We propose a new algorithmic method for factorization and root localization of characteristic polynomial of Hermitian operator, implemented in CAS Maple.

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CELL SENSITIVITY AND RECOVERY AFTER COMBINED ACTION OF CHEMICAL AGENTS AND RADIATIONS WITH DIFFERENT LET

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Introduction. A lot of the relative biological effectiveness (RBE) of ionizing particles differing in linear energy transfer (LET) have been reported for variety biological test systems. It is known that the mechanism of action of many photosensitisers is associated with inhibition of the ability of cells to recover from the damage induced by ionizing radiation. Densely ionizing radiations are widely applied in radiation therapy. However, there are very little results published in literature for radiosensitization of cells to radiation with different LET. Therefore, in this paper we investigate the anticancer drugs cisplatin and endoxan, used in clinical practice to compare the effect of these compounds on the radiosensitivity and sensitization after cell exposure to gamma-rays and alpha-particles.
Materials and methods. In these experiments diploid yeast cells of Saccharomyces cerevisiae (strain XS800) have been investigation. A source of densely ionizing radiation was alpha emitted 239Pu (20 Gy/min). A source of gamma-rays was 60Co radionuclide (16 Gy/min). Cell viability was assessed by their ability to form colonies visible to the naked eye after 5-days incubation on solid nutrient medium at 30 °C. Cisplatin (platinum complex) and endoxan (cyclophosphamide) applied in medicine as anti-cancer agents have been employed in our work. Their sensitizer effects are related with the inhibition cell recovery ability. To conduct the experiments, the drugs at a concentration of 0.002 and 0.01 and 0.02 mg/ml for gamma-rays and 0.005; 0.01 and 0.05 mg/ml for alpha-particles have been fed down.
Main results. Survival curves were obtained for diploid yeast cells irradiated with ionizing radiation of different LET. Cells were incubated in solutions with various concentrations of drugs during post irradiation recovery in not nutrient environment. The survival curves were also obtained after combined action of ionizing radiation and drugs analyzed. Both drugs have been shown to inhibit the process of cell recovery, the inhibitory effect was more pronounced after low-LET radiation and at higher drug concentrations.
Conclusion. It is concluded that the mechanism of radiosensitization of both drugs is related with inhibition of cell ability to recover from damages induced by ionizing radiation with different LET.

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Evaluation of atmospheric deposition of heavy metals in the Ostrava agglomeration (the Czech Republic) using moss biomonitoring

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The objective of my study is the evaluation of atmospheric deposition of heavy metals in the Ostrava agglomeration (the Czech Republic) using moss biomonitoring. Mosses absorb majority of nutrients directly from precipitations and dry deposition, the uptake of metals from soil is small. Therefore they are suitable as bioindicators of heavy metals from atmospheric deposition. Samples were collected at 41 sites in the Ostrava agglomeration using grid sampling intensity of 15 km. Concentrations of copper, nickel, cadmium, arsenic and lead were determined. Samples were analyzed using atomic absorption spectroscopy and neutron activation analysis. The results were compared and evaluated in time series.

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Thermal conductivity of composite nuclear fuels during burnup

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Thermal conductivity of uranium dioxide containing SiC spheres, SiC whiskers, single wall carbon nanotubes, single wall carbon nanotubes coated with SiC and K1100 graphite fibers coated with SiC is modelled during burnup. Radiation degradation of SiC thermal degradation is described with a simple model but due to lack of data on thermal conductivity degradation on carbon, a simplified assumption had to be used in modelling of thermal conductivity degradation of carbon compounds. In compare with pure UO2, thermal conductivity of composite nuclear fuel is higher in all cases even at low concentration of additives. High thermal conductivity of additives overcomes the negative effect of Kapitza resistance at phase boundaries.

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Presence of heavy metals in soil samples from Czech Republic analysed by X-Ray Fluorescence

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The aim of this study is to find out over limited values of heavy metals which are noxious for the enviroment. Using X-ray fluorescence analysis were measured 53 soil samples from river Elbe and Moravia. The study was held in Flerov Laboratory, JINR. We observed over limited concentrations of nickel in the most of the samples. The reason could be draining of insufficiently cleaned water to the rivers from the industrial areas. The higher concentration of cadmium was detected from the Elbe river than in Moravia. This study is in comparison with results from AAS and chemical analytical methods. This overview of elemental composititon is very useful for public safety in Czech Republic and for protection of soils.

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Feasibility studies of TiO2 and LiTiO2 polymorphs using Density Functional based Tight Binding (DFTB+)

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Titanium dioxide nanoparticles, which are anticipated for use in a wide range of batteries industries. This enhancement has mostly been attributed to their large surface-area to volume ratio and has attracted enormous research interest in recent years. In this work, structural and electronic properties have been predicted on anatase TiO2 and LiTiO2 (bulk and nanotubes) using DFTB+ code. Structures of anatase TiO2 and LiTiO2 were generated using crystal code. The potentials derived using DFTB+ for LiTiO2, were used to optimized TiO2 nanotubes with lithium inserted successfully.

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The influence of doping liquid crystals with magnetic particles on the phase transition temperature

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The possibility to alter the isotropic- nematic (I-N) transition temperature (TI-N) in liquid crystals with an external field has been known for long time [1]. However, the effect has not been produced via magnetic field until recently. The first experimental observation of the predicted magnetic field dependence of the TI-N has been carried out with a powerful electromagnet using a bent-core nematic LC [2]. An increase of the phase transition temperature by 0.7°C has been achieved with application of a magnetic induction of B=30 T. An even larger increase of the I-N phase transition temperature (4°C) has been reported in another bent-core nematic by an application of only B=1 T [3]. Doping LC with various magnetic particles may also affect the temperature of the I-N phase transition. Our results [4] have proven that ferronematics composed of calamitic LCs and rodlike magnetic nanoparticles (MNPs) can be just as effective in demonstrating the magnetic field induced I-N phase transition as pure bent-core nematics [2]. Recently a consistent mean-field model was developed for the field-induced shift of the temperature of I-N phase transition in ferronematics [5]. It shows that particles might either enhance or decrease the clearing temperature of the suspension depending on the anchoring conditions on the particle surface and may be promising for future application [6]. We will also demonstrate the influence of the shape anisotropy of MNPs on the I-N phase transition in ferronematics based on the nematic liquid crystal 4-(trans-4-n-hexylcyclohexyl)-isothiocyanato-benzene (6CHBT) [7].

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Development of the relational database for BM@N offline analysis

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Today relational and NoSQL databases are extensively used in large high-energy physics experiments. They can provide unified access and data management for all collaboration members, correct multi-user data processing, ensuring the actuality of the information being accessed, data consistency and integrity. This report presents the developed relational database for the fixed target experiment BM@N at the Joint Institute for Nuclear Research. The structure and purposes of the experiment will be noted. The database solves the following problems encountered after the first BM@N technical run and concerned with data storing: the usage of multiple files and arbitrary formats, duplication of information, data isolation and inefficient search. The entity-relationship scheme and its parameters will be described. The developed database implemented on the PostgreSQL provides user access to the actual information of the BM@N experiment: configuration, calibration, parameter and algorithm data. The C++ interface developed as a part of the BMNRoot environment for BM@N offline analysis will be presented. Also the Web interface implemented to simplify reading and changing the data by users will be shown.

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Stochastic cooling system at Nuclotron

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Stochastic cooling system is one of the crucial elements for NICA accelerator-collider facility. The preparatory experimental work on longitudinal stochastic cooling is carried out at accelerator Nuclotron. Filter and time-of-flight stochastic cooling methods are chosen to be operating at Nuclotron. In this work the structure of the system is described. Given algorithms allow to make remote adjustment of system components features (e.g. filter frequency, delay line time) and to switch all devices to operational regime.

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CALCULATION OF THE BAND STRUCTURE OF THE HETEROJUNCTION AlxGa1-x/GaAs

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This paper considers the calculation of the potential well profile for a heterojunction AsGa. Joint self-consistent solution of integro-differential equations of Schrodinger and Poisson equations is applied for calculation. The calculations of dependences of the charge density to the potential well of the heterojunction are shown. The approximation of the potential well of the triangular profile is substantiated, the advantage of this approximation compared with the infinite rectangular pit is displayed. The use of the calculation of the band structure during computing the dependence of the electron-electron interaction is shown.

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Exclusive photoproduction of a2(1320) at the COMPASS experiment.

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The charge exchange reactions at high energies are the object of lively interest. In the proposed talk we discuss our study of the exclusive photoproduction of charged a2 meson off the target nucleon using data of the COMPASS experiment.
COMPASS (COmmon Muon and Proton Apparatus for Structure and Spectroscopy) is a high-energy physics experiment at the Super Proton Synchrotron (SPS) at CERN designed to study of hadron structure and spectroscopy with high intensity muon and hadron beams. The cross-section of the studied process is estimated in the energy range from 10 GeV to 120 GeV. The obtained preliminary results don't contradict to the existing theoretical predictions.

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Efficiency calibration of NaI(Tl) detector for measuring the plume of nuclear power plant.

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A method of efficiency calibration of collimated scintillation detector for measurement of the nuclear power plant (NPP) plume was developed. The method consists of two stages. At the first stage, intrinsic efficiency of detector, that includes both the energy and angular response of the detector, was estimated. At the second one, the integral efficiency of the NPP plume was calculated by software based on the Monte-Carlo method.
The intrinsic detector efficiency was determined for 2.5×2.5″ NaI(Tl) detector using as a source 226Ra with radioactivity (367 ± 11)·105 Bq. The measurements were carried out at the distance of 5 meters from the detector front face considering radiation source as a point. The detector efficiency was determined for a set of six energies (ranging from 242 to 1238 keV) and 10 angles (between 0 and 90 degrees, with 10 degree increments). The uncertainty of the peaks measurement results did not exceed 5%. Mathematical processing of the obtained discrete data resulted in the acquisition of a set of smooth dependences, which describe efficiency values as a function of distance and angle. Uncertainties of efficiency curve values in dependence of the photon energy were in the range 3÷8 %.
The software, which allows calculating the angular correction factors for efficiency in the presence of the detector collimator, was developed. Software requires the following set up parameters: intrinsic detector efficiency, geometrical parameters of the plume, which depend on the atmosphere state, distribution of radioactivity inside the plume, average plume height over the ground, etc. At low distances (hundreds of meters) from NPP the radioactive plume can be described by Gauss model. Absorption coefficients in the air, which depend on the weather conditions (temperature, atmospheric pressure, humidity) were also included in calculations. To determine the average plume height a special two-step procedure based on gamma-ray spectral data was applied. At the first step the plume height was accepted to be equal to the height of the ventilation pipe of NPP with addition of some extra value, which depends on environmental parameters. At the second iterative step the plume height was determined from spectral data by means of measurement of suitable photo peaks ratio belonging to the same radionuclide.
The integral efficiencies for different radioactivity distributions inside the plume were calculated. It was shown that uniform distribution may lead to a significant overestimation of the results comparatively to non-uniform. Use of a triangular distribution gives the relative difference up to 20% with respect to Gaussian one.

The work is supported by the Russian Fund for Basic Research (Grant № 16-33-00434).

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PREDICTION OF VOID SWELLING IN THE BAFFLE OF VVER-1000 REACTORS BASED ON VVER-1000 MOCK-UP CALCULATIONS IN LR-0 REACTOR

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The planned lifetime of first commercial VVER units was –designed for 30-35 years. Most of early VVER plants are now reaching and passing the 35-year mark. Service life extension for another 10-30 years is now under investigation. Life extension requires the evaluation of pressure vessel internals material degradation under long-term irradiation. One of the possible factors limiting the service life of VVERs is void swelling of the Russian type titanium stabilized stainless 08Ch18N10T used to construct the baffle surrounding the core.
Void swelling of internal parts of the reactor is closely related to the temperature at the site of gas formation in the barrel material. This temperature may be significantly higher than the temperature of the coolant in internal parts of reactor because there is significant heating due to gamma radiation. Gamma caused heating got origin by fission in fuel or neutron interaction. Mainly in deep parts of the barrel an important role is played by the gamma originated by thermal capture on steel (7.63MeV a 7.65 MeV). Since, these reactions are caused mainly by thermal neutrons, theirs correct description is fundamental for accurate gamma field distribution description.
This study aims to estimate the impact of gamma heating on barrel material degradation. Experiments of VVER-1000 mock up loaded in LR-0 reactor provide data such as reaction rates distribution, neutron and gamma field distribution. The comparison of MCNP6 calculations with experimental data allows declaring that the computation model is correct with the given precision. Moreover, the calculation provides data which is impossible to measure, such as deposited energy of particles. Completing this data with thermo-hydraulic computation in Fluent code, it is possible to determine the Void swelling in material caused by radiation

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Nanoindentation Study of Amorphous Alloy at Nanoindentation

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Nanoindentation experiments were performed on amorphous metallic ribbons. The alloys with composition of Fe40Ni40B20, Cu47Ti35Zr11Ni6Si1 and Zr65Cu17.5Ni10Al7.5 were chosen for their different microhardness and glass forming ability. The individual serrated plastic flow events were analyzed in a wide range of the loading rates from 0.05 to 100 mN.s-1. It found that the serrations in the load-displacement (P-h) curve are more pronounced at lower loading rates and gradually disappear upon increasing loading rate. More developed discontinuities at higher deformations are created for the materials with lower microhardness and so lower strength. We have estimated the contribution of the inhomogeneous plastic deformation from pop-in events on the P-h curves. It was found that the discontinuities began at a certain local deformation independently on the macroscopic mechanical properties of a ribbon.
During nanoindentation the stepwise plastic deformation occurs and the catastrophic failure is suppressed. Using scanning electron microscopy the shear band pattern on the indent region was observed and compared with the pop-in population.

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The influence of geometry of the template on the crystal structure of Ni based nanotubes

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In recent years, a growing interest in artificially ordered magnetic nanostructures caused not only by the desire to understand the fundamental properties of these materials, but also by the variety of possible applications. Such applications range from magnetic recording to the sensors and bio-magnetism. Among the different tested materials, Ni-based nanostructures are attractive due to their excellent magnetic properties, high level of magnetization. One-dimensional nanostructures can be prepared by various methods such as molecular beam epitaxy, electrochemical deposition and nanolithography. Electrochemical deposition of metals within the pores of nanoscale patterns is particularly attractive because it is a simple and cheap method of making large arrays of nanowires with monodisperse diameters and lengths. This method makes it possible to adapt the size, length, shape and morphology of the material by controlling the morphology of the template and synthesis parameters, which in turn makes it possible to accurately determine the structure and magnetic properties of the nanostructures.

In this paper we consider the influence of the pore diameter of sample matrix on the formation of the crystalline structure of Ni-nanotubes obtained by electrochemical deposition. As a template there were used PET based track membranes with thickness of 12 microns, irradiated on the heavy ion accelerator DC-60, with diameters from 180 to 380 nm. To study the characteristics of the Ni-nanotubes there were used methods of REM, EDS, XRD. With the increase in pore diameter we observed the increase of the growth time of nanotubes, as well as the wall thickness due to the increase of the pore volume. At the same time the volume rate of deposition of nickel at the same potential difference for all of the samples remain constant, that allows you to control the process of growth of nanostructures. Electrochemical deposition process accompanied by the release of hydrogen as well as adsorption by the surface of cathode of impurities as hydroxide molecules, salts of anions, some of which precipitates on the surface of a template matrix and form a blocking film that prevents movement of the metal ions, there by passivating the surface of cathode. Also, the impurities may be incorporated in the crystal lattice, thus causing deformation of crystallites associated with the introduction of impurity atoms into the surface of nanotubes. With increasing deposition time by increasing the pore diameter, the thickness of the blocking film formed on the surface of the template matrix increases. Since during the electrochemical deposition of the plating metal ions moving along the normal to the cathode surface, the formed blocking film may reverse the direction of motion of the ions to the cathode. Moreover, if the metal ions have sufficient energy to overcome the blocking film, the movement of ions to the cathode surface is in the direction of growth with the axis of texture [111], if the ions do not have sufficient energy then occurs tangential growth of crystallite with the axis of texture [200].

Analysis of the width and shape of the diffraction peaks shows that the test samples have a polycrystalline structure with fcc phase, and crystal lattice parameters differ from the reference values, indicating the presence of microstresses microdistortions in the structure and lattice. According to XRD analysis of the obtained samples, it was determined that with the increase in pore diameter, and therefore, the deposited volume, the increase in the intensity of the peak (200) is observed on the diffraction patterns, thus also changes the geometry of the peak (111) in the direction of the asymmetry, which might be caused by the presence of impurities in the crystal structure. Reducing in the intensity of the peak (111) is due to the decrease in the size of the blocks of coherent X-ray scattering (crystallite size), oriented in the same direction (111), while increase in the intensity of the peak (200) caused by the reduction of microstrain degree in the crystal structure and increase of the size of crystallites oriented in the direction of [200]. Calculation of texture coefficients according to the Harris equation also confirms the assumption about the reorientation of the crystal structure with an increase in geometric parameters of template matrices and the allocation of texture in the [200] direction. It is also possible to make an assumption about the effect of wall thickness on the change in the crystal structure. With the increase in the pore diameter, the transverse process of the growth of the structure begins to prevail over longitudinal growth due to the increase of deposited volume. In this case, the tangential growth of crystallites begins to prevail over the growth in the normal direction due to the formation of the multilayer growth structure of nanotube.

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Angular observables and di fferential branching fraction of the decay $B_{s} \to \phi\mu^{+}\mu^{-}$ in the covariant quark model

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[2] *Alekseevich*

We present an angular observables of the $B_{s} \to \phi\mu^{+}\mu^{-}$ decay using the recent LHCb measurements of the primary observables S_{3},S_{4},S_{7} and A_{5},A_{6},A_{8},A_{9}. Also we present our numerical results for the differential decay distribution and branching ratio. We compare our findings with the results of other approaches.

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Measurement of the beam flux density with an organic scintillation detector

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The results of measurements of the beam flux density of heavy ions with organic scintillation detectors are presented.

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The investigation of the structure of bicelles by the method of small-angle scattering

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The results of the small-angle X-ray (SAXS) and neutron (SANS) scattering experiments on bicellar systems are presented. The main goal of the experiments is to investigate the changes of the bicellar structural parameters during the crystallization of membrane proteins. The measurements were carried out on the samples with the molar ratio of DMPC/CHAPSO = 2.7, with different concentrations of the lipids, buffer composition at different temperatures. The experiments showed the changes of the structural parameters of the bicelles with the changes of the lipid concentration, buffer composition and time of the stabilization of the solution.

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Multi-loop calculation of critical exponents in the model A of critical dynamics.

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In this paper we consider a dynamic model A in 4 loop approximation, which describes a uniaxial antiferromagnetic.

Physical interest is to find the dynamical critical exponent z, which determines the growth of the relaxation time near the critical point. Renormalization group method allows us to calculate this exponent in the form of epsilon-expansion (d = 4 − 2 epsilon, d – the dimension of space).

The main problem of multi-loop calculation is a large number of diagrams in critical dynamic models. In the present work it is shown that the suitable regrouping of diagrams can significantly reduce the number of the integrals which required to calculate the final result. The main outcome is obtaining of epsilon-expansion z in 4 order.

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The methodology of manufacture of electrodes for model lithium-ion batteries

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A methodology for the manufacture of cathodes and anodes for modeling electrochemical cells was developed. These cells were designed for in situ neutron structural analysis of the processes occurring during of lithium-ion batteries work. Electrochemical characteristics of commercial and our electrodes prepared of the same electrode materials are approximately equal. It allows to explore the real-time work of new electrode materials which are promising for use in lithium-ion batteries.
We are grateful to A.V. Ushakov for help in developing the methodology.
Our work is supported by Russian Science Foundation, grant no. 14-12-00896.

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INVESTIGATION OF EXOTIC STATES OF 13C

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The differential cross-sections of the elastic and inelastic α + 13C scattering were measured at E(α) = 29 and E(α) = 65 MeV. The radii of the states: 3.09 (1/2+) and 8.86 (1/2-) were determined by the Modified diffraction model (MDM) at E(α) = 65 MeV and 3.09 (1/2+) at E(α) = 29 MeV.

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HYDRO-/SOLVOTHERMAL SYNTHESIS AS A VERSATIL TOOL FOR SYNTHESIS OF MAGNETIC NANOPARTICLES

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In the present work the cobalt ferrite nanoparticles (CFO NPs) were prepared via one-step hydro-/solvothermal method. The effect of solvent (water, ethylene-glycol and water/penthanol 2:1) and critical synthesis parameters on the physicochemical properties of as-prepared samples was examined. The obtained powders were characterized by X-ray powder diffraction (XRD), transmission electron microscope (TEM), scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FT-IR) and vibrating sample magnetometer (VSM). In the case of hydrothermal synthesis where water was used as solvent and sodium hydroxide as precipitating agent, the results show that the formation and growth of CFO phase depends on the pH of the starting solution. Additionally, magnetic properties of CFO NPs can be changed from ferrimagnetic to superparamagnetic by controlling the pH. It was observed that the synthesis temperature has influence on the growth of particles, as well as their morphology. The change of the solvent and precipitating agent to ethylene-glycol and ethanolamine resulted in formation of ferrimagnetic CFO nanospheres with diameters in the range of 100-300 nm. TEM images showed that each CFO nanosphere is being composed of smaller CFO nanoparticles with size around 7-8 nm. In order to overcome the problem of agglomeration of NPs the water/penthanol 2:1 was used as a solvent whereas the oleic acid was used as surfactant. The sample prepared without oleic acid consists of highly agglomerated nanoplatelets, while the addition of oleic acid decreases the size of the CFO NPs and changes their morphology into sphere-like. The results show that the 0.25 M oleic acid is the critical concentration at which CFO NPs changes magnetic behavior from ferrimagnetic to superparamagnetic. It can be concluded that the selection of different solvents and control over critical parameters of the hydro-/solvothermal method provides a simple, one-step synthesis of magnetic nanoparticles with different size, morphology and magnetic properties that can satisfy various demands in the wide application range.

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Nonequilibrium meson production in strong fields

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Abstract:
We develop a kinetic equation approach to nonequilibrium pion and sigma meson production in a time-dependent, chiral symmetry breaking field according to the inertial mechanism [1]. We investigate the question to what extent the low-momentum pion enhancement observed in heavy-ion collisions at CERN - LHC can be addressed within this formalism. In a first step [2], we consider the inertial mechanism for nonequilibrium production of σ–mesons and their simultaneous decay into pion pairs for two cases of σ mass evolution. A complete description of σ-π system requires the solution of the relativistic Boltzmann equation including π-π rescattering effects with a condensate component in the pion distribution function. We present the solution of the kinetic equation for a rapidly expanding hadronic fireball (Hubble flow). We employ techniques that have been developed for studying kinetic processes in the expanding universe [3].

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FLUKA and GEANT4 simulations for studying the production of 6He

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In this paper the experimental results and simulation results of the production of the exotic 6He nuclei with the use of the 22 MeV electron beam provided by the MT-25 microtron are presented.

This method for obtaining 6 He nuclei may turn out to be one of the most optimal and inexpensive as compared with other methods, which are used for the production of exotic nuclei.

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2d Bose condensation and Goldstone singularities.

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2-d Bose-gas model with density-density interaction is considered. The possibility of the finite temperature phase transition is shown. The Goldstone singularities are investigated for homogeneous ground state and for the vortex one of the KTB type. It can be connected with another vortex structures investigations.

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Study of the influence of inhomogeneities and chemicals in tissues on the Bragg peak

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Cancer treatment is one of the most meaningful branch of the medicine in our days. Almost half of all people with cancer have radiotherapy as part of their treatment plan. The main criterion used in all radiotherapy techniques is to deliver a sufficient dose to achieve tumor while minimizing side effects. In this case use of light nuclei, e.g. carbon ions, have an additional advantage compared to protons associated with their enhanced relative biological effectiveness.[1]. Since hadron therapy just a part of cancer treatment it is needed to consider the effects of chemotherapy.
Computational physics allows us predict the biological response with accuracy necessary for therapy planning. So in this work was used a Geant4 toolkit[2] to simulate the passage of carbon ion through homo- and heterogeneous matter, calculate depth-dose distribution and investigate the influence of inhomogeneities and chemicals on the Bragg peak.

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Research of the influence of electron irradiation on the degree of roughness of the silicon

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Currently, the most popular material for semiconductor electronics is silicon. It is used in the manufacture of semiconductor devices, chips and processors, in household appliances and computers, mobile phones and solar energy, digital television, navigation systems, etc. Wide range of silicon applications is due to the quite large band gap, the unique features of the etching, high mechanical properties of its oxide and virtually unlimited natural stocks. One of the main applications of a semiconductor silicon is solar energy. For about 85% of photoconverters for solar cells are silicon-based, having electron or hole conductivity with average specific resistance of 1 ohm*cm.

The least explored field is influence of external factors (heat treatment, irradiation with high-energy particles, deformation, etc.) on the electrical parameters of silicon semiconductors and aspects of purposeful modification of the electrical properties of the material. In the literature there is extremely few papers about analysis of the effect of thermal annealing and electron irradiation (there is practically no information on the impact of high-energy electrons) on the electrical parameters of silicon semiconductors. Single-crystal silicon wafers were used as the study sample. Irradiation was carried out with the accelerator ELV - 4 (Kurchatov, Kazakhstan) by electrons with an energy of 5 MeV and current density of 8 mA. Examination of silicon surface was conducted before and after the electron irradiation with aid of atomic force microscope. Analysis of the data showed that the electron irradiation reduces surface roughness by annealing of electronic defect.

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THE RADIAL DENSITY GRADIENTS OF SOLAR COSMIC RAYS

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In this paper change of N-S asymmetry of solar cosmic rays (SCR) during solar flares was investigated and radial density gradients for solar flares of 23-24 cycles of solar activity were calculated.

Investigation of propagation of SCR in interplanetary magnetic space (IMS) showed that the radial density gradients of SCR can vary within a wide range for various flares and to take both positive and negative values. For flares, for which the N-S (north-south) asymmetry is negative and close to zero, radial gradients repeat course of N-S asymmetry. Since the main contribution to calculation of radial gradients brings values of N-S asymmetry. For such flares, for which the N-S asymmetry is positive the radial density gradients of SCR varies in anti-phase. Analysis of events of 23-24 cycles of solar activity shows that most of the flares observed a positive N-S asymmetry of SCR.

Keywords: solar flare, N-S asymmetry, radial density gradients.

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Magnetic field buoyancy in accretion disks of young stars

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We investigate fossil magnetic field of accretion disks of young stars. It is assumed that Parker instability leads to the formation of the flux tubes of the toroidal magnetic field in regions of the effective generation of the magnetic field. We modify our magneto-gas-dynamic model of accretion disks [1] in order to take into account buoyancy of the toroidal magnetic field. Stationary solution of the induction equation is written in the form in which buoyancy can be treated as the additional mechanism of the magnetic flux escape.

We calculated intensity of the fossil magnetic field of accretion disks of young T Tauri stars using the modified model. We consider cases when cross-section radius a of the magnetic flux tubes is 0.1H, 0.5 H or 1H, where H is the accretion disk scale height. Calculations show that buoyancy limits magnetic field intensity at the level comparable with the intensity of the vertical magnetic field component for the case a=0.1H. Applications of the results to the activity of young stellar objects are discussed.

Acknowledgements. This work is supported by Russian Science Foundation (project 15-12-10017).

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High-order WKB corrections to the quantum mechanical two-Coulomb-centre problem

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The asymptotic formulae for the two-Coulomb-centre quasiradial and quasiangular wave functions are obtained for large internuclear distances R by means of the modifi ed perturbation theory. It is shown that in each order of $1/R$ the corrections to the wave functions can be expressed by a fi nite number of Coulomb wave functions with the modifi ed charge. Simple analytical expressions for the first, second, and third corrections to quasiradial and quasiangular functions are derived.
The consistent scheme for obtaining WKB expansions for solutions of the quasiangular equation in quantum mechanical two-Coulomb-centre problem Z_1eZ_2 is developed. In the framework of this scheme quasiclassical two-Coulomb-centre wave functions for large distances between the fixed positive charges (nuclei) are constructed for the entire space of the negative particle (electron).

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THE DEVELOPMENTOF A SELF-CONSISTENT NUCLEAR CLUSTER-CORE POTENTIAL FOR STUDYING CLUSTER PHENOMENON IN SUPER HEAVY NUCLEI

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The project will require the mathematical formulation of the bound state properties of performing a literature survey of all available experimental quantities on the structure of SHN, such as the excitation energy spectra for the positive parity states, electric dipole B(E1) and quadrupole moments B(E2). A mathematical formulation, based on a relativistic mean field approach, of the structure observables will be developed, and used to construct computer codes to perform all the relevant calculations, where after the model predictions will be analysed and compared to experimental data.

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Matter effect in neutrino oscillations for NOvA experiment

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NOvA is an accelerator experiment at FNAL (USA) devoted for studying neutrino oscillations (electron neutrino appearance and muon neutrino disappearance in both neutrino and antineutrino modes). This is one of off-axis new generation experiments with two detectors sited at 14 mrad off the NuMI beam axis and separated by 810 km of the Earth crust. The nu_e appearance analysis aims to determine the neutrino oscillation mass spectrum and measure the CP violating phase. First results of the NOvA experiment based on 1 year statistics in neutrino mode were presented in 2015. In this talk we focus on matter effect in oscillation phenomenon — observing an enhancement in nu-mu to nu-e oscillations by passing nu-mu beam through the earth crust (in comparison with a vacuum case).

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Three-atomic systems in the framework of Faddeev differential equations.

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The properties of pairs of rare gas atoms are studied. Spectrum, average distance and mean square radius of all possible homogeneous and heterogeneous rare gas dimers in the different potential models are calculated. The spectrum of helium trimer in the framework of the Faddeev differential equations in the representation of total angular momentum is calculated. It is shown that all modern potential models reproduce well the position of the excited state with respect to the threshold of the pair of atoms. Although the absolute values of the excited state energy of the trimmer and the binding energy of the helium dimer are significantly different in other studies. This situation requires further investigation.

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EXPERIMENT FOR DOSE MEASUREMENTS AROUND THE IRRADIATED PHANTOM IN THE TREATMENT ROOM FOR PROTON THERAPY IN DUBNA FOR THE SESSIONS OF AVM RADIOSURGERY

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Regular sessions on proton therapy of cancer and some other diseases are carried out at the Medical-Technical facility of the Laboratory of Nuclear Problems, JINR. Dose measurements around the irradiated phantom have been performed in the treatment room for proton therapy using proton at 170 MeV energy. The ratio of the ambient dose equivalent to the maximum absorbed dose in the phantom was equal to 0.05 mSv/Gy at 0.5 m distance from the phantom in the condition similar to real patient irradiation. The effective quality factor of secondary radiation is almost constant in space around the phantom, its value is equal to 3.5. This value shows a predominant role of neutrons. The obtained data play a significant role for consideration of presence of accompanying person in the treatment room that may be important for various medical or psychological reasons.

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Experimental data analysis optimization for fast radiation-hard silicon detectors

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One of the beam diagnostics methods at the future Super-FRS@FAIR is the time of flight measurement (TOF). Recently, the application of fast radiation-hard silicon strip detectors (SSDs) to the time measurements have been suggested. The experiment testing SSDs of different sizes and parameters was conducted at FRS GSI in August 2014. We have compared two independent procedures of data analysis. Two sets of fast electronics have been used: 1. PADI preamplifier/discriminator + VFTX2 multihit TDC, 2. CAEN FADC DT5743. The results of these two approaches were analyzed and compared.

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Ultra-compact portable gamma detector system based on CdTe

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IEAP CTU group in cooperation with NRPI (National Radiation Protection Institute) and other partners have interests in the field of ultra-compact portable radiation detectors. Detectors of this type can be mounted on UAVs (unmanned aerial vehicles - such as very popular RC drones or model RC aircraft) and perform precise inexpensive large area radiation scans without people being present in the affected area. This is now in high demand and much needed in the event of incident with releases of nuclear material (like Fukushima Daiichi nuclear disaster). For this purpose, a prototype of ultra-compact portable gamma detector system based on CdTe detector was constructed. Preliminary results of measurements with this device and its features will be presented.

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The 2D hydrogen atom energy spectrum dependence on the orientation of the external static magnetic field

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The theoretical investigation of the 2D hydrogen atom in external fields is presented. The 2D hydrogen atom is considered as a system, where the electron motion around the positive proton charge is constrained in a plane, but electromagnetic fields are not confined to a plane. The effective algorithm for resolving the eigenvalue problem with the model's Hamiltonian is suggested. The numerical scheme is based on the inversed iteration and the original wave function expansion technique, similar to the one used in our recent work [PHYSICAL REVIEW A 89, 052710 (2014)]. The good agreement with existing results for the case of magnetic field orientation along the Z axis was obtained. The energy spectrum values for strong magnetic field were refined. The generalized case of the field arbitrary orientation was studied, the strong dependence of the energy values of the system on the field orientation for different field's strength was shown, that is the main result of the work.

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Application of Zn nanostructures as emitters

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The unique mechanical properties of nanostructures make these structures promising basis for new types of materials that combine high strength properties with thermal and chemical stability, as well as electrical conductivity and low resistance values compared to the bulk materials. An important feature of metallic nanostructures is a high aspect ratio (ratio of height to diameter of the nanotubes), through which the electric field near the tip of the nanotubes is a hundred times greater than the average value of the electric field generated by an external source.
The preparation of Zn-based emitters with a conical geometry is described in this paper. Conductometric method of preparing asymmetric tracks makes possible to produce conical nanostructure with a massive base of the cone and the top of the order of 100 nm, which is suitable for mass production of nano-emitter devices, as geometrical parameters are retained over the entire area of the matrix template. We made a theoretical calculation of the dependence of current density on the electric field with aid of the Fowler - Nordheim ratio, as well as the effect of the aspect ratio of nanostructures on the emission properties.
Changes in the structure of the tip of nanostructures causes a change in the field amplification factor in the range of 6-8%. There is a higher coefficient of field amplification in the case of conical nanostructures, where the structure of the tip results in additional amplification effect of electric field. Zinc-based nanocones obtained by electrochemical deposition may be afterwards applied in the creation of the emitter-base.

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Induction and repair of DNA DSB in human cells after high- and low-LET irradiation

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It is known that high- and low-LET radiation has a significantly different effect on human cells. Low-LET radiation mainly induces isolated DNA lesions, which are generally repaired efficiently. DNA lesions caused by high-LET radiation are more difficult to repair and in some instance are irreparable.
Human fibroblasts were irradiated by 1 Gy of 60Co γ-rays (LET ≈ 0,3 keV/μm), accelerated 11B ions (LET = 134 keV/μm; E = 8,28 MeV/n) and 20Ne ions (LET = 130 keV/μm; E = 47,51 MeV/n) for investigation of influence of high- and low-LET radiation on repair kinetic of DNA double-strand breaks (DBS). To obtain dose response, human fibroblasts were irradiated by 60Co γ-rays and 11B ions in the range of doses from 0,25 to 3 Gy. For DNA DSB detection two DNA DSB response markers - γH2AX and 53BP1 proteins, which form discrete foci at the place of DSB formation, were used and visualized by immunostaining technique and fluorescent microscope.
Analysis of γH2AX/53BP1 foci showed slower elimination kinetics in cells irradiated with accelerated 11B and 20Ne ions compared to γ-irradiation. Within 4 h after γ-irradiation most of the foci were eliminated, while after the action of the 11B and 20Ne ions, number of γH2AX/53BP1 foci decreased only a little. The obtained results further shows the difference between elimination of foci induced by the accelerated ions - 11B ions induced γH2AX/53BP1 foci were eliminated faster than foci formed after the exposure to 20Ne. Dose responses of γH2AX/53BP1 foci formation after 11B and γ-rays irradiation were analyzed. Both curves had a linear character.The obtained results demonstrated various effects of the impact of different qualities of radiation.

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The mathematical model of state safety

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The aim of this paper is to introduce an authorial model of state safety. This model can be used to quantify the power of every state and thus serve as basis for comparing states. The authors present algorithms which outline step by step how to determine state potential and the self-agency force: the efficiency with which a government transforms state potential into state power. The summary of this paper is the presentation of the mathematical model that can by used to quantify and compare the power of analyzed states.

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Global optimization using CUDA parallel computing platform and the evolutionary algorithms

Mr. KUCZKOWSKI, Łukasz [1]

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Global optimization is a branch of applied mathematics or numerical analysis which is focused on optimization of function or set of functions under certain criteria, taking into account constraints. Global optimization differs from regular optimization by considering whole search space not only ranges with local minima and maxima.
Evolutionary algorithm is a method of solving optimization problems using mechanisms inspired by the nature. Evolutionary algorithm processes a set of solutions called the population. The environment on which it operates is defined based on the task pending (fitness function, constrains). Each individual (single population member) represents a different problem's solution. Based on the fitness function each individual is assigned a parameter called the fitness score. The fitness score determines the quality of the solution represented by each member. The algorithm processes the set of solutions using biological based mechanisms such as reproduction, mutation, recombination, selection, and provides a close to optimal solution. It has been proven the evolutionary computation is an effective way of solving global optimization problems. Unfortunately, the algorithm generate huge computational costs.
CUDA is a parallel computing platform and programming model that allows to accelerated computing using GPUs.
In the presentation I would like to show the aplication of CUDA for solving simple global optimization problems using evolutionary algorithms.

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EVOLUTION OF QUARK-GLUON PLASMA AND QUARK-HADRON PHASE TRANSITION

Dr. KUMAR, Yogesh [1]

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We study the effect of thermal quark mass in the free energy evolution of a quark-gluon plasma using simple statistical model after incorporating the curvature term. In this study, the thermal quark mass is dependent on temperature and chemical potential. Also a thermodynamic variable like entropy and specific heat show a nature of phase transition. The results are found to produce significant improvements over earlier results.

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Phenomenological studies of the production of electromagnetic radiation from hot quark gluon plasma

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We study the production of electromagnetic radiation from hot quark gluon plasma. In this study, we use simple phenomenological model incorporating the parametrization factor in the quark mass. The quark mass only depends on temperature but also the function of chemical potential. The results of the production of electromagnetic radiation are enhanced using quark mass and compared with the other results.

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B-Meson Light-Cone Distribution Amplitudes and Their First Inverse Moments

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B-meson consists of the light u- or d-quark and heavy b-antiquark. In the Heavy Quark Effective Theory (HQET) framework, the heavy antiquark is considered as the stationary source and the meson dynamics is completely determined by the motion of the light quark. In the factorization approach, which is commonly used in theoretical calculations of exclusive B-meson decay rates, one needs to know several transition matrix elements, in particular, from the B-meson state into the vacuum one. In case of the later transition matrix element, there are two Lorentz-invariant functions only after the Heavy-Quark Symmetry is taken into account, which are called leading and non-leading Light-Cone Distribution Amplitudes (LCDAs) of the B-meson. As LCDAs are the non-perturbative quantities, their values can be evaluated within, say, the QCD Sum-Rules method and the parameters of the model functions satisfying the general asymptotic properties of LCDAs can be fitted. There are three models for the leading LCDA (by Grozin and Neubert, by Kawamura et al., and by Braun, Ivanov, and Korchemsky) which are widely using in physical applications. Later on, Lee and Neubert suggested the modified form of the exponential model by Grozin and Neubert which, starting from definite scale, matches the asymptotic form following from the perturbative QCD. The non-leading LCDA can be related with the leading one by virtue of the Wandzura-Wilczek relation. Both leading and non-leading LCDAs are modeled within the simplest models by Grozin and Neubert and by Kawamura et al. but two other, more complicated models are presented by the leading LCDA only. We have calculated these non-leading LCDA model related with the models in the Wandzura-Wilczek approximation. Using these LCDAs the momentum-transverse-dependent first inverse moments have been calculated which are of impotence, for example, in the analysis of exclusive radiative, semileptonic and hadronic decays of B-mesons.

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Air pollution characterisation in the Moravian Silesian region using nuclear and related analytical techniques

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This contribution presents the current research activities, that have been taking place at the VŠB Technical Univeristy of Ostrava in the Czech Republic. Research was focused on characterization of the source of air pollution particularly for the particulate matter (PM10) in the Moravian - Silesian region which is one of the most polluted regions of the Czech Republic. The chosen methods were the air pollution vertical monitoring using an unmanned airship and pasive method of biomonitoring through moss species - Hypnum cupressiforme, Pleurozium schreberi and Brachythecium rutabulum. The measured values were evaluated by interconnection among mathematical modeling, Geographical Information Systems and Supercomputers. The moss samples were analyzed using Atomic Absorption Spectroscopy, Instrumental Neutron Activation Analysis (JINR - the reactor IBR-2 of FLNP) in Dubna – Russia, elemental analysis (nitrogen), and chromatography for determination of polycyclic aromatic hydrocarbons. In order to determine the distribution of the particular elements in the moss thalli, modifed sequential elution technique was applied on the part of the collected moss material. Sequential elution technique allows the differentiation between the extracellular, intra- and intercellular sites - which is helpful to assess the form of the accumulated metals - and hence provides the information on the bioavailability of contaminants.

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Charged particles trajectories reconstruction in multiwire proportional chambers at the BM@N experiment

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The algorithm for track reconstruction in the multiwire proportional chambers (MWPC) at the BM@N experiment is described.
Beam tracks before the target and trajectories of charged particles after the target are reconstructed using Nuclotron experimental data with deuteron and carbon beams bombarding the carbon and copper targets.
Trajectories are extrapolated to the interaction point and to the drift chambers.
Efficiencies of MWPCs have been obtained.

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Energy deposition patterns in the synaptic receptors under irradiation with charged particles

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The initial physical structure of high-energy heavy-charged (HZE) particle tracks plays an important role in understanding the basic mechanism of radiation actions on biological tissues. The Monte-Carlo based simulations provide detailed information on properties of the interactions such as spatial distribution of energy depositions, interaction types (ionization, excitation, etc.) and radical species produced [1, 2]. Some recent challenges referred, for example, to preparation of deep-space exploratory missions and to ongoing expansion of the radiation therapy for brain cancer treatment require prediction of radiation risk for the central nervous system (CNS) [3]. In this regard, development of new simulation techniques aimed at estimation of radiation injury to CNS is of great importance. Accordingly, we suggest a model approach designed for prediction of radiation-induced impairments in synapses and synaptic receptors, which are considered to play an important role in radiation damage of the hippocampus-dependent learning and memory. The large energy deposition in small volumes likely enables HZE nuclei to induce violations in the synaptic active zone and, in particular, cause damage of synaptic receptors. Although the precise mechanism of radiation effects on synapses is unknown, this study may contribute to better understanding of the early stages of damage, starting from the primary interaction of a charged particle with the biological matter. In our work, a simulation technique was developed that enables the stochastic energy depositions of particle`s tracks traversals to the synaptosomes and synaptic receptors within individual neurons. Voxelized model of receptors caused by particle track structures of HZE nuclei, that's adapted in Geant4 Monte-Carlo toolkit [4]. The abilities of the suggested simulation technique are demonstrated with the use of 1H, 4He, 12C, 28Si, and 56Fe particles as a damaging factor and the GluN1a/GluN2B NMDA receptor as a target for radiation.

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Effects of finite correlation time and compressibility on the active-to-absorbing-state phase transition: renormalization group approach

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The direct bond percolation process is studied in the presence of random velocity fluctuations. Using Doi approach a coarse grained field-theoretic action is obtained which captures universal
properties of the model near its second order phase transition. Velocity field is modeled by the stochastic Gaussian field with finite correlation time and compressibility taken into account.
The multiplicative renormalizability of the model is proven and the renormalization procedure is then performed to the one-loop order. Stable fixed points of the renormalization group are determined and corresponding regions of stability are calculated within the three-parameter (ε,y,η) expansion.
The model exhibits eight distinct universality classes. Some of them are already well known: the Gaussian (free) fixed point, a directed percolation without advection, and a passive scalar advection. The remaining points correspond to new universality classes, for which an interplay between advection and percolation is relevant.

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Trace metal contamination of surface soil and recycled building materials in Parts of the Sinai Peninsula and Gaza strip

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This work aims to assess the contamination levels of trace metals found in soils and recycled demolition debris located in parts of the Gaza Strip and North Sinai Peninsula, and to identify the main anthropogenic pollutants affecting trace metal contents. Due to the excessive siege and aggression in Gaza, contamination has been found in multiple sites across the region. With such devastation, residents are in critical need to acquire currently scarce resource of building materials in an attempt to rebuild their homes along with necessary infrastructure, and thus, are being forced to utilize the contaminated debris from the aggression as recycled building materials. Also, due to the close proximity of the North Sinai Peninsula and the presence of high pollution, it is expected that similar contamination will be found in this region as well due to the spreading of pollutants via rain or wind, thus necessitating an assessment of contamination levels in both regions. Sixty four samples were collected to represent soil, raw building materials (Ex. cement, Gypsum, and concrete), and recycled demolition debris from the recycling plants in the Gaza strip. Results show high concentrations of Pb, Cd, As, Hg, Ti, Mn, and Cr in most of soil samples from the Gaza strip and more specifically in the heavily bombed areas. These samples also exhibited a clear increase in the average concentration of Zn, Al, Fe, Co, Cu and Ni than the benchmarked values recorded in previous studies. Contamination of Pb, Cd, Cr , Mo, Sr ,Ba was shown in Nagela and Romana zones in the North Sinai Peninsula. Further, concrete blocks and recycled building materials collected from destroyed buildings and crushers from the 2008 war, show high concentrations of Sr, As, Pb, Mn ,Ni, Al , Ti, Ba, Mo, V, Zn and Cu, in comparison to the concrete blocks bought from local suppliers. Contamination levels of soils were assessed on the basis of geoaccumulation index and enrichment factor. Anomalous contamination levels of some trace metals in heavily bombed areas of the Gaza strip are an indicator for being the bombing one of the main pollution sources there. Cluster and correlation analysis revealed that trace metal contamination in soils are of anthropogenic origin.

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Effect of NOS-inhibitor NS23 on radiation-induced alteration in hemapoiesis and survival of irradiated animals

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Suppression of the synthesis of the endogenous nitric oxide after injection of NOS-inhibitors is a promising approach to induce radioresistance. Previously we have shown that radioprotective activity of some isothiourea derivatives had a correlation with their NOS-inhibitory activity. In this study we investigated the influence of one of our newly synthesized N,S-substituted derivative of isothiourea with proven NOS-inhibitory activity on recovery from bone marrow syndrome of acute radiation injury.

Materials and methods. In this research we used substance NS23, an N,S-substituted derivative of isothiourea. Male F1 (CBA×C57Bl6j) mice were exposed to gamma-radiation with dose rate 75-80 mGy/s. To investigate radioprotective activity of new substance we used standard radiobiological tests: 30-days survival of mice and survival of their bone marrow clonogenic cells by methods of splenic endo- and exogenous colony formation. Also we estimated the quantity of cells in bone marrow and peripheral blood using the automatic hematology analyzer Abacus Junior Vet (Diatron, Austria).

Results. Using the splenic exogenous colony formation method we showed that injection of NS23 before irradiation facilitated survival of bone marrow clonogenic cells. Statistically significant radioprotective effect was observed when NS23 was used at dose 1/8 LD16 (40 mg/kg), at dose 1/4 LD16 (75 mg/kg) the effect reached the maximum level and then, when NS23 was used at higher doses, its radioprotective effect remained virtually unchanged. The results of this study allowed to consider the dose 75 mg/kg of NS23 as optimal radioprotective dose for this animal species.

Using the splenic endogenous colony formation method we studied the duration of the radioprotective effect. Statistically significant increase of clonogenic cell survival was observed so far in five minutes after NS23 administration, then radioprotective effect reached the maximum and was stable within an hour after injection. Although after an hour we observed some decline in the efficacy of NS23, nevertheless statistically significant radioprotective effect persisted for at least two hours.

Thus, NS23 protected from radiation bone marrow clonogenic cells. It allowed us to expect that this substance had an effect on hemapoietic recovery after irradiation. At the same time many authors demonstrated the enhancement of migration and proliferative activity of hemapoietic clonogenic cells by NOS-inhibitors. Certainly all of this affects influenced the quantitative structure of peripheral blood of irradiated mice. When 75 mg/kg of NS23 had been used at 30 min before irradiation the severity of pancytopenia and manifestations of hemodepression were much less intensive than in control animals.

Attenuation of radiation-induced hematopoietic changes by NS23 made this substance responsible for protection animals against radiation death. In our study we showed that this NOS-inhibitor protected no less than 90% mice irradiated with 9 Gy and wasn't inferior to the effectiveness of cystamine. Dose modification factor for NS23 was determined by different methods in independent experiments and amounted to 1,44 (1,26 ÷ 1,65) in 30-day survival test; 1,81 (1,29 ÷ 2,38) and 1,56 (1,21 ÷ 1,94) in exogenous splenic colony formation test.

Summary. As a result NS23 strongly protected bone marrow clonogenic cells from radiation. It allowed this NOS-inhibitor to weaken radiation-induced hemapoietic disorders and largely ensure the survival of irradiated at medullary dose range animals.

According to existing criteria of pharmacological selecting of potential radioprotective agents substance NS23 is definitely promising for further development. Carrying out its preclinical studies as emergency radioprotector seems quite appropriate.

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ATMOSPHERIC DEPOSITION OF TRACE ELEMENTS IN THE SOME REGIONS OF KAZAKHSTAN

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The method of moss biomonitoring of atmospheric deposition of trace elements was applied for the of Southeastern, Northeastern and Central parts of the Republic of Kazakhstan to assess the environmental situation in this regions. The ninety moss samples were collected in summer of 2014-2015 growth period. A total of 42 elements (Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Ni, Co, Zn, As, Se, Br, Rb, Sr, Zr, Nb, Mo, Ag, Cd, Sb, Ba, La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Tm, Hf, Ta, W, Au, Th, and U) were determined by epithermal neutron activation analysis. Multivariate statistical analysis of the results obtained was used to assess the pollution sources in the study area of the Almaty, Pavlodar, Oskemen, Shymkent and Semey regions.
Multivariate statistical analysis of the results obtained was used to assess the pollution sources in the study areas.
The descriptive statistics of the 22 analysed elements in all collected moss samples in median values and minimum-maximum ranges for the contents of all elements were compared with the data obtained in Republic of Macedonia (Barandovski, et al., 2010), and the data obtained from Georgia moss survey in 2014 and the data Norway considered as a pristine area of Europe (Shetekauri, et al., 2015).
A comparison of concentrations Kazakhstan-Norway showed the increased values for most of heavy metals (Fe, Mn, Ti, V, As, Mg, Al, Ca, etc) in the studied samples that apparently are due to the state of the industrial pollution in this regions.

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Construction of HTS electromagnets

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Strong magnetic fields are widely used in various fields of science like physics, medicine and biology. Very strong magnetic fields are obtained by superconducting electromagnets. Superconductors can be split into two groups, low-temperature and high-temperature. Low temperature works in liquid helium (4.2K) while high temperature can switch into superconducting state in125K and work effectively at temperature of liquid nitrogen (78K). These two groups are different not only by their critical temperature but also by technology of construction. It varies from adjusting material, components and matrix to designing form of wiring and protection system. As HTS are ceramic materials any distortion in structure, lowers current critical value. It connects with necessity of constructing HTS electromagnets in form of multisection wiring, in which, next sections are separately winded and then connected with resistive elements. In this process there are energy losses. For compensation of this losses there are tries of winding HTS electromagnets similar to classic superconducting electromagnets. Construction method of such electromagnet and problems connected with it are shown in this article.

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Recent exposures of nuclear track emulsion to radioactive nuclei, neutrons and heavy ions

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Featuring excellent sensitivity and spatial resolution a nuclear track emulsion (NTE) maintains a position of universal and inexpensive detector for survey and exploratory research (http://becquerel.jinr.ru/) in microcosm physics. Use of this classical technique on beams of modern accelerators and reactors turns out highly productive. In a number of important tasks completeness observations provided in NTE remains unachievable for electronic detection methods. Computerized microscopes will enable one to approach at a new level to application of NTE.
In particular, clustering features of the wholesome family of light nuclei including radioactive ones were investigated using NTE. New data on the charge topology of 11C dissociation are presented and compared with data on the nuclei 7Be, 8,10B, 9,10C and 14N. Probabilities of occurrence of a variety of ensembles of fragments allow one to reveal their structural weights.
When testing the novel NTE a variety of physics tasks related with measurements of alpha-particle tracks were addressed. Decays of stopped 8He nuclei breaking-ups of 12C nuclei by thermonuclear neutrons are analyzed. Splittings induced by thermal neutrons are studied in boron enriched emulsion. There arises a problem calibration of ranges of heavy ions for ternary fission studies. For this purpose Kr and Xe ions are implanted into emulsion at the JINR cyclotrons. Progress of analysis of NTE samples exposed to Am and Cf sources is presented.

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Compact spherically symmetric static stars with realistic equations of state in the model of minimal dilatonic gravity

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Here a solution of the equations describing compact spherically symmetric static star (SSSS) in the model of minimal dilatonic gravity (MDG) using realistic equations of state (EoS) is presented. We use some of the Brussels-Montreal EoS, which differ by stiffness: BSk19, BSk20, BSk21. The maximum mass of around two solar masses is in a good accordance with the latest observations of neutron stars. We obtained a mass-radius relations for compact SSSS for different mass of the dilaton for the three used EoS. We studied the connections between mass and radius of the compact SSSS and the variables deriving from the dilaton and the cosmological constant. Some of the quantities in the model are able to describe effects analogous to the effects of dark matter and dark energy, confirming the conclusion that the dilaton could play simultaneously the role of dark matter and dark energy.

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Beyond Lithium-Ion Batteries: A Computational Study on Advanced Lithium – Sulphur Battery

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Energy storage will be more important in the future than at any time in the past. Among the myriad energy-storage technologies, lithium batteries will play an increasingly important role because of their high specific energy and energy density.

Li-ion batteries have transformed portable electronics and will play a key role in the electrification of transport. However, the highest energy storage possible for Li-ion batteries is insufficient for the long-term needs of society, for example, extended range electric vehicles. To reach beyond the horizon of Li-ion batteries is a formidable challenge; there are few options.

Here we consider a study on Li–S battery which holds the promise for the next generation of battery technology. The energy that can be stored in Li–S cells is compared with Li-ion; the operation of the cells is discussed, as are the significant hurdles that will have to be overcome if such batteries are to succeed. Fundamental scientific advances in understanding the reactions occurring in the cells as well as new materials are key to overcoming these obstacles.

In the current work we present a comparative study on stability, structural and electronic properties of discharge products formed in Li-S battery, using planewave pseudopotential methods. Structural parameters for the suggested materials were calculated and compare well with experimental results. The elastic constant of all the discharge products formed in Li-S battery accord reasonably with experimental results, and the corresponding stability conditions are satisfied. Furthermore, the lattice dynamics of the products were calculated. The phonon dispersions also suggested that the structures are stable agree well with experimental studies using from neutron scattering experiments.

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Features of the hardware-software environment of the heterogeneous cluster HybriLIT

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The main feature of the HybriLIT cluster is the heterogeneity of its computational nodes – the cluster includes computation accelerators of different architectures. This fact poses specific requirements both for the system software and the specialized software that allows efficient use of the computational nodes of the cluster. The main constraint in the system software setting was the selection of the operational system, the file system, the job management system, etc., such as to be compatible with all the components.

The network boot method [1] provides a convenient tool for making simultaneous changes in the software at all the computational nodes. The method involves several steps: development of a unique image of the basic modules of the operational system Linux for all the computational nodes; development of an image for the automatic adjustment of the nodes encompassing the different architectures of the computational modules (cpu, gpu or mic); image decompression during the computational nodes loading. Such a solution allows making changes in all the computation components of the cluster, future developments included.

The management of the environment variables asked by the users is the using specific module commands [2]. A module-file that contains a list of configured environment variables for users is avoidable for each installed package. Such an approach allows dynamic adjustment of the environment variables and installs the required compilers and libraries.

The CVMFS package [3] enables the access to the software libraries of CERN. It allows dynamic expansion of the available software of the cluster HybriLIT though environment variable adjustments. The needed packages are dynamically loaded on the computational nodes.

The SLURM [4] queueing for each type of a computational node architecture allowed to meet the requirements of all the existing user groups.

The developed hardware-software environment of the HybriLIT cluster secures efficient system administration. It provides wide possibilities for the future cluster expansion, it matches the requirements of scalability and high fault tolerance. It also provides the users with a convenient environment for the development of applications on the basis of parallel programming technologies and for carrying out computations by means of computation accelerators of various architectures.

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Influence of thermal annealing on the conductive properties of CoFeMgnanotubes

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Metallic nanostructures are of great interest, due to their unusual optical, electronic, magnetic and chemical properties. There are various possibilities of their application in optoelectronic devices [1], as catalyst [2] in chemical reactions, as well as in biosensors [3]. To prepare metallic nanotubes and nanowires it is convenient to use the method of template synthesis. The main advantage of this method is the ability to control the rate of metal deposition, as well as the deposition time in the pores by varying current and applied voltage. By adjusting these parameters one can obtain nanoscaled objects with the desired structure.
In this paper we examined the effect of magnesium supplements into the structure of CoFe based nanotubes on the conductive properties during thermal annealing. Polymer PET membrane with pore diameters of 390 - 400 nm were used as template matrix. REM, EDS, XRD methods were used to study the characteristics of the nanotubes. It is shown that the addition of Mg in an atomic ratio of 1.2% leads to a second minimum in the change in resistance versus annealing time graph, which can be explained by changes in the crystal texture and reducing in the defect structure during the annealing process.

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Phase states of 2D Ising-like antiferromagnetic with strong single-ion anisotropy

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The model of ultrathin strongly anisotropic antiferromagnetic films with the frustrated Ising-like exchange interaction has been investigated within the mean-field approximation at low temperatures. Using the diagram technique of Habbard operators it was shown, that different phase states can be realized. So, depending on the relationships between the material parameters, the homogeneous phases are realized: the ferromagnetic, the quadrupole, or the supersolid magnetic phase with. Moreover, the account of dipole-dipole interaction between magnetic ions leads to spatially inhomogeneous states existance. Analysis of the stability lines of these phases allowed determining the phase diagram of the system.

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Mathematical simulation studies of some properties of GaAs:Cr based Timepix pixel radiation detector.

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The Cr compensated GaAs material is characterized by a high electrical resistivity, good electron transport properties, high atomic number and excellent radiation hardness. These properties make GaAs:Cr a very promising material for developing advanced semiconductor detectors for many applications in a wide energy photon range. In this study the interaction of X- and γ-rays with a Timepix semiconductor pixel detector based in GaAs:Cr have been modeled using the Monte-Carlo method. The in-depth distribution of deposited energies and the charge collection efficiency (CCE) of detector with real device dimensions (900 μm thick, pixels of 45x45 μm2 and pitch of 55 μm) have been obtained. A similar semiconductor detector, but with Si as sensor material, have also been simulated for comparison purposes. The calculations have been made for the 241Am photon energies and the energy corresponding to the Kα1 Mo characteristic line. To perform these simulations the code systems MCNPX and ARCHIMEDES have been employed. Using C++ programming language a code to estimate from the simulation results the induced in the detector electrodes charge were developed. The obtained results are analyzed and compared with the experimental ones.

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Event reconstruction in the GEM detector of the BM@N experiment

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Event reconstruction is a fundamental problem in the high energy physics experiments. It consists of track finding and track fitting procedures in the experiment tracking detectors. This requires a tremendous search of detector responses belonging to each track aimed at obtaining so-called <>, i.e. initial approximations of track parameters of charged particles. In the current work a new algorithm of the seed-finding procedure for the BM@N experiment is proposed.

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Specialized thermal neutron detectors for spectrometry at IBR-2.

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The importance of the measurements of neutrons intensity and energy distribution appeared together with their discovery and it continues to be relevant to the present. The complexity of this problem is the lack of electric charge, so that requires transformation of neutrons energy in the kinetic energy of any charged particle. For spectrometry of thermal neutrons in Scientific and Experimental Department of Complex of IBR-2 spectrometers FLNP were developed following specialized detectors in which is used the time of flight method:

• Gas-filled multi-ring detector of thermal neutrons for diffraction studies on microsamples in axial geometry.
• Detector for small-angle scattering of thermal neutrons.
• Scintillation detector based on ZnS(Ag)/6LiF.

These detectors intended for experimental and applied research in the field of solid state physics, carried out on neutron beams of the IBR-2M.

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Multifractal Analysis of Multiplicity Fluctuations in 32S-AgBr Interactions at 200 AGeV.

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Co-Author: Prof. AHMAD, Shafiq [1]

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The multifractal analysis of relativistic shower particles produced in 32S-AgBr interactions at 200 AGeV has been investigated using the method of modified multifractal moments, Gq, in pseudo-rapidity (h) space. A power law behaviour has been observed in the data. The anomalous fractal dimension, dq and generalized fractal dimension, Dq is determined for the present data for different order of moment. The experimental data reflects multifractal geometry in the multipion production process. The multifractal specific heat has also been evaluated for the present data using the generalized fractal dimensions, Dq. We compared our experimental results with those obtained from simulated events of the Lund Monte Carlo Code FRITIOF and uncorrelated Monte Carlo events, (MC-RAND) generated randomly in h-space based on the assumption of independent emission of particles. The experimental data on multifractality has been found to exhibit a remarkable proximity to the analogous data obtained from the FRITIOF code and the uncorrelated Monte Carlo events.

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Calculation of scaling exponents of the direct percolation process in three-loop approximation

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[4] *University of Duisburg-Essen*

Direct percolation process near second-order phase transition between absorbing and active state is investigated by means of renormalization group approach. We carried out numerical calculation of scaling exponents and β functions up to three loop approximation.

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DEVELOPMENT OF TOOLS FOR REAL-TIME BETATRON TUNE MEASUREMENTS AT THE NUCLOTRON

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Co-Author: Mr. GORBACHEV, Evgeny [1]

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A betatron tune measurement system was developed and tested at the Nuclotron. A white noise and chirp signals were used for transverse beam motion excitation. A custom FlexRIO digitizer module was developed which provides excitation signal generation for kicker electrodes and real-time signal acquisition from pickup electrodes. A high resolution FFT algorithm was implemented inside a NI PXI FPGA module, connected to digitizer. The measurement system is integrated with the NICA control system based on the TANGO Controls. Results and tests performed with the Nuclotron beam are presented.

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Differentiation between locations of bioaccumulated ZnO nanoparticles in moss using the Sequential Elution Technique.

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Nanoparticle pollution becomes an important part from the bulk of the pollution, both from the sources connected with their engineering and accidental release from other processes, hence, methods of its monitoring has to be developed and improved. Biomonitoring is one of such methods that represents available alternative to more technical and costly approaches. In an unprecedented study, common terrestrial moss Pleurozium schreberi (Brid.) Mitt. was, therefore, used to asses the distribution of the bioaccumulated ZnO nanoparticles in the moss thalli. Samples were collected in an unpolluted area of Protected Landscape Area Beskydy (Czechia) and exposed to known concentrations of ZnO nanoparticles suspensions for the period of time from 1 up to 8 weeks. Moss material was then subjected to modified Sequential elution technique in order to differentiate between the nanoparticles accumulated on its surface, in the extracellular and intracellular space as well as in the unleachable fraction (particulate material). Leachates from consecutive washings were analysed by the Inductively coupled plasma atomic emission spectroscopy and temporal trends in distribution were assessed and discussed.

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DETERMINATION OF SELENIUM IN VEGETATION SAMPLES FROM POLAND BY REACTOR NEUTRON ACTIVATION ANALYSIS

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Selenium is one of the most important element for living organisms. Research in past 50 years has revealed many functions of this element, especially as a component of selenoproteins. The selenium concentration in biological samples depends on its concentration and bioavailbility in soil. Its concentration in samples is often <1.0 mg/kg, thus very sensitive analytical technique is required for its quantitative determination. Neutron activation analysis at the reactor IBR-2 of FLNP, JINR was used for determination of Se in vegetation samples collected in Poland. Selenium content was determined through short lived isotope 77m-Se and long lived isotope 75-Se. The results obtained are discussed.

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Gamma spectroscopy in the ^{150}Sm rare earth nucleus

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[4] *University of Western Cape*

Intermediate states of ^{150}Sm, excited through the ^{150}Nd (^{4}He, 4n) ^{150}Sm fusion evaporation reaction were studied using clover detectors AFRODITE array at iThemba LABS in Western Cape, South Africa. A beam energy of 45 MeV was used. The gamma-gamma coincidences, DCO (Direct Correlation of oriented states) ratios and linear polarization measurements were carried out and the previously known level scheme of ^{150}Sm was extended in the intermediate region. In this work we report on the gamma spectroscopy results of the ^{150}Sm nucleus and present experimental evidence to further support octupole correlation in the low lying negative parity states in^{150}Sm.

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Creation and results of experiments on a full scale model of the cold moderator in the central direction (CM 1) for IBR-2 reactor. Technical support and devices.

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In the plan of the modernization IBR-2 reactor around a reactor core will be installed 3 cryogenic neutron moderators. For slowdown neutrons in moderators use a mesitylene with m-xylene as frozen beads with a diameter of 3-4 mm. These pellets are served in a moderator chamber by a helium flow. Currently, one of the moderators (202) is already installed and working on the experiment.
Given the positive experience of the moderator (202) is now commissioned a full-scale stand retarder 201 with reference to the premises. The report will be submitted to the moderator 201. The main problem of transportation is download pellets in a moderator chamber (pellets should raise up the height of 4 meters at an angle of 50 degrees). It condition is defined by the geometric position of the moderator in a reactor biodefense . Will present the results of experiments on the loading pellets into the moderator chamber and proposed the concept of a moderator with the continuous change of pellets without stop of the reactor cycle.
In presentation will be show a cryogenic system for all cryogenic complex of cold moderator. It is including two cryogenic refrigerators 700 watt and 1200 watt. If necessary, refrigerators can replace each other.

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Physico-chemical effects of charged particles in the central nervous system: Simulation technique and practical applications

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The radiobiological studies on the radiation effects in the central nervous system (CNS) has become an increasingly important field of research for two major reasons: the nuclear medicine treatment of brain cancers with hadron beams and astronauts traveling outside the Earth's magnetosphere under irradiation with high-energy heavy charged particles [1]. The precise mechanisms of radiation-induced impartments in CNS are poorly understood, however, our proposed modeling approach allows quantitative calculation of ionizing radiation energy and dose deposits in the certain structure of neuronal cells [2]. In this work, using the developed approach were estimated the radiolytic yields of basic radiolysis products as well as direct interaction of charged particles with individual components in neurons. The computational model simulates the complex energy deposition track structure, and overproduction of free radical species during from physical interactions to chemical reactions and diffusions of high-LET particles (i.e., 56Fe) inside and outside individual neurons (in particular, in axons and spines).

The result of present study performed that the total energy and dose deposits with respect to the LET in individual neurons with soma, dendrites, axons and dendritic spines irradiated by different radiation qualities and doses. Also, was observed the radiolytic yields of the main radiolysis products at end of chemical stage (after 1 microsecond) as a function of the LET of charged particles.

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Freezeout Parameters and Dynamical Net-Charge Fluctuations at NICA Energies

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The dependencies of different particle ratios on nucleus-nucleus center-of-mass energy, which can be related to the chemical potential are calculated by using hadron resonance gas (HRG) and Ultra-relativistic Quantum Molecular Dynamic (UrQMD) models. For UrQMD two different types of phase transitions are taken into consideration, namely crossover and first order, while the HRG model implements fully statistical aspects in describing the particle production and their correlations, especially in the hadron phase. The calculations cover a wide range of energies; 3 - 62.4 GeV. The freezeout parameters, temperature (T) and ⊠, are deduced by fitting the particle ratios estimated from the even generator UrQMD with the calculation from HRG at [7.7, 11.5, 19.6, 62.4] GeV. The results agree with the parameters which are independently determined from statistical fitting of the experimentally measured particle ratios and the thermal models. Furthermore, the net-charge fluctuations for K/π, P/π and K/P determined UrQMD, and HRG are compared with the available STAR and NA49 measurements. Their lower energies are also well covered by the future NICA facility. The excellent agreement justifies the conclusion that both UrQMD and HRG are suitable to explain both freezeout parameters and the dynamical net-charge fluctuations.

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Anisotropic flow fluctuations in Pb-Pb collisions at the LHC energy in HYDJET++ model

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The LHC data on event-by-event harmonic flow coefficients measured in PbPb collisions at center-of-mass energy 2.76 TeV per nucleon pair are analyzed and interpreted within the HYDJET++ model. To compare the model results with the experimental data the unfolding procedure is employed. The essentially dynamical origin of the flow fluctuations in hydro-inspired freeze-out approach has been established. It is shown that the simple modification of the model via introducing the distribution over spatial anisotropy parameters permits HYDJET++ to reproduce both elliptic and triangular flow fluctuations and related to it eccentricity fluctuations of the initial state at the LHC energy.

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PARCS/TRACE coupled neutronics thermal-hydraulic calculation in the L335 Benchmark

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This study deals with Control Rod Ejection Benchmark – NEACRP-L335 and coupled neutronics thermal-hydraulic calculation. Coupled calculation is used evaluate transients which occur during nuclear reactor operation. Control Rod Ejection is a transient problem, therefore utilization of the coupled calculation is appropriate. New thermal-hydraulic model was developed in TRACE. This model includes new 3D Cartesian Vessel component which is utilized to represent reactor core. Cartesian Vessel component more closely represent real reactor core than Cylindrical Vessel component, therefore this component was implemented in the TRACE. Right function of the Cartesian Vessel component as well as the correct function of the automapping procedure with Cartesian Vessel component is under investigation within this study. Brief description of the used codes (PARCS and TRACE) is also given in this paper. Comparison of the coupled calculation results with PARCS standalone calculation and with original results of the benchmark shows an agreement.

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Determination of the reactions of heavy ions with atoms of Zn – nanotubes

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Radiation effects occurring in nanomaterials under the influence of ionizing radiation have a number of features that are different from similar effects in micro- and macro-sized objects. From the viewpoint of practical use to create new items of equipment spacecrafts is interest in nanotubes which is based on zinc and produced by template synthesis. The interaction of ions with high energy comparable to the energy of cosmic radiation, with a nanostructure, it passed only a small part of the energy of the incident particle. At the moment, there is no generally accepted description of the specifics of the radiation effects in nanoscale materials and their degree of influence on the structural and conductive properties, as well as the characteristics of products based on them.

To determine the length of the path of accelerated ions in metallic nanostructures was a theoretical calculation of the energy loss by electrons and nuclei studied nanostructures using SRIM Pro, 2013.

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Dose perturbations induced by the presence of dental implants in proton therpay

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The presence of titanium dental implants near the tumor may affect the dosimetric accuracy of proton therapy.
We performed dosimetric experiments using a scanned proton pencil beam in the Proton Therapy Center Prague, Czech Republic, in order to measure the microdosimetric distributions of dose and Linear Energy Transfer (LET) spectra in a phantom containing metallic implants. Using two different materials, which are in standard use in dental worldwide implant production, the 2, 5, 10, and 15 mm thick layers were created. The first phantom type consists of a titanium grade 2 and the second one is made from titanium grade 5. The metallic implants were inserted in 65 mm thick water-equivalent plastic material. Track etched detectors (TED) have been placed behind the phantoms to collect the data.
To study the dose effects of metallic implants and the production of secondary particles, we performed four experiments. The irradiation of both phantoms was first set up in such a way that proton ranges correspond to the position of 10 mm thick layers. In the second experimental set up we used a very high energy (226 MeV) to study the LET spectra at the plateau region of the Bragg peak.
In the case when the range of protons corresponds to the end of 10 mm thick implant we detected a large number of particles at the edges of 15 mm thick implant and the tissue equivalent environment. These tracks result from the scattering of protons in titanium alloys. For the second experimental setup, the results indicate no major differences between the LET spectra of the same material studied and different thicknesses. A large number of tracks, corresponding to particles with LET from 7 keV/μm up to 1000 keV/μm, were detected for all tooth implant materials. In this study we investigated the dose perturbations induced by the dental implants in order to optimize the treatment for head tumors.

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Experimental cross sections for alpha particle induced reactions on p-nuclei

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Preliminary alpha capture cross sections on p-nuclei at energies close to the Gamow window will be presented. The cross section were measured by means of the activation method using an alpha beam delivered by the IFIN-HH tandem accelerator. The induced activities were measured in close-to-detection geometry using two large volume HPGe detectors in a low background passive shielding.

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Using CompactRIO Embedded Controllers in experiment MASHA

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Experiments designed to study chemical properties of elements 112 (Copernicium) and 114 (Flerovium). Synthesized in reactions 242,244Pu + 48Ca. Setup of MASHA is a combination of ISOL (Isotope Separator On-Line)methods and the classical mass spectrometry. There is a requirement for high reliability and stability of the measurement and control. CompactRIO was applied for control(Motor for rotating target and vacuum measurement) and connecting to whole experiment. CompactRIO is programmable in graphical programming environment LabVIEW, which is good for communication between developers and engineers.

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Gamma Radiation Dose Assessment in Yemeni Buildings

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Gamma-radiation activity concentrations in building materials that are most commonly used in Yemen are analyzed. They are measured with the High Purity Germanium (HPGe) detector. The exposure dose rates for individuals staying inside buildings constructed from those materials are calculated. The calculations are done with using the MCNP simulation code. The obtained results are compared with other studies and other countries. The estimated annual gamma doses from the concrete types are high for some samples. Granite stone and cement brick annual doses are even higher than concrete. Some of the samples are found to give radiation doses that could cause harmful effects on population's health.

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Elemental and Radioactive Analysis for some Eye Cosmetics

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Some standard eye cosmetics are collected and investigated for their elemental and radioactive concentrations. The samples are inclusive of both traditional and artificial types. The elemental measurements are made by the Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) to assess the concentrations of the most toxic elements; As, Cd, Hg and Pb. The radioactive measurements are made by the High Purity Germanium detector (HPGe) to determine the radioactivity concentrations of the natural radionuclides 238U, 235U, 226Ra, 232Th and 40K. The obtained results are analyzed, and the average annual absorbed amounts of the heavy elements from daily appliance are estimated. According to our analysis, the average concentrations of the elements As, Cd, Hg and Pb are a bit high in some samples that they might cause some harm to our health. On the other hand, the average radioactivity concentrations for 238U, 235U, 226Ra, 232Th and 40K are not that high. A simulation model for the eye is carried out, using the MCNP code, to estimate the annual radiation doses for the lens of the eye as a result of using the kohl types.

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Development of the CBM RICH readout and DAQ

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We would like to present the results of the comparison of two different types of readout and data acquisition systems (DAQ) through the example of CBM RICH DAQ. Two triggerless DAQ systems are characterized – one based on nXYTER chip and SysCore readout controller and second based on PADIWA front-end board and multi-functional TRB board. Measurement of time characteristics in laboratory and beam situations of the second readout chain is performed, in particular precision of leading edge timestamp detection by separate components and whole chain. The method of software timestamp correction aimed at the performance is developed. The method for measuring luminescence time profile is developed and applied to the wavelength shifter decay time determination.
In order to perform the listed tasks a test setup has been built in the laboratory, measurements have been done, corresponding unpacking and analysis software modules have been developed and obtained results have been analyzed.
The source of the signal in CBM RICH is the modern Hamamatsu H12700 multi-anode photomultiplying tube (MAPMT). This PMT has outstanding characteristics – high and uniformly distributed over cathode quantum efficiency, low noise and cross-talk, small gaps between the sensitive areas.
nXYTER chip allows to register the amplitude of the input signal together with the timestamp of the leading edge of the input signal. This chip splits the input signal into two. First channel is processed asynchronously by a relatively fast shaper and is needed to detect the timestamp of the input pulse. Second channel is processed by the synchronous electronics detecting pulse amplitude using relatevily slow shaper.
PADIWA and TRB are boards which realize most of the functionality using FPGA: PADIWA is a preamplifier and discriminator and TRB is usually programmed such that 4 of 5 available FPGAs work as time-to-digit converters (TDC) and 5th as data concentrator.

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Study of the molecular disturbances in neurons of rodents brain by influencing of ionizing radiations

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Abstract

With the advent of the long and distant interplanetary missions exceptional importance is ensuring radiation safety of crews of spacecraft. The specific nature of the transfer of energy heavy ions when passing through the tissue leads to a completely different type of radiation effects on the body of GCR in a flight into outer space. Evidence of the development of radiation syndromes under the action of heavy charged particles on the structure of the brain and lead to violations of the integrity of its integrative, give reason to consider central nervous system as "critical" system in assessing the risk of radiation exposure to astronauts body in the implementation of interplanetary flight.
We studied patterns of induction and repair of double-strand breaks (DSB) under the action of γ-rays 60Co and accelerated heavy ions 7Li (LET 20 keV/μm). A comparative analysis of the kinetics of DSB repair during irradiation in vivo and in vitro. It is shown that irradiation in vivo kinetics of repair is complex: the initial section is characterized by an increase in the number of DSB (at t = 4-5 h) and subsequent fall. It is assumed that the increase in DNA DSB radiation period due to the influence of the immune system and repair enzymes.
Data obtained from neurons in experiments with rodents γ-rays help to simulate a complete picture of the radiation hazard when the orbital and interplanetary missions, taking into account the effect of multiply charged ions.

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Background suppression in HPGe detectors using Pulse Shape Discrimination methods

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To achieve low background in rare events physics experiments, several techniques are used. Apart from external veto and shielding, one can recognize the physical process taking place in the detector by analyzing the pulse shape of the detector signal. A presented discrimination method between multi-site and single-site energy deposition events in High Purity Germanium detectors is performed on the basis of the shape of preamplifier's signal rising edge, using multivariate classifiers (Multi Layer Perceptron Neural Networks and Projective Likelihood).

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Synthesis of silica fibers from natural asbestos by acid leaching procedure

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The nanofibrous silica with the high surface area was extracted from chrysotile by the acid-leaching method. Naural minerals chrysotile asbestos from Stragari, Korlace, Serbia was employed as the starting material. The modification of fibers is done by chemically treatment with HCl monitoring mineral dissolution by the XRD and TEM-EDS analysis in order to highlight the effect of leaching processes. These results shows that the applied concentration of acid solution (0.5 M HCl solution) and processing time (4 h) were sufficient to effective destroy of magnesium hydroxide layer and change of crystal structure of the chrysotile during the leaching process. IR confirmed these results. The specific surface area, SBET, calculated by BET equation, lie within 147-435 m2 g-1. Also, a significant part of specific surface is in micropores.

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Assessment of basic physical and dosimetrical parameters of PTW microDiamond Type 60019 detector and its application in small field dosimetry

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Purpose:
Stereotactic radiosurgery performed by Leksell Gamma Knife (LGN), Stereotactic Linear Accelerator or CyberKnife systems is based on using small radiation fields. Accurate dosimetric measurements and verifications of small field´s parameters represent one of the biggest challenges in current radiotherapy. In addition to loss of charge particle equilibrium, accuracy of patient positioning and geometry of system, it has to be taken care of the size of used detector. One of promising detectors, especially because of its small sensitive volume (0.004 mm3), seems to be new single crystal diamond detector PTW 60019 MicroDiamond. The purpose of this study is to assess basic physical and dosimetric parameters of this type of detector.

Materials and Method
In this study the measurement of relative output factors for Leksell Gamma Knife Perfexion was performed. In addition basic dosimetric parameters of MicroDiamond detector were verified in clinical linear accelerator photon and electron beams. For the output factors measurement in LGN Perfexion system collimator sizes 4 mm, 8 mm and 16 mm were used so the detector was tested for small field´s dosimetry. In linear accelerator the measurements of short time stability and detector response on dose rate, beam energy, temperature and angular dependence were performed in standard field (10x10 cm). For the whole measurement the PTW Unidos electrometer with 0 voltage was used. All results obtained by MicroDiamond detector were compared with manufacturer reference values and independent Monte Carlo Geant4 simulations.

Results
First of all the stabilization of the detector had to be performed and for sufficient response stability was necessary to deliver dose about 100 Gy (depending on the dose rate the stabilization of detector lasts about 40 minutes). The short-term stability of detector after this pre-irradiation was 0.25% (difference between minimum and maximum value) and the standard deviation of all measurements takes a value 0.07% within an hour. The dose rate dependence was measured for 6 different dose rates (100 – 600 MU/min). Dose difference between maximum and minimum value was 0.24% with standard deviation of measurements 0.09%. Energy dependence was measured in 2 different photon energies (6 and 18 MV) and 5 electron energies (6, 9, 12, 16 and 20 MeV). For photon beam values the difference between maximum and minimum was 0.12% (standard deviation 0.04%), for electron beams this difference was 4.54% with standard deviation of response value 1.62%. The temperature dependence of detector was performed for 5 different temperatures form 16 to 35 °C. The relative difference between minimum and maximum value was 0.66% (standard deviation 0.09%). For angular dependence the difference between minimum and maximum value was 0.90% with standard deviation 0.09%. Finally, results of comparative measurement for relative output factors of the LGN Perfexion for 4 and 8 mm collimators were 0.831 and 0.900, respectively. These values are in a good agreement with vendor values (0.814 and 0.900) and Monte Carlo simulation.

Conclusion
The diamond detector PTW 60019 MicroDiamond appears to be promising tool for relative output factor measurements in small radiosurgery fields. The dosimetric parameters verified in linear accelerator correspond with limits set by manufacturer. However, relatively long
pre-irradiation process is necessary prior to measurement before the detector can produce reliable data. There will follow further measurements and data analysis for this detector.

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JINR Tier1 service monitoring system

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The first Tier1 center of CMS experiment was presented in 2015 in JINR. In order to increase productivity, accessibility and reliability Tier1 operators should keep an eye on many different things. Infrastructure monitoring is already done. The new system was introduced to collect, analyze and visualize the status of all the services. Another purpose of this system is to give detailed information for a possible problem. The most challenging part is to discover the list of tests which allows to establish the overall status of Tier1 center. This work is ongoing, but some results are already achieved.

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Anomalous diffusions in biological cells

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Identifying the underlying mechanism of anomalous diffusions inside biological cells presents a challenging issue for theoretical modelling. In order to tackle this problem, we propose a modification of the well-known stochastic process "fractional Brownian motion". Both analytical and numerical behaviours of main observables of the process named p-variation and ergodicity breaking parameter found using our approach are in very good agreement with experimental data on mRNA molecules' motions inside live E. coli cells.

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Web-service for monitoring Hybrilit hybrid cluster

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Even though tasks of monitoring of distributed computing and gathering its statistics are encountered more and more frequently, there is not so many well-known methods to do this. We developing web-service for hybrid heterogeneous cluster “HybriLIT”, that solves that task using Node.JS as it’s server and AngularJS for a presentment of data. Monitoring itself carried out by a sensor written on C++ with the using of libgtop library. At the moment functions of monitoring CPU load, memory load, network load of the computing node and browsing that data in both table and graphical form are already implemented. Also, there are diagrams of usage for different laboratories and users, information about currently running jobs and an archive table for a jobs that was computed on a cluster.
Link: http://stat-hlit.jinr.ru/#/home

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Phase formation of polyoxotungstates in aqueous-organic solutions

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A new synthetic route for polyoxotungstate synthesis is proposed. Novel clusters of decatungstates with organic and inorganic cations were successfully synthesized from aqueous-organic solutions. The thermodynamic aspects of synthesis, chemical composition, crystal structure, surface morphology, thermal decomposition and magnetic properties were investigated by mathematical modeling, chemical, UV-vis., FTIR- and Raman-spectroscopy, X-ray, DTA analysis and SQUID-magnetometry. These substrates could be used in catalysis, biomedicine, molecular electronics, energy and optical application.

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The effects due to continuation of perturbative results into the timelike domain

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The effects due to continuation of spacelike perturbative QCD results
into the timelike domain are studied. The perturbative contribution to the spectral function is explicitly calculated. The R–ratio of electron–positron annihilation into hadrons is studied and the higher-order pi2-terms are calculated.

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Phenomenological theory of meson gas in the non-perturbative quark-gluon condensate

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Thermodynamic properties of strongly interacting matter were investigated in a wide temperature range within the framework of phenomenological quantum field model of meson gas on the non-linear background, corresponding to quark-gluon condensate. The coincidence of microscopic quantum field approach and thermodynamic analysis of extremes of generating functional was proven analytically. The specific features of temperature dependence of particle masses, condensate amplitude, heat capacity and other thermodynamic quantities were revealed and then used to show and discuss the existence of phase transition in meson gas in high temperature area.

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Electric response in the molecular crystal of halo-substituted derivatives of 3,6-dihydroxy-1,4-benzoquinones with bipyridyls

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Proton transfer plays a crucial role in many chemical reactions or biological processes. Moreover, the proton dynamics in hydrogen bond determines a variety of interesting physical properties, such as ferroelectricity, antiferroelectricity or protonic conductivity and even semiconductivity. In organic electronics, such materials' properties are necessary to build the organic field effect transistors, OFET, used in the non-volatile memories. In the crystal structure of these complexes one-, two- or three-dimensional polymeric structure can be formed. The substances containing benzoquinones may be classified as intriguing compounds in supramolecular chemistry and crystal engineering. Their properties result from their molecular structure because their molecules possess two OH proton donor and two >C=O proton acceptor centers. From the intermolecular proton transfer viewpoint, the combination of complexes of halo-substituted derivatives of 3,6-dihydroxy-1,4-benzoquinones and bases having similar proton affinities guarantees the formation of chains with the one-dimensional hydrogen bonds . The crystals with these properties exhibit a strong anisotropy of physical parameters. Likewise, complexes are named uniaxial ferroelectrics or one-dimensional conductors. In the case of the long-range interactions, the proton dynamics can be estimated by the temperature dependent measurements of the complex value of electric permittivity in the radio frequency range .

The problem undertaken in this presentation is related to a determination of the electric response parameters of the benzoquinone-type compounds as well as their crystal structures The dielectric relaxation, ac and dc conductivity and thermal analysis of crystals have indicated the proton jumps along the chain of the OHN hydrogen bridges [1,2].

1. G.Bator, W.Sawka-Dobrowolska, L.Sobczyk, M.Owczarek, A.Pawlukojć, E.Grech, J.Nowicka-Scheibe, Chemical Physics, 392(2012) 114-121;

2. M.Rok, A.Piecha-Bisiorek, M.Szklarz, G.Bator, L.Sobczyk, Chemical Physics, 452 (2015) 53-60.

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Temperature Dependent Hadronic Bag and QGP Phase Transition in Dual QCD

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Co-Author: Prof. CHANDOLA, H. C. [2]

[1] *Kumaun University Nainital*

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Based on the magnetic symmetry structure of non-Abelian gauge theories, a dual QCD gauge theory is constructed which takes into account the local structure as well as the topological structure of the color gauge group into its dynamics and contains two potentials, the electric and the magnetic potentials in a dual-symmetric way. Using the dual version of QCD in thermal domain following the partition function approach and the grand canonical ensemble formulation, the phase transition from hadron to QGP phase has been investigated within the framework of temperature dependent hadronic bag in the entire T-μ plane. The various thermodynamic properties including pressure, energy density, entropy density, speed of sound and specific heat of the hadron/QGP phase have been investigated and shown to give the firm evidence of the first order phase transition. The profile of the pressure has been shown to be continuous function of the temperature across the phase transition and energy densities have finite jump discontinuities at critical temperature with latent heat. For zero chemical potential it has been shown that the first-order QGP phase transition turns into a rapid crossover. All the independent thermodynamic quantities are exponentially suppressed below the critical temperature and rather slowly approach their Stefan-Boltzmann limits at high temperatures. The interfacial surface tension has also been calculated and found to be proportional to the cube of transition temperature. These predictions are in remarkable agreement with lattice and MIT bag model results.

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On the distribution of separability for qubit-qubit and autrit-qutrit pairs

Mr. KHVEDELIDZE, Arsen [1]; Mr. ROGOJIN, Ilia [1]

[1] *JINR*

The probability o separability, i.e. probability to find the separable states among the randomly generated quantum states are studied for the qubit-qubit and qubit-qutrit systems.
The distribution of separability over diverse invariant characteristics of system have been computed.
The strong evidence of independence of probability on the Bloch radius of single qubit has been identified.

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Trigger system for BM@N setup 2016

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Co-Authors: Mr. SERGUEV, Serguei [1]; Mr. BOGOSLOVSKI, Dmitriy [1]; Dr. YUREVICH, Vladimir [1]; BATENKOV, Oleg [2]

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[2] *Radium Institute*

The report presents a trigger system concept for 2016 BM@N run, it's characteristics and test results of the T0U module during the Run 2015.
The BM@N facility is a fixed target experiment based on heavy ion beams of the Nuclotron-M accelerator. The aim of the BM@N is to study nucleus – nucleus collisions at energies up to 4.5 GeV per nucleon.
The trigger system is used to generate a BM@N zero level trigger and a TOF detector precise start. A level 0 trigger processor unit (T0U) generates trigger signal based on beam line, target area and GEM detector signals. This module also provides both control and monitoring of the detector front-end electronics power supplies.
A prototype T0U for the BM@N deuterons and carbon ions at Run'2015 has been developed.

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The cooling, the regulation and the temperature stabilization system for MPD detector at JINR accelerator complex NICA

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[1] *WUT*

The cooling, the regulation and the temperature stabilisation system is very important for every kind of electronics. Devices which are not cooling can be destroyed and burned. My master thesis is dedicated for this kind of systems for MPD detector as an example of TOF detector.

I prepared simulation of heat transfer in TOF detector whereby I found the best way to avoid destruction in electronics modules.

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Experiment for Detection Coherent Neutrino – Ge Nucleus Elastic Scattering.

Mr. ROZOV, Sergey [1]

[1] *JINR*

The nuGeN is new experiment at the Kalinin Nuclear Power Plant (KNPP) for detection of coherent Neutrino–Ge Nucleus elastic scattering. Recent neutrino and Dark Matter search experiments have revolutionized the detection of rear events, and rear events with low energies, in particular. Experiments have achieved sensitivities on the level of several events per hundred kg of detector material per day with energy thresholds from few hundred eV. This opens up a new unique possibility for experimental detection of neutrino-nucleus coherent scattering that has been considered to be impossible so far. The GeN project uses low threshold high-purity Ge-detectors (HPGe) developed by JINR (Dubna, Russia) in collaboration with BSI (Baltic Scientific Instruments, Riga, Latvia) for creation of a setup designated for first observation of neutrino coherent scattering on Ge. As a powerful neutrino source the experiment will use electron antineutrinos from one of the power-generating units (reactor unit #3) of the KNPP. The coherent neutrino scattering will be observed using a differential method that compares 1) the spectra measured at the reactor operation and shut-down periods; 2) the spectra measured at different distances from the reactor core during the reactor operation. For a setup placed at a 10m distance from the center of reactor core and with an energy threshold of 350 eV up to tens of events corresponding to neutrino coherent scattering on Ge are expected to be detected per day in the constructed setup with four HPGe low-energythreshold detectors (400 grams each). The setup sensitivity will be even more increased by using new detectors with total mass up to 5 kg.

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Measurement of special modes of double beta decay in experimnets TGV and OBELIX

Ms. RUKHADZE, Ekaterina [1]

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Two HPGe spectrometers were developed for investigation of double beta decay processes and installed at the Modane underground laboratory (LSM, France, 4800 m w.e.). One of them TGV-2 is devoted to the search for double beta decay (β+β+, β+EC, EC/EC) of 106Cd. A new experimental run (phase III) was started using the TGV-2 spectrometer at February 2014 with ~23.2 g of 106Cd (enrichment 99.57 %). Another setup so-called OBELIX is dedicated to investigations of two-neutrino double beta decay to excited states of daughter nuclei and resonance neutrino-less double electron capture. One of such investigations was performed with OBELIX spectrometer and a large sample (~21.7 kg) of natural nickel containing ~68% of 58Ni. The latest results obtained in the TGV-2 experiment with 106Cd and new experimental limits obtained in the measurement of 58Ni using the OBELIX spectrometer will be presented.

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Gluonic Component of Ultrarelativistic Pseudoscalar Flavor-Singlet Meson

Mr. RUSOV, Alexander [1]

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The method of constructing the quark-antiquark pseudoscalar interpolation currents for light pseudoscalar mesons is learned in details on the π^+-meson wave-function as an example. When the π^+-meson is a fast-moving particle its wave-function is considerably simplified and can be written in terms of Light-Cone Distribution Amplitudes (LCDAs) of increasing twist. In the η- and $\eta^\prime$-mesons the set of interpolating currents should be extended by introducing the gluonic interpolating currents which results to additional LCDAs. An attempt to study some of these LCDAs was recently undertaken but more detail analysis of gluonic LCDAs of pseudoscalar mesons is still necessary. The inter-polation currents of the twist-3 was considered by us and the corresponding asymptotic forms of LCDAs are presented based on the confor-mal symmetry. The mixing of these states with the conventional (quark-antiquark) ones as the result of the current renormalization is planning to be worked out.

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Suppression of the Antiferromagnetic State in La0.82Ba0.18CoO3 Cobaltite at High Pressure

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Co-Authors: Prof. KOZLENKO, Denis [1]; Dr. KICHANOV, Sergey [1]; Mr. LUKIN, Evgeny [1]; Dr. SAVENKO, Boris [1]; Prof. TROYANCHUK, Igor [2]

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[2] *Scientific and Practical Materials Research Center, National Academy of Sciences of Belarus*

The crystal and magnetic structure of La0.82Ba0.18CoO3 complex cobalt oxide is studied by the neutron diffraction technique at high pressure (up to 4 GPa) within the temperature range of 10–290 K. At normal pressure, the crystal structure of La0.82Ba0.18CoO3 corresponds to the rhombohedral symmetry described by the
space group R c. At temperatures below TN = 100 K, the onset of a noncollinear antiferromagnetic (AFM) phase is observed. This phase is characterized by the wave vector k = (0, −0.5, 0.5). The applied high pressure
leads to the rapid suppression of the AFM phase, which completely vanishes at P > 2 GPa. InLa0.82Ba0.18CoO3, the degree of instability of the AFM phase with respect to the high pressure is appreciably higher than that in the related compounds with the ferromagnetic ground state. The correlation between the
instability of the AFM state in La0.82Ba0.18CoO3 at high pressure and the changes in the electron configuration of Co3+ ions is also analyzed.

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Study of production the direct photons at NICA SPD.

RYMBEKOVA, Aierke [1]

[1] *Kairatkyzy*

Photons produced in the hard scattering of partons, named the direct photons, provide information about the internal structure of hadrons.
This talk will present the preliminary results for possibility to study the production of the direct photons in the proton-proton collisions at the NICA collider. Possibility to extract the signal of the direct photons among background photons from another sources will be discussed.
The obtained results can be used for developement and optimization of the SPD detector.

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Monte-Carlo Event Generator for Decays and Direct Reactions

Mrs. RYMZHANOVA, Sofya [1]; Mr. SHAROV, Pavel [1]; Prof. GRIGORENKO, Leonid [1]; Dr. PARFENOVA, Yulia [1]; Mrs. EGOROVA, Irina [1]

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The interest of the dripline studies is naturally shifting to the side of particle-unstable systems. Due to pairing interaction practically half of the dripline systems demonstrates dynamics forms which can be understood as three-body phenomena. Complicated correlation data are obtained in the modern experiments where nuclear reactions and decays with three fragments in final state are emitted. This information can provide important insight into the structure and reaction mechanism. However, ability to extract this information is hindered by distortions introduced by experimental setup. To overcome this difficulty the results of theoretical estimations made for three-body correlations in the final state should be used in Monte Carlo simulations taking into account peculiarities of the measuring apparatus. The need for fully quantum mechanical Monte Carlo event generator for three-body reactions was first realized in 2005 while studying the population of 5H states [M.S. Golovkov, et al. PRC 72 064612 (2005)]. Since that time considerable developments were undertaken within research projects financed by FRRC. Nowadays the Three-body Event Generator for Decays and Direct Reactions (TEG-DDR) is a sufficiently mature software package. The functionality of this tool has been proven in data treatment made for several experiments performed at GSI [L. V. Grigorenko, at al. Phys. Rev. C 82 (2010) 014615; I.G. Mukha, Phys. Rev. C 82 (2010) 054315], at JINR [A.S.Fomichev, et al. Phys. Lett. B708 (2012) 6; A.S. Fomichev, at al. Int. J. Mod. Phys. E, 20 (2011) 1491], and at MSU [L.V. Grigorenko, et al. Phys. Rev. C 86 (2012) 061602(R); I.A. Egorova, et al. Phys. Rev. Lett. 109, (2012) 202502].

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Kinetic Processes in Highly Doped Heterojunctions

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This paper presents the theory of calculation of the electron-electron interactions in quantum semiconductor heterostructures. The calculation of profile of the potential well of the heterojunction and its approximation are considered. The theoretical dependences of the electron-electron interaction on the temperature, which can justify the observed experimental anomalies, are obtained. The calculation of the matrix elements of the potential for a complete screening of different channels of electron-electron interaction is made. The spectrum of the dielectric function of the heterojunction is computed, the analysis of dependence of resonant frequency on the concentration of impurities in the heterojunction is given.

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Application of sum coincidence corrections for study of reaction rate of residual nuclei in fission and spallation

Ms. SAGIMBAEVA, Fariza [1]

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Nowadays, problem with managing of spent nuclear fuel is an important issue. Therefore development of advanced nuclear systems is essential. Our group in the Joint Institute for Nuclear Research focuses on accelerator driven systems. It uses special set-ups made from spallation target and subcritical blanket. The set-ups are irradiated by relativistic proton or deuteron beam and a vast amount of neutrons comes into existence. Use of activation detectors for measurement of the neutron production is a reliable and very convenient method. When reaction rates of residual nuclei from fission and spallation reactions are evaluated, corrections of sum coincidence effect need to be taken into consideration.

40

Influence of the conical shape of the latent tracks near the irradiated surface on the correct measurements of the latent track size

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The difference in track parameters registered in some oxides at the same energy loss and different ion beam energy, so called “velocity effect” have been evidenced by number of experimental methods. Most of corresponding data on damage cross-section and then on the track radii were found by means of Channelling Rutherford Backscattering Spectroscopy or X-ray diffraction while the contribution of TEM results in the whole data array still remains very limited. In this report we give analysis of existing TEM results related the “velocity effect” and consider how the conical shape of latent tracks observed in the subsurface region of the swift heavy ion irradiated oxides may affect the correct determination of the track size as well as the critical electronic energy loss for track formation. The discussion is based on our cross-sectional TEM studies of high energy Bi and Xe ion induced latent tracks in TiO2 and Al2O3 single crystals.

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Probing the source of FUV diffuse emission in Orion

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Dust scattering is the main source of diffuse emission in the Far Ultraviolet (FUV). For several locations near M42, Far Ultraviolet Spectroscopic Explorer (FUSE) satellite has observed diffuse radiation in the FUV as scattering of starlight from the Trapezium stars by dust in front of the nebula. The dust grains are known to be anomalous in Orion with RV = 5.5 and these are the first measurements of the FUV optical properties of the grains outside of "normal" Milky Way dust. Infrared (IR) emission features at 8 micron are generally attributed to Polycyclic Aromatic Hydrocarbon (PAH) molecules, while emission at 24 micron are attributed to Very Small Grains (VSGs). We compare the FUV diffuse emission with the mid-infrared (IR) and far-IR diffuse emission observed by the Spitzer Space Telescope (SST) and the Akari satellite for the same locations. The intensity ratios in the different mid-IR and far-IR bands for each of the locations will enable us to determine the type of dust contributing to the diffuse emission as well as to derive a more accurate 3D distribution of stars and dust in the region. This, in turn, may be used to model the FUV scattering in the Orion nebula.

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Study of deep inelastic reactions within the multidimensional dynamical model of nucleus-nucleus collisions

SAIKO, Vyacheslav [1]; Dr. KARPOV, Alexander [1]

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In the present work, the theoretical analysis of deep inelastic collisions (DIC) with heavy ions is performed based on the dynamical model of ion-ion collisions. Studying of this type of nuclear reactions allows one to extract the information about complex interaction of heavy ions with each other leading to the significant dissipation of the initial kinetic energy and the exchange of a large number of nucleons. In addition, DIC is a promising method of producing new isotopes of heavy and superheavy elements unavailable for obtaining in other reactions (fusion, fragmentation).

Developed in FLNR JINR the multidimensional dynamic model of nucleus-nucleus collisions allows one to calculate the energy, charge (mass) and angular distributions of products of reactions with heavy ions. This model was tested by well-measured DIC reactions: ^{136}Xe + ^{209}Bi and ^{136}Xe + ^{208}Pb. The calculated characteristics of DIC obtained within our model are in good agreement with the corresponding experimental values.

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Selecting a perspective pelletized cold neutron moderator the "central direction" pulsed research reactor IBR-2.

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In this paper describes the modern ideas of using pelletized cold neutron moderators for high-intensity neutron sources as well as comparison of advanced materials for cold neutron moderator on "central direction" pulsed research reactor IBR -2. A comparison of mechanical properties, radiation resistance, cold neutron output used as materials for cold moderator substance: mixtures of aromatic hydrocarbons and m-xylene and mesitylene aromatic hydrocarbon triphenylmethane. It is shown that with a small loss in the flux of cold neutrons for triphenylmethane, its radiation resistance of about 10-fold better than that of a mixture of meta-xylene, and mesitylene.

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Gauged Aloof Baby Skyrme Model

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[1] *Department of Theoretical Physics and Astrophysics, BSU Minsk*

I present a study of U(1) gauged modification of the 2+1 dimensional planar Skyrme model with a particular choice of the symmetry breaking potential term which combines a short-range repulsion and a long-range attraction. In the absence of the gauge interaction the multi-solitons of the model are aloof, they consist of the individual constituents which are well separated. Peculiar feature of the model is that there are usually several different stable static multi-soliton solutions of rather similar energy in a topological sector of given degree. I investigated the pattern of the solutions and find new previously unknown local minima. It is shown that coupling of the aloof planar multi-Skyrmions to the magnetic field strongly affects the pattern of interaction between the constituents. I analyse the dependency of the structure of the solutions, their energies and magnetic fluxes on the strength of the gauge coupling. It is found that, generically, in the strong coupling limit the coupling to the gauge field results in effective recovering of the rotational invariance of the configuration.

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Remote Operation Center at Dubna for NOvA experiment

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Co-Authors: SHESHUKOV, Andrey [1]; Ms. KOLUPAEVA, Liudmila [1]; Ms. PETROVA, Olga [1]; Mr. SHANDROV, Igor [1]; Mrs. BOLSHAKOVA, Anastasia [1]

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The ROC-Dubna, Remote Operation Center at Joint Institute for Nuclear Research (Dubna, Russia), supports the NOvA experiment located 14000 km away in Fermilab (Batavia, Illinois, USA) and Ash River (Minnesota, USA). The ROC allows Russian physicists to operate the NOvA detector and monitor the NuMI neutrino beam complex. ROC-Dubna for NOvA is the first fully operational ROC outside USA.

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RESEARCHING OF THE ANTI-TUMOR AND ANTI-METASTATIC ACTIVITY OF ISOTHIOUREAS DERIVATIVES

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Oncological diseases remain difficult to treat despite the limited success in the fight against cancer. In recent years, a large number of drugs created and tested for chemotherapy of the malignant tumors. However, the problem of creation of new pharmacological drugs is very actual. One of the modern targeted approaches in oncology is the development of pharmacological agents for angiostatic therapy of tu-mors. The new original derivatives of isothiourea (ITU) which were synthesized in the laboratory of radiation pharmacology of A. Tsyb MRRC exhibit the properties of nitric oxide (NO) synthase inhibitors. Using the ITUs as anticancer agents is relevant, because their ability to inhibit endothelial NO synthase largely provides the antiangiogenic ac-tivity of these substances. In this study we investigated the anti-tumor and anti-metastatic activity of a number of new original compounds - isothiourea derivatives.

Materials and methods. The investigations have been done in male mice F1 [CBA×C57BL6j], 13-17 animals per group. We used epider-moid tumor model - the lung Lewis carcinoma (LLC). All the studied compounds were injected daily intraperitoneally at dose 1/5 LD16. The linear sizes of tumors were measured in each animal every 2-3 days since the 7th day of the experiment and then the volumes of the tu-mor were calculated. On the 21th day of the experiment the animals were euthanized by cervical dislocation with ether anesthesia. Lungs were removed, fixed in the acidic Bouin's fluid and the number of small and large lung metastases were counted on the following day.

Results. The compounds ITU-II, ITU-III and ITU-IV were injected intraperitoneally to experimental animals at a dose of 60 mg/kg daily, from 2 to 21 days after transplantation of LLC. Animals in the control groups were injected with physiological solution in the equivalent vol-ume. All the studied compounds have a similar impact on the devel-opment of LLC. The volume of the tumor in the experimental groups was significantly lower than in the control animals - the tumor growth inhibition index was 25-35% for the ITU-III and 30-40% for the ITU-II and ITU-IV. The anti-tumor effect of the tested compounds was more evident in the early stages of tumor development. The delaying of tumor growth was 1.5-2 days for the compounds ITU-III and ITU-IV and 3-3.5 days - for ITU-II. This effect determined the difference in LLC growth in control and experimental groups. The effect of NOS inhibitors also accompanied with a significant anti-metastatic effect – the number of metastases was reduced by 40-50 % and for ITU-II - by 70%.

The all tested compounds when administered to animals in the non-toxic doses had a similar impact on the development of LLC, which manifested in significant inhibition of the tumor growth and suppres-sion of the tumor metastasis. The most anti-tumor and anti-metastatic activity showed derivative ITU-II.

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Development of the software package ExpertRoot for modeling in physics of radioactive beams

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The EXPERT (EXotic Particle Emission and Radioactivity by Tracking) project is devoted to the study of extremely exotic nuclei at the fragment separator Super-FRS (FAIR, Darmshtadt) used in the separator-spectrometer mode.
ExpertRoot is a software package based on the FairRoot framework. Its tasks include EXPERT experiment event generation, simulation of detector digital response, reconstruction and analysis of the events. ExpretRoot is developed on the principle of continuous integration with automated building of the project and a set of automated tests. Algorithms for digital response simulations for the neutron detector NeuRad, gamma detector GADAST and microstrip tracker mu-Si have been developed. Development of the reconstruction and analysis algorithms is in plans.

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Design of new beam stop trigger for Dubna gas-filled recoil separator

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The detector module in Dubna Gas Filled Recoil Separator was developed from 12 strip position sensitive Si detector into double sided silicon detector with 48*128 strip geometry. After that number of spectrometric channels were increased from 12 to 176. New detector will provide better position and energetic resolution. To optimise system dead-time and number of required modules a lot of electronics modules were redesigned. This work is connected with development of new beam stop triggering system used as part of main data acquisition system. New blocks are using 15ns programmable logical array chips from ALTERA Corp.

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INVESTIGATION CONDUCTING PROPERTIES OF Cu - NANOTUBES SUBJECTED TO IRRADIATION BY ELECTRONS WITH AN ENERGY OF 5 MEV

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Over the past ten years in the contemporary world there is an increased interest in the investigation the properties of nanoscale materials. From a scientific point of view, it is related to their extremely small size, because of nanosized materials have unique optical, electrical, structural properties compared to the same macro-objects. From a technological point of view, the new and improved properties can lead to potential applications in electronics, semiconductor physics, optics.

Ionizing irradiation of metallic nanostructures is an effective tool for stimulating the controlled modification of properties of materials, such as structural, optical, electrical and magnetic. Irradiated with high-energy particles: electrons, heavy ions or neutrons, which in passing through material, transfer their energy to atoms of target, causing electronic excitation, displacement of atoms from original location. Monitoring of radiation modification of materials is carried out by controlling the energy of the particles used for irradiation.

In this paper we considered the effect of electron irradiation on the crystal structure and the conductive properties of Cu-nanotubes obtained by template synthesis. Irradiation obtained nanostructures was conducted by electron beam with an energy 5 MeV and current density of 8 mA. Investigation of the dependence changes in the conducting properties by the radiation dose by measuring the current-voltage characteristics of Cu - nanotubes showed with increasing radiation dose, the specific conductivity was increased by 7.5% at a dose of 50 kGy, and 9% at a dose of 100 kGy.

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Synthesis of nano-Pb/PVA reinforced in Polypropylene through ball milling and it's gamma shielding property

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Preparation of nano-Pb by ordinary chemical methods is relatively expensive and gives poor yields. Mechanical methods to prepare nanomaterials ended up with reversal results for pure Pb due it's high ductility. In this research, nano-Pb was prepared through ball milling using a polymeric surfactant. Elemental Pb and Polyvinyl alcohol (PVA) as the surfactant were milled for different milling times and characterized each time with XRD. According to XRD results, the optimum milling time to get the finest size of Pb (68 nm) was 60 min. The milled Pb-PVA mixture for 60 min was characterized by field emission scanning electron microscope (FE-SEM) and high resolution-transmission electron microscope (HR-TEM) to study the progress in the size and morphology of the nano-Pb particles. Then, nano-Pb/PVA was mixed with Polypropylene for different mass ratios and processed by hot compression. The new composites were tested against the 0.662 MeV gamma rays from Cs-137 source. The experimental mass attenuation coefficient of each sample was compared to the value reported for it's normally sized counterpart in Nist-XCOM database. The comparison showed enhancement in the gamma attenuation properties of nano-Pb by 70.8%. The new composite can substitute conventional gamma shielders with great mass and cost savings in addition to it's easy production in bulk amounts.

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Introduction into the Multi-Model Earth Density Approach

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In this report I'm going to introduce a new program that calculates neutrino flavour transition probabilities in Earth matter.
The algorithms used in MMEDA (Multi-Model Earth Density Approach)
were earlier implemented for the NovA experiment in order to
esteem a value of constant density that can be used for calculating
oscillation probabilities in matter of varying density given by CRUST1.0.
The resulting effective density amounted to 2.75 +/- 0.06 g/cm3.
Following the same approach we're planning to examine the DUNE experiment as well as such atmospheric experiments as Hyper-Kamiokande and IceCube.

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17Ne low-energy spectrum studies

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The structure of 17Ne nucleus is attracted a lot of interest. The multiple efforts to investigate it, both theoretical and experimental, have not yet provided convincing clarity about its properties. There are several questions of special interest connected with this nucleus which are actually tightly interwoven. One of them is two-proton decay of 17Ne first excited state. First excited state of 17Ne (3/2-) is located only 344 keV higher than 2p-decay threshold and it 2p-decay partial width is greatly lesser then gamma-decay partial width. Existing experimental threshold for the gamma/2p ratio is few order of magnitude greater then theoretical predictions.

In the recent experiment at the ACCULINNA fragment-separator (Flerov Lab. JINR) the two-proton decays of the low-lying states of 17Ne populated in the p(18Ne,d)17Ne transfer reaction were studied. An original method of the two-proton decay events registration was used in the experiment. Using of the method allow to get relative good energy resolution and achieve new gamma/2p ratio threshold for (3/2-) state that is at least one order of magnitude lesser than existing value. Conducted experiment shows perspective of this method for studies of unbound nuclear systems located near drip-lines.

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The method of digital signal processing for Time-of-Light measurements in high-energy physics

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At present the new methods to measure the time-of-flight (TOF) in experiments, the new electronics with high computational power which allow using more modern mathematical processing of digital data from analog-to-digital converters for signals, which are generated by the detector electronics are widely used.

In this talk we present a method of mathematical processing of digital data to determine the time delay between signals, based on the approximation of the base line and the rising edge of the signal with linear functions. Data are filtered using fast discrete Fourier transform to obtain the best convergence of the fit.

The results show that the proposed method based on fitting points with linear function could increase the accuracy of calculation of the time delay between pairs of signals if points from the zero line and the front line have been interpolated and filtered using fast discrete Fourier transform. This method especially gains the accuracy of calculation in cases where the sampling frequency of the signal is poor and hence insufficient for approximation of the rising edge of the signal with straight line.

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CHANNELS OF ELECTRON-ELECTRON INTERACTIONS IN HIGHLY DOPED HETEROJUNCTIONS

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Electron-electron interactions in a single highly doped heterojunction are considered taking into account both intra- and intersubband trans¬itions. Expressions are derived for the time of electron-electron interac¬tion, matrix elements of the full screening potential and dynamic dielectric function in a 2D electron system with the fine structure of the energy spec¬trum, and for the electron density spatial distribution. The theoretical de¬pendences provide a good description of the experimental times of Landau levels collisional broadening.
With respect to the nature of induced transitions the e-e interactions can be classified into three types: interactions within a single subband limited to the transitions within the same subband; intrasubband interaction exciting the intersubband transitions, and intersubband interactions resulting also in the intrasubband transitions.
Calculations of theoretical dependence of the e-e interactions were performed within the outlined schematic model of the Landau quantization destruction taking into account the paths corresponding to the channels of e-e interactions including both intra- and intersubband transitions employing the Matthiessen rule, where the summation is performed over all intra- and intersubband components.

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Detecting galactic SuperNova with NOvA Far Detector

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Supernova explosions produce large number of neutrinos with energies around 10-60 MeV, during the early phases.
This neutrino signal is peaked at several milliseconds after the core bounce and then has a decaying tail for several seconds.

Studying these neutrinos can provide information about the processes on various stages of supernova explosion and probe existing models.

This work describes a developed data-driven trigger, which detects neutrino signal from a galactic supernova using NOvA Far Detector.

Since NOvA experiment is designed to measure neutrino oscillations in a ν_{μ} beam
with average energy of 2 GeV, detecting interacting low-energy neutrinos from supernova requires dedicated selection and background reduction.

To detect the supernova event we monitor the number of selected interactions per 5ms block.
Since the background is stable in time, we can detect the supernova neutrino time structure above the background.

The developed supernova trigger for NOvA Far Detector is sensitive for supernova explosions at distance of 10 kpc.
This sensitivity can be improved by applying more advanced methods for background rejection.

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EFFECT OF ELECTRON IRRADIATION ON THE PROPERTIES OF Co – NANOTUBES

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The electron irradiation of metallic nanostructures is an effective method for stimulating controlled modification of the properties of materials, such as structural, optical, electrical and magnetic. Properties of target material can be changed in a desired direction by varying the irradiation conditions. Irradiation causes structural changes in material, which directly affect its properties. In this paper we examined the effect of electron irradiation on crystal structure and conductive properties of nanotubes based on cobalt. Obtained nanostructures were irradiated by electrons with an energy of 5 MeV, current density of 8 mA in the accelerator ELV - 4 (Kurchatov, Kazakhstan). Radiation doses were 50 and 100 kGy.

According to the study change in resistivity for Co - nanotubes, is nonlinear and is subject to the law of a polynomial y=3E-05x2 − 0.005x − 1.0737. According to information received, electron irradiation results in a reduction of resistance by 16.7% at a dose of 50 kGy and 21.6% at a dose of 100 kGy. The value of the conductivity is increased by 19.5% and 25.5% at doses of 50 and 100 kGy for Co - nanotubes.

Increasing the dose of irradiation leads to the restructuring of the crystal structure of Co - nanotubes by reducing the effect of the metastable phase β - Co. Also, there is a decrease the number of microstrain created FCC phase in the crystal lattice, thus there is increase in the degree of texturing of samples in the texture plane [100] during electron irradiation. The degree of texturing dose increases from 1,147 for the initial sample to 1,258 and 1,372 at doses 50 kGy and 100 kGy, respectively, with increasing radiation.

As a result of irradiation electron flow, a change of the crystal lattice obtained nanotubes, indicating that electronic annealing of defects. The crystal structure of obtained nanotubes was reconstructed with increasing doses of radiation. Defect numbers directly affect the conductive properties of investigated nanotubes. Thus, irradiation by electron flow allows modification of the crystalline structure of the nanotubes, to carry out electronic annealing of defects, which does not destroy the nanostructure, increasing conductivity and reducing the resistance of the nanotubes.

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Experiments on the synthesis of superheavy nuclei 118 in the 249-251Cf+48Ca reactions

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In 2015 we started the experiments aimed at the synthesis of element 118 isotopes with mass numbers 293-296 and study of their radioactive properties. The experiments are carried out using the Dubna Gas-filled Separator at FLNR, JINR, in collaboration with the laboratories of Oak Ridge (ORNL), Knoxville (UT), Livermore (LLNL), and Nashville (VU). The target with a thickness of 0.35 mg/cm2 was produced at ORNL and consists of a mix of isotopes 249Cf (50.7%), 250Cf (12.9%), and 251Cf (36.4%). The energy of 48Ca ions in the middle of the target layer is 252 MeV that corresponds to the expected maximum of the complete-fusion reactions 249-251Cf+48Ca with evaporation of three neutrons.

By now, at a beam dose of 9*10^18 48Ca ions, we detected one decay chain of 294 118 which is produced in the 3n channel of the 249Cf+48Ca reaction. In the same reaction we synthesized four nuclei of this isotope in 2002, 2005, and 2012 [1]. The decay properties of all the nuclei 294 118, 290Lv, and 286Fl are in good agreement with the results obtained both in the reaction with 249Cf and in the cross reactions 245Cm(48Ca,3n)290Lv and 242Pu(48Ca,4n)286Fl [1]. The cross section of the 249Cf(48Ca,3n)294 118 reaction also corresponds to the value measured in 2005 at close 48Ca energy (about 0.5 pb).
The experiments are in progress.

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The Fe/Co nanotubes: synthesis, structural characteristics and properties.

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Synthesis of multicomponent metallic nanostructures is a non trivial task, because their morphology and properties strongly depend on the electrochemical deposition parameters. In this work, the Fe/Co nanotubes have been obtained at different electrodeposition potentials in the pores of the ion track template. An influence of deposition parameters on the atomic composition and structural characteristics have been determined. Investigations of electrical and magnetic properties have been carried out. Their dependence on the composition of the nanotubes have been established.

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X-ray study and computer simulation of amorphous pseudowollastonite structure

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The amorphous pseudowollastonite (α-CaSiO3) was obtained by a mechanical activation of sample in a centrifugal planetary mill AGO-2 for 30 min in air. The X-ray diffraction patterns were registered in MoKα radiation [1]. The arrangement of atoms in short-range order regions in initial models were constructed by translating the unit cell of the triclinic phase along the crystallographic axes X, Y, Z. The X-ray patterns of atoms configurations were calculated using the Debye's method [2].

The coincidence of scattering intensity distribution and s-weighted interference function H(s) calculated for different atoms configuration with the corresponding experimental curves was the criterion for the reliability of the model. It was established that the model of mechanical mixture of three phases corresponds to this criterion. The cluster consists of four unit cells of pseudowollastonite 2a; 2b; 1c (480 atoms: 96 - Ca, 96 - Si, 288 – O), one unit cell of vaterite CaCO3 and one unit cell of quartz SiO2.

The theoretically calculated distribution of scattering intensity was corresponded the following ratio:

- 0,75 scattering intensity of cluster consisting of four unit cells of pseudowollastonite;
- 0,25 scattering intensity of cluster consisting of one unit cell of CaCO3;
- 0,25 scattering intensity of cluster consisting of one unit cell of α-SiO2.

It should be noted that the cluster consisting of four unit cells of pseudowollastonite was disordered by the molecular dynamics experiment [3]. Crystalline pseudowollastonite belongs to a class ring silicates with isolated groups of three silicon-oxygen tetrahedra. It structure is characterized by four layers of the three rings of tetrahedra. Their planes are perpendicular to the c axis. Between the layers of tetrahedrons are layers of atoms of calcium. Calcium polyhedra are distorted. It was found that rings of three tetrahedra broken as a result of molecular dynamics experiments and about 30% of tetrahedra are linked in the continuous chain. There are chains consisting from 2 to 8 tetrahedra in this configuration.

Thus mechanically activate of pseudowollastonite in air led to a chemical reaction, which resulted in the formation of calcium carbonate and silica. In general, the chemical composition in regions of the short-range ordering is responsible CaC0.997Si0.014O3.02. Crushing of the polycrystalline grains and disturbance of the order in the arrangement of atoms in them was occurring in the grinding of pseudowollastonite.

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PROGRAM DEVELOPMENT OF MULTI-CHANNEL LV/HV SUPPLY SYSTEM WIENER MPOD

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In the report we present results for program development of multi-channel LV/HV supply system Wiener Mpod. The application was developed for Unix-like operating system. Software is made using cross-platform development tool Qt creator 3.5.1 on the C++ language. The main tasks of application are module management, information extracted from the module (channel name, status, voltage, current, etc.) control and visualization, and module parameters setting. The operator could set module parameters interactively or from the plain file, which used to parameters storage. The application uses Qt threads to eliminate the response delay of the application window. This work was performed as part of DSS (Deuteron Spin Structure) project to study the structure of light nuclei at the Nuclotron.

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Graph theory method for structural investigating of model atomic nanoclusters

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The studies of nanoscale materials' new properties are the most relevant at the present time. These properties depend on the structural organisation which must be known for prediction of materials' behaviour under different conditions. The most economical way to obtain this information is computer modelling and theoretical investigation of nanoparticles. In case of crystalls possessing translational symmetry the structure is uniquely identified by a unit cell. Description of unordered system's structure is a much more complex problem.

This paper presents the results of developing a new method for investigation of unordered model clusters' atomic structure. The method is based on graph theory and allows to quantitatively describe structural features of the analyzed atomic systems. Further comparison of graph invariants for different models allows to draw conclusions about similarity or difference of their structures.

The developed method consists of several steps. The first step is search of ordered atom groups (e.g. coordinational polyhedrons) in the original cluster. The second step is defining presence of atoms belonging to several groups, groups containing shared atoms are treated as connected. The next step is building graph G. Every found group is associated with graph's vertex. An edge connects two vertices if the corresponding groups are connected. The last step is calculation of topological invariants for graph G. These are used to describe atomic structure of the analized models.

Several experiment series were run to demonstrate the capabilities of the developed approach. One of them was the molecular dynamics experiment on crystallization of magnesia nanocluster. Initial configuration was a random distribution of Mg and O ions in specified volume with the limit of shortest interion distance equaling 2Å. On every timestep of experiment the search of coordinational polyhedrons (MgO-octahedrons) was conducted, graph G was built and the order of its maximal component was calculated.

Analyzis of the curves for the potential energy and for the order of graph's maximal component showed that significant changes can be seen on both curves on the time interval from 15000 to 30000 timesteps (1 step = 1 fs). This corresponds to cluster's phase transition to crystalline state. This means that the curves reflect the sensitivity of the graph invariant to changes of cluster's order degree.

The second experiment consisted of nanotubes' formation from crystalline clusters possessing a form of elongated box. Corresponding graph G had vertices of two types. Vertices of the first type corresponded to four-membered rings of Co and O atoms; other vertices (2 type) corresponded to six-membered CoO rings. In the course of the experiment the modularity of the graph was observed. Local minimums of the invariant's values appeared when the whole nanotube consisted of rings of only one type. The local maximums indicated the presence of alternating domains consisting of rings of the same type.

The method was also used for analyzing influence of cobalt's distribution on the structures of two samples of xerogel based on cobalt modified liquid glass. First cluster's (A) initial configuration was a random distribution of 1120 atoms of Na, Si, O and Co in a spherical volume of radius 20Å. Interatomic distances were not less than 2Å. The second cluster (B) was a sphere of radius 15Å which contained 960 atoms of Na, Si and O and was surrounded by 2Å layer of 160 atoms of Co and O. The method has shown that in the case of cluster A a single carcass of SiO-tetrahedrons was not formed. Corresponding graph contained a set of small connected components. But the graph for cluster B had a giant component which contained more than 76% of vertices. The reason is cobalt's embedding in SiO-matrix of the cluster A with formation of Si-O-Co-O... bonds.

Thus a new method for model atom cluster's structure investigation has been offered. The method is based on using invariants of a graph which describe relative positions of ordered atom groups. Such groups may be coordinational polyhedrons or any other atomic configurations from short-range order. The method's capabilities for quantitative description and structural studies of different model clusters were demonstrated. In the future the method may be used for searching of structure-property correlations.

The reported study was funded by RFBR according to the research project No. 16-32-00137 мол_а.

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Critical behavior of direct percolation process in the presence of compressible velocity field

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The reaction-diffusion system known as Gribov process or directed bond percolation process is studied near its second-order phase transition. The main goal is to determine the effect of compressible turbulent fluctuations on the critical behavior. The turbulent field is generated by the stochastic Navier-Stokes equation for compressible fluid. Using methods of quantum field theory, namely field-theoretic reformulation and perturbative renormalization group the large scale behavior of the model is analyzed. Possible stable regimes are determined to the one-loop approximation. The critical exponents are calculated in the double expansion scheme (y,ε), where y describes scaling behavior of velocity fluctuations and ε is a deviation from the upper critical dimension dc = 4.

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Challenges and progress in the design of the Fast Interaction Trigger for the ALICE upgrade.

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The Fast Interaction Trigger (FIT) [1] will be installed as part of the ALICE upgrade [2] during the Long Shutdown 2 of the LHC in 2019. To cope with increased luminosity and event rate after LHC upgrade ALICE has to modify most of its detector subsystems, which includes replacing currently used T0, V0 and FMD with FIT.
Because FIT is located at the very center of ALICE, the accessibility will be very limited after the upgrades of other subdetectors are installed. Thus early and reliable design, as well as thorough testing, is required. This is also why FIT modules should be radiation hard and resist ageing. Moreover FIT is expected to achieve exceptional time and amplitude resolution, which in turn translate to the (independent from tracking) vertex position estimation and multiplicity determination (event plane, centrality) at high pseudorapidity range.
This talk will present the latest design concepts of the FIT detector module along with the beam test results carried out at CERN in the fall of 2015 in light of their importance for the overall future performance of ALICE.

[1] W.H Trzaska, Synergy in Fast Timing R&D;, talk at NICA Days 2015 in Warsaw
[2] The ALICE Collaboration, Technical Design Report for the Upgrade of the ALICE Readout and Trigger System (http://cds.cern.ch/record/1603472?ln=en)

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Primary data analysis for the Baikal-GVD neutrino telescope

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In April 2015 the demonstration cluster "Dubna" was deployed and started to take data in Lake Baikal. This is the first stage of the cubic kilometer scale Gigaton Volume Detector (Baikal-GVD). In this work I will review methods and status of primary data analysis which includes offline detector hardware monitoring and raw data preparation for reconstruction.

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Radiation damage to p53 protein

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The tumour suppressor protein p53 is one of the most important factors regulating cell proliferation, differentiation and programmed cell death in response to a variety of cellular stress signals. P53 is a nuclear phosphoprotein and its biochemical function is closely associated with its ability to bind DNA in a sequence-specific manner and operate as a transcription factor.
A model study of influence of radiation on the ability of p53 protein to recognize and bind DNA has been performed. Protein p53 in its binding buffer was irradiated by gamma radiation Co-60 and consequently incubated with DNA plasmid pPGM2 containing binding sequence 5'-GTAAAACGACGGCCAGT-3'. The proportion of protein specifically bound to DNA has been determined using agarose gel electrophoresis. Experimental study has been complemented by theoretical modeling using simulation code RADACK.
Theoretical modelling in radiobiology is a useful tool for simulation of primary processes of radiation damage to biomolecules and cells and predicting yields and types of radiation damage. RADACK code allows predicting oxidative attack of biomolecules by OH radicals, arising in large yields from water radiolysis by ionizing radiation with low linear energy transfer (LET). By comparing the results of our simulations and experimental data, we can obtain information about the importance of individual amino acids for interaction of protein p53 with DNA.

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Testing of reactor antineutrino detector S-cube

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The detector S-cube is a plastic scintillator detector based of polystyren used for detection of reactor antineutrinos. The scintillating plate (40 x 20 x 1 cm3) with an improved chemical composition as a basic element of the detector will be described. Properties of the first detector prototype (20 x 40 x 20 cm3) as well as measurements of background with/without complex shielding (lead, polyethylene, borated polyethylene) will be presented.

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Neutron Spectrum Determination of the p(37)+D2O Source Reaction by the Dosimetry Foils Method

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The accelerator-driven fast neutron generator at the Nuclear Physics Institute of the ASCR in Rez near Prague uses the unique target with flowing heavy water. The thick target neutron field of the p + D2O source reaction was investigated for a proton energy of 37 MeV. The spectral neutron flux close to the source target at 0° was determined by using the multi-foil activation method and validated against the MCNPX predictions. The produced broad neutron spectrum up to 34 MeV is relevant to the IFMIF (International Fusion Material Irradiation Facility) spectrum and suitable for the integral validation of activation cross-section data and radiation hardness tests of electronics against fast neutrons.

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THE MATHEMATICAL MODEL OF WAX DEPOSITION PROCESS IN THE PIPELINE

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One of the most common problems in the heavy oil production involves the formation of paraffin wax deposits in pipelines. The inner surface of the pipeline becomes fouled with these paraffin deposits, which reduces the flow diameter, decreases overall through-out, and results in a higher pressure drop when oil is pumped through the pipeline. The deposits within the pipelines decrease the capacity of the duct and cause pipelines breaking. Wax deposition is a serious problem of oil production in the petroleum industry. Therefore, accurate prediction of this solid deposition problem can result in increasing the efficiency and safety of oil production.

The authors consider the problem of wax deposition in pipelines and the growth model of paraffin deposits in pipelines which is based on the model developed in the Michigan University. The model describes deposits growth time dependence based on molecular diffusion. This model also includes the aging of the deposits that is a process of increasing of the wax fraction in the deposit due to the internal diffusion.

This research is intended to be a part of the project dealing with the development of the flow simulator. The discussed model is to be integrated in the VSS (Ventilation System Simulator).

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Properties of three-site four-spin exchange interaction in Ising model.

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This work is devoted to the study of the special case of multi-spin exchange interactions, namely three-site four-spin exchange interaction. In this work we have obtained exact results for a two-dimensional Ising model in which, in addition to the standard pair exchange interactions, we have also considered unconventional three-site interactions between each decorating spin and its nearest neighbors. The exact results are derived for the ground-state and finite temperature phase diagrams, thermal dependence of the sublattice and total magnetization, correlation functions, internal energy, Helmholtz free energy, specific heat and entropy of the system.

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Possibility of delayed multi-neutron emission of neutron-rich Ca isotopes

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Starting from Skyrme interaction we investigate the β-decay properties of neutron-rich Ca isotopes. The pairing correlations are taken into account in HF-BCS approximation including the blocking effect in the odd-odd and odd-even nuclei. Using TIJ Skyrme forces we study the different contributions of the tensor interactions. Our results reproduce available experimental data of Qβ window. We consider possibility of delayed multi-neutron emission of 56-60Ca isotopes.

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Determination of the neutron flux by temperature differences at the massive spallation uranium target QUINTA

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There are several possibilities of the neutron flux determintaion inside of facility. The most using one method is the determination of neutron flux by threshold foils (detectors). This method is complicated to analyzing because irradiated foils need to be measured by gamma spectrometry. It usually takes a few weeks to get results of the neutron flux determination. Another methods are also available. One of them is determination of neutron flux by measuring of released heat inside of the facility. This method allows online measuring and is greatly variable to measure unlimited number of positions. The research project of investigation of this type of neutron flux determination is lead by Dzhelepov Laboratory of Nuclear Problems (DLNP) at the group of J. Adam. The temperature differences are measured by high accuracy thermocouples. Two experiments took place on 2015 at the massive spallation uranium target QUINTA at facility Phasotron at JINR. Results of these experiments will be discussed at presentation and article. Another 4 experiments are planned on 2016.

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Characterization of the air pollution in the Moravian Silesian region using nuclear analytical techniques and GIS technology

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Within the first half of October 2015 the survey focused on the characterization of the origin of particulate matter of air pollution in the Moravian-Silesian region has been done. This region is suffering from long-term increased values of air pollution concentrations. For the assessing of situation were used methods of mathematical modelling, unmanned remote controlled airship monitoring system and moss survey. Based on data from mathematical modeling it was determined the area of interest with largest values of air pollution (1600km2), where the mosses were collected. This area is located on the Czech-Polish border. In this area were created 41 points in regular network. In proximity of these 41 points were made 43 samples. Each sample was analyzed by atomic absorption spectroscopy and neutron activation analysis. The results of these analyzes were imported to Geographic information system (GIS), where the values were processed by spatial interpolation and statistical analysis. Hereby was obtained the distribution of values in space. These results were compared with the results of mathematical modeling and with the results from previous survey in the central Europe [1]. This survey helped us to understand the air pollution problem in the Czech-Polish border region and allowed better characterization of the origins of air pollutants.

[1] Harmens, H; et al. Heavy metal and nitrogen concentrations in mosses are declining across Europe whilst some “hotspots” remain in 2010. Environmental Pollution. 200, 93-104, May 1, 2015. ISSN: 0269-7491.

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Determination of the lipolytic effect of high dietary calcium using the immunoradiometric techniques

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The present study was undertaken to find out a suitable dietary regime to maintain a lower prevalence of overweight or obesity by adjusting the diet components. Therefore, male Swiss albino rats were selected according to their ages and divided into two main groups, i.e . premature and mature groups. Each rat group was
divided into 4 subgroups and each subgroup was fed on a diet of varied composition. Serum levels of lipids, calcium, phosphorous and testosterone were determined in addition to body weight measurement. The results indicate non-significant decrease of percentage of body weight gain in premature rats fed on high-calcium diets while
significant decrease of percentage of body weight gain in mature rats fed on the same diet composition. The levels of serum HDL-C, LDL-C, triglycerides and testosterone were significantly decreased in premature rats fed high- calcium diets. In premature
rats, only rat subgroup fed on high calcium from milk, showed a significant decrease in serum cholesterol levels. Calcium and phosphorus levels exhibited non- significant change between premature rats. In mature rats, LDL-C data demonstrate non-
significant changes while cholesterol and triglyceride levels were significantly decreased in rats fed high -calcium diet compared to control. HDL-C level revealed a significant decrease in sera of mature rats fed on high calcium from milk. Serum testosterone levels were significantly decreased in mature rats fed low- fat diets or low fat diets supplemented with high- calcium level. In general, one would suggest to consume low fat diet (4%) supplemented with high calcium from dry skimmed milk fortified with hydroxyapatite as suitable dietary program to avoid overweight or
obesity.

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Investigation and Monte Carlo Simulations of Neutron Flux in Subcritical Setup QUINTA

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The collaboration “Energy&Transmutation; of Radioactive Waste” is involved in experiments with subcritical transmutation setups. It is important for development of accelerator driven systems (ADS) and fast nuclear reactors. The setups are made from lead or uranium target which is surrounded by natural or depleted uranium blanket. High energy proton or deuteron beam from Phasotron or Nuclotron accelerator is aimed to the target and neutrons are produced by spallation reactions arisen. These neutrons are suddenly multiplied in the subcritical blanket and huge neutron fields are created as a result. An experiment with setup QUINTA was performed, reaction rates (neutron flux) measured by activation detectors and investigated by activation techniques. Experimental results were then compared with Monte Carlo simulations.

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Parallel realizations of locally one-dimensional difference schemes for solving the initial-boundary value problems for the multidimensional heat equations

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Economic schemes are especially useful for solving initial-boundary problems for multidimensional heat equations using the finite difference method. They include the best features of explicit schemes, i.e. amount of calculations, and implicit ones, which are indefinitely stable. In spite of the advantage of explicit schemes concerning parallel realization, limits on time step are essential, so large computing resources are required for solving problems with high precision, i.e. using small step grids. Parallel realizations of locally one-dimensional schemes for solving initial-boundary problems for multidimensional quasi-linear heat equation are considered in the work. They allow to perform calculations on multicore computing nodes (OpenMP realization), calculations using graphics processing units (CUDA realization) and Intel Xeon Phi coprocessors (OpenMP realization with coprocessor extensions). Comparative analysis of efficiency for developed parallel realizations has been performed.

The calculations were performed on heterogeneous computing cluster HybriLIT (LIT JINR), and the parallelization details are presented in the "Parallel features" project (https://gitlab-hlit.jinr.ru/) together with the program solutions for all computing architectures mentioned above.

This work is partially supported by RFBR grant No 15-29-01217.

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Mechanical issues arising during the design of busbars for superconducting particle accelerators

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Large currents present in the operation of particle accelerators require the application of superconducting busbars capable of carrying them. They cause large Lorentz forces which can lead to the damage of an insulation. In order to avoid this proper materials have to be applied. Also busbar shape needs to be optimised to balance the trade-off between mechanical and electrical properties. In this work several examples of busbar assemblies are shown as well as the methods to avoid aforementioned issues.

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On the entanglement space of X-states for low-dimensional quantum systems

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The algebraic and geometrical characteristics of low-dimension
quantum systems, essential for the description of quantum
correlations, are discussed for a special class of mixed states, the so-called X-states.
The entanglement properties of X-states are exemplified in details
for qubit-qubit pairs and qubit-qutrit systems.

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Heterogeneous cluster HybriLIT: New possibilities for the development of parallel applications

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In order to increase the efficiency of work on the heterogeneous cluster HybriLIT, there appears a need to develop an information-computing environment for work with parallel programming technologies used in the development of high performance applications and for carrying out computations by means of resources of the heterogeneous cluster.
In order to provide new possibilities for a more efficient work on the cluster, the following software has been installed on the cluster:
• SLURM (Simple Linux Utility for Resource Management);
• CernVM-FS (CERN virtual machine file system);
• EOS (file system);
• NFS (network file system);
• MODULES.

With an increasing number of users of the cluster, in order to provide new possibilities for efficient work management and mutual development of projects, new services such as GitLab [1] and FreeIPA [2] have been introduced. Other services provided for users include:
• HybriLIT website [3];
• HybriLIT User Support project in Project Management Service [4];
• Indico service [5].

References:
1. GitLab service: gitlab-hybrilit.jinr.ru
2. FreeIPA: dobby.jinr.ru
3. HybriLIT portal: hybrilit.jinr.ru
4. Project Management Service: pm.jinr.ru
5. Indico service: indico-hybrilit.jinr.ru

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Fast neutron background in the Daya Bay experiment

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The precise measurements of neutrino mixing angle \theta_{13} and square of mass splitting are the main goals of the Daya Bay experiment. There are several types of systematic uncertainties in that measurement. The backgrounds induced by cosmic muons(fast neutrons, unstable isotopes of Li and He) are important sources of systematic errors because signature of its' interaction in detector is indistinguishable from antineutrino interactions.
The fast neutron background is produced by energetic neutrons created in interaction of cosmic muons with the material of the detector. We present study of the selection procedure for such events and preliminary results for its' rates and spectra based on data set from 2012 to 2015.

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THE APPLICATION OF THE PRINCIPAL COMPONENT ANALYSIS FOR STUDY OF THE NOISE COMPONENT OF IBR-2M REACTOR

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The application possibility of the principal component analysis for study of the noise component of IBR-2M reactor was considered. The behavior of the principal components in the pulse energy noise depend on the operation time of reactor with an average power of 2 MW was studied. The first four components are determined, which are mainly related the level and structure of the random fluctuations of the pulse energy. The power spectral density of pulse energy associated with the first two components is caused by the vibrations of moving reflectors.

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Production and analysis of multi-component heat-resistant coatings for gas turbine engine blades

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The objective of this review is to present the results on the production techniques, process parameters and compositions of heat-resistant coatings for heat-resistance alloys. The data reported concern the resistance of such protective coatings in air at temperatures up to 1250 ⁰C. Coatings of this type, generally, have a multilayer structure based on the refractory compounds such as carbides, borides, silicides of transition metals and oxides with a high melting temperature. The paper presents a new complex method for formation of heat-resistant coatings on the heat-resistance alloys. The method combines the vacuum-activated diffusion saturation in the presence of a liquid-phase and self-propagating high-temperature synthesis (SHS) simultaneously. This method can be applied not only to cover the outer surface but also to the internal cavity.
Multicomponent coatings on ZhS26 oxidation-resistant nickel alloy samples produced by this method are studied to protect blades of turbine engines against high-temperature gas corrosion. Thermodynamic analysis of potential reactions in conditions of diffusion hardening and chromium plating in a multicomponent mixture is carried out. Results of X-ray diffraction and high-temperature corrosion resistance of the coatings at 1200 ⁰C are presented. The coatings are corrosion-resistant and self-healing. Their oxidation resistance is much higher than that of the alloy without a coating.
Multiphase coating first obtained in this study protects the alloy ZHS26 high temperature corrosion for a long time. (T = 1200°C) A coating on turbine blades, including the internal cavity and the perforations. Work is underway on the development and establishment of an integrated protective cover self-healing can increase the operating temperature of the blade turbine engine (T = 1250°C), thereby to increase the efficiency of the engine.
These coatings can be used in aeronautical engineering, nuclear power industry and mechanical engineering.

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Recoil effects and the fine shift of S energy levels of hydrogen-like atoms

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Contributions of recoil effects to the fine shift of S energy levels of hydrogen-like atoms have been considered. The detailed analysis of the influence of retardation effect on the value of the logarithmic in respect to the mass ratio correction from one-photon diagram has been realized.

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MANIFESTATION OF 9Be CLUSTER STRUCTURE IN DIRECT NUCLEAR REACTIONS

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Specifics of interaction of 4He with the light nucleus 9Be are studied. The interaction potential for the 4He + 9Be system is calculated within the framework of the double-folding model using the 9Be ground state wave function obtained in the three-cluster α + α + N approximation. Differential cross sections of elastic and inelastic scattering, as well as those of nucleon transfer reactions at moderate energies are calculated. A comparative analysis of the available in literature experimental data with the results of calculations demonstrates good agreement and, consequently, correctness of the model-based assumptions made about the 9Be structure.

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Extracting the resonance parameters from experimental data on scattering of charged particles

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A new parametrization of the multi-channel S-matrix is used to fit scattering data and then to locate the resonances as its poles. The S-matrix is written in terms of the corresponding “in” and “out” Jost matrices which are expanded in the Taylor series of the collision energy E around an appropriately chosen energy E0. In order to do this, the Jost matrices are written in a semi-analytic form where all the factors (involving the channel momenta and Sommerfeld parameters) responsible for their “bad behaviour” (i.e. responsible for the multi-valuedness of the Jost matrices and for branching of the Riemann surface of the energy) are given explicitly. The remaining unknown factors in the Jost matrices are analytic and single-valued functions of the variable E and are defined on a simple energy plane. The expansion is done for these analytic functions and the expansion coefficients are used as the fitting parameters. The method is tested on a two-channel model, using a set of artificially generated data points with typical error bars and a typical random noise in the positions of the points.

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The study of Coulomb breakup of the halo nuclei in quantum-mechanical approach

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Coulomb breakup of nuclei is one of the main tools in the study of the halo nuclei in modern few-nucleon nuclear physics . Theoretical study of the halo nuclei is actual for planned experiments to study light nuclei in the radioactive beams. Coulomb breakup of exotic nuclei are studied in non-stationary quantum-mechanical approach.

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UMASS Lowell Research Reactor Irradiation Channel Analysis

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Pilot measurement of cooperation project between Brno University of Technology and University of Massachusetts Lowell was carried out by joint group of students and faculty members on the UMASS Lowell research reactor in summer 2014. The main goal of the measurement was to analyze neutron field in horizontal channels for further research studies of BUT students – thermal column and beam port facilities. This paper gives preliminary information about selected spectral indices which were measured on beam port and thermal column facilities of UMASS Lowell research reactor. The spectral indices were measured using a set of activation detectors from an alloy of copper, manganese and nickel, a molybdenum and last detectors were made from an alloy of tin and antimony. Activation foils were irradiated with and without cover. Foils were shielded by covers which were made from gadolinium, cadmium, hafnium and boron carbide. This paper brings preliminary results about spectral indices of first sort of activation detectors which were made from the alloy of copper, manganese and nickel.

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TPC MPD/NICA readout electronics

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The readout system is one of the most complex parts of the TPC. The electronics of each readout chambers is an independent system. The whole system contains 95232 channels, 1488 front-end cards (FEC), 24 readout control units (RCU). The front-end electronics (FEE) based on modern ASICs, FPGA and high-speed serial links. The main parameters of FEE are the following: data stream from the whole TPC - 10 GB/s; power consumption less than 100 mW/ch; signal to noise ratio (S/N) - 30; ENC < 1000e- (Cin=10-20 pF); digital signal processing which includes baseline correction and zero suppression.
A set of front-end cards is produced, tested and firmware for RCU was designed. A prototype system with RCU and FEC was tested. Functional testing of the system demonstrated feasibility of the approach and its rightness.

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Cross-sections from irradiation of thorium with 3.5 GeV/A deuteron beam

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The residual nuclei yields are of great importance for the estimation of basic radiation-technology characteristics (like a total target activity, production of long-lived nuclides etc.) of accelerator driven systems planned for transmutation of spent nuclear fuel and for a design of radioisotopes production facilities. Experimental data are also essential for validation of nuclear codes describing various stages of a spallation reaction. Therefore, products of deuteron induced spallation reaction of 232 Th are studied by means of activation measurement and gamma spectroscopy methods. The samples made of thin natural thorium foils were irradiated at JINR Nuclotron accelerator with a direct deuteron beam of energy 3.5 GeV/A. This energy has not been measured before. Experimental cumulative and independent cross-sections were determined for more than 60 isotopes including meta-stable isomers. Non-symmetrical mass yield fission curve was reconstructed. The results were compared with MCNP6 Monte-Carlo code predictions. Several different combinations of high-energy event generators and nuclear models were used (LAQGSM.03.03, INCL). Generally, experimental and calculated cross-sections are in a reasonably good agreement with the exception of a few isotopes in fragmentation region. Measured data can be used for future development of high-energy nuclear codes and will supplement rare data in EXFOR database.

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SOCRAT-BN simulation of Siena loss-of-flow experiments

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To solve actual problems in the area of safety analyses of sodium-cooled fast reactors (SFRs) IBRAE RAS develops SOCRAT-BN code system. The code system is based on the “water” SOCRAT code system, which was developed for the PWR safety analysis. The SOCRAT-BN code system allows to carry out coupled analysis of design and beyond design basis accidents at SFR using thermal hydraulic, neutron kinetic, strain stress, etc. simulation. For complex thermal hydraulic simulation of sodium behaviour one- and two-dimensional, non-homogenous, non-equilibrium two-fluid models were developed and included in the code system. One-dimensional model can be used to simulate loop pipes, since there is no need to know spatial distribution of physical parameters. Two-dimensional approach could be used to simulate reactor core and heat exchangers where we need to simulate spatial behaviour of sodium coolant.

The paper describes the validation of the two-dimensional thermal hydraulic model on the experiments with fuel rod imitators in the triangular geometry. The approach of the simulation and obtained results is presented in the paper. Siena loss-of-flow experiments (Japan) with 19- and 37-pin rod bundles were simulated using two-dimensional approach and conventional closure relations for bundle geometry. Simulation shows the capability of the two-dimensional thermal hydraulic model to predict sodium boiling behaviour, sodium and pin surface temperature evolution during pump rundown, etc. Although the numerical results are in good agreement with the experimental data, the two-dimensional thermal hydraulic model should be further improved. Other experiments are planned to be simulated, in order to further develop and validate the two-phase sodium flow model.

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Adaptive response of retina to low dose of proton irradiation

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The retina consists of terminally differentiated cells that have lost their ability to proliferate. The death of these cells leads to the loss of sight. The retina is characterized by relatively high resistance to radiation, which is provided by its ability to repair damage caused by environmental factors. The aim of our work was to assess the damaging effect of proton radiation and chemical (methylnitrosourea) effect on the DNA structure in the mouse retina, the functional activity of the retina, and its ability to recover in vivo. The results confirm the post-irradiation ability of the mature retina to structural and functional recovery and the possible participation of Müller glial cells in retinal cellular damage repair. Radiation preconditioning of the mature retina in vivo increases its resistance to degeneration.

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New limit on the electron lifetime in the Borexino experiment

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Borexino is a liquid scintillation neutrino experiment located in the Laboratori Nazionali del Gran Sasso, Italy. Its large mass and extremely high radiopurity makes it possible to investigate besides neutrino various rare processes and fundamental laws. The present study is a test of the electric charge conservation law. The sought-for electric charge non-conserving process is a hypothetical electron decay $e^-\rightarrow\gamma\nu_e$. The signal for this decay mode is a monoenergetic 256 keV photon detected in the scintillator. The result obtained is the best up to date.

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Femtoscopic in MPD experiment

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Heay Ion Collsion (HIC) are used for study properties of matter that existed at early stage of the universe. One of main topics of those studies is structure of phase diargram of strongly interactin matter, different parts of this diagram can be studied by collisions of heavy ions with different energies. Such measurements will be also done in MPD (Multi-Purpose Detector) in NICA facility with is now under construction in Dubna. One of method used in analysys of HIC is femtoscopy, this method uses two-particle correlations to obtain information about space-time evolution of source of the particles. As part of preparations for MPD experiment some analysis with simulated data where performed. Three sets of simulations has been made, with and without viscosity of bulk dense matter, and with different type of phase transtion from Quark Gluon Plasma to hadronic matter - one of most interesting problems that will be studied by using MPD. Those analysis shown that system that creates particles during collision lives longer when first order phase transition occurs what was expected by theorist, however standard femtoscopic measurements are not suitable tool for study such effects as it was expected. It's mean that new methods or combining more observables toghether must be used like imaging methods.

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5-Azoniaspiro[4.4]nonyl derivatization as a tool for analysis of trace amounts of peptides by mass spectrometry

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Mass spectrometry is the based analytical technique, used in proteomics research for biomarkers determination. However, some peptides do not undergo effective ionization process and therefore their trace amounts can be analysed only after proper derivatization.
Recently Chemistry and Stereochemistry of Peptides and Proteins Group discovered new ionization tags like betaine derivatives[1]. They allow analysing peptides at attomole levels[2]. For qualitative and quantitative analysis betaine derivatives are isotopically labelled by deuterons. The aim of our work is to examine new ionization tags: 5-azoniaspiro[4.4]nonyl and benzazoniaspiro[4.4] nonyl groups, which are stable during MS/MS experiment and can be used for peptide sequencing[3]. We investigated their impact on ionization efficiency and check the detection limit. We also examined the use of labelled tags for isotopic dilution. We synthesized a model peptide, which is a fragment of human protein – ubiquitin and applied ionization enhancers. Peptide conjugates were analysed by mass spectrometry. We also examined the hydrogen-deuterium exchange in 1% TEA/D2O, followed by back exchange in H2O. In this conditions all labile deuterons undergo back-exchange, but only one deuterium atom at α-carbon of 5-azoniaspiro[4.4]nonylcarboxyl residue exchanges to deuterium. After that we performed MS/MS analysis of deuterated and non-deuterated analogues obtaining b and y type series of daughter ions. For recognize detection limits of peptides analysis we performed MRM MS experiments of highly diluted peptides conjugates.
Azoniaspiro[4.4]nonyl system increases ionization efficiency and can be used in the same time for isotopic dilution for quantitative peptides analysis. Its possibility to lower the detection limit may lead to develop new biomarkers based on proteins of low abundance.
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Transmutation of Spent Nuclear Fuel

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From the beginning of the nuclear era the presence of long-lived actinides and fission products in the spent nuclear fuel stands as great disadvantage of nuclear energy. The most interesting method of management of spent nuclear fuel is transmutation. The purpose of presented experiment was to study transmutation rates – in particular the neutron induced fission rates – in the actinide samples located in the secondary neutron field generated in the spallation process by the 660 MeV proton beams irradiating the massive uranium spallation target QUINTA. Exclusively, transmutation rates of 237Np and 239Pu were investigated. Results of experiment were expressed in the form of both the individual reaction rates and the average fission transmutation rates. For 237Np sample the average fission transmutation rate per beam energy unit is equal to (0.647 ± 0.342) ×10-26, whereas for 239Pu sample equals (2.99 ± 0.0521) ×10-26 [atom-1proton-1 GeV-1].

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New molecular-ionic ferroelectric based on diisobutylammonium cation

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Ferroelectric crystals are import and basic materials for technological applications in capacitors, pyroelectric, and electrooptical devices. Their nonlinear characteristics were found to be very useful, for example, in optical second-harmonic generators and other nonlinear optical devices.[1] Much of the attention in this field has been focused on developing ferroelectric inorganic compounds such as KH2PO4 (KDP),[2] perovskite-type compounds (BaTiO3) and LiNbO3.[3] Recently, the molecule-based ferroelectrics, simple alkylammonium organic salts: diisopropylammonium chloride (DIPAC) and diisopropylammonium bromide (DIPAB) have been synthesized and characterized.[4,5] They undergo a reversible phase transition from a high temperature paraelectric phase (2/m) to a low temperature ferroelectric phase (2) at ca. 440 K and 425 K, respectively with the spontaneous polarization resulting from the ordering of the organic cations (order–disorder-type ferroelectric).

A particular behavior of their dielectric parameters (especially DIPAB) distinguishes them from the formerly reported organic, hydrogen-bonded ferroelectrics.[5,6] This compound is characterized by an extremely high value of the spontaneous polarization (23 μC cm^-2), a high Curie temperature (426 K), a high dielectric constant, small dielectric losses and a low coercivity field.[5,6] Additional qualities of DIPAB are: facility of preparation, low cost, nontoxicity, and good thermal stability. DIPAB also shows a strong piezoelectric effect and has a well defined ferroelectric domain structure.

Recently, we have synthesized and characterized the physicochemical properties of a novel biferroic material: diisobutylammonium bromide [i-(C4H9)2NH2][Br] (DIBAB) by thermal, electric and spectroscopic measurements.[7] DIBAB exhibits unique and unexpected properties related to ordering of chains of diisobutylammonium cations. It undergoes a strongly discontinuous phase transition (at 285/286 K, cooling/heating respectively) driven by an order–disorder mechanism strongly coupled to macroscopic deformation.

The polar properties of DIBAB in the low temperature phase have been studied by the pyroelectric current measurements. The spontaneous polarization was found to be reversible
in an external electric dc field (±6 kV cm^−1) and equals 5×10^−2 μC cm^-2. This corroborates the structural findings concerning the orientation of molecular permanent dipoles. The behavior of the spontaneous polarization also resembles that of a canted ferromagnetism.[8] The ferroelasticity in DIBAB was confirmed by the optical observation of the ferroelastic domains under polarizing microscope. The crystal shows a phase growth and a domain pattern resembling that of martensitic phase transitions. It is the most spectacular result of this work and the first example of martensitic transition in the organic compound.

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Cu-dendritic nanostructures in porous Si/SiO2 template for SERS

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The novel SERS-active surface Si/SiO2(Cu) has been produced on the base of silicon substrate. Porous Si/SiO2 templates using ion track technology have been created. Copper nanostructures have been grown in the pores of Si/SiO2 templates by electrochemical method. A tendency of growing Cu-nanostructure with dendritic shape has been demonstrated by means of scanning and tunneling electron microscopy. The obtained Si/SiO2(Cu) substrates have been used as SERS-active surface for an investigation of Rhodamine 6G spectrum. As a result, it was shown that the investigated substrates allow obtaining the Raman amplification of the signal by the four orders of magnitude. These substrates could be used in chemo- and biosensoric devices.

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Research of relativistic three-nucleon systems within the Bethe-Salpeter-Faddeev approach

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The relativistic properties of the three-nucleon system are investigated using the Faddeev equations within the Bethe-Salpeter approach. The nucleon-nucleon interaction is chosen in a separable form. The Gauss quadrature method is used to calculate the integrals. The system of the integral equations are solving by iterations method. The binding energy and the partial-wave amplitudes (1S 0, 3S 1 and 3D 1) of the triton are found.

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Ways of stealing and securing scientific data. Defects and good solutions in network security systems.

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There are many reasons to protect data obtained in research. Unfortunately, it is possible to access well-encrypted wireless network in few minutes. Nowadays almost every computer is connected to network. Firstly, computer that uses network interfaces is exposed to unwelcome access from anybody who does not have physical access to it. All network interfaces are very dangerous because their basic protocols do not comply with security issues. Many vulnerabilities was detected recent years and currently used devices have not been fixed. Many security and cryptography standards are now deprecated but still used. Also encrypted communication can be compromised easily. Despite this, correct configuration and functionality can make it admittedly more protected. During my Engineering Thesis I analyzed many vulnerability in wireless access points and suggest ways of solving them in the future. Furthermore, many sensitive information can be stolen from another room even if computer is not connected to any network.
Second aspect of protecting scientific data is sending them safely via Internet. Unluckily, using strong encryption is not enough. Cryptographic keys distribution, random numbers generators, certificates, old network protocols are issues that can make encrypted connection vulnerable. Because of that complex security plan of protecting data is necessary. Installing encryption software and using it without professional configuration is usually unsecure and valuable data can be lost or even stolen.

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Dissociation of 10B nuclei in a track nuclear emulsion at an energy of 1 GeV per nucleon

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Featuring an excellent sensitivity and spatial resolution nuclear track emulsion (NTE) maintains the position of a universal and inexpensive detector for survey and exploratory research in microcosm physics. Use of this classical technique on beams of modern accelerators and reactors turns out highly productive. In a number of important tasks the completeness of observations provided in NTE cannot be achieved for electronic detection methods. In particular, in the last decade clustering work of a whole family of light nuclei including radioactive ones was investigated in the processes of dissociation of relativistic nuclei in NTE [1].
The preliminary analysis of the NTE has pointed out that triples 2He + H constitute about 65% among 50 “white” stars found to that time. However, origins of this effect have not been studied being in a “shadow” of emerging studies with radioactive nuclei. The distribution of 2He pairs over the opening angle Θ2He in an interval 0 < Θn(arrow) < 10.5 mrad allows one to count 54 decays 8Beg.s. in all found events 10B ⟶ 2He + H including 37 in the “white” stars (Fig.1). Then, the condition on the opening angle Θ(8Beg.s. + H) < 40 mrad allows one to identify 21 decays 9B in all found events and 15 in the “white” stars(Fig.2).

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CLUSTER STRUCTURE OF NUCLEI AND NEW EXPERIMENTAL REGULARITIES

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By the authors of this work in recent years experimentally found of several new nuclear-physical effects, phenomena and regularities which are in detail described below, that are leading to revision of some established views on the composition and structure of nuclei – their clustering and ordering in the volume of the nucleus.

1. New regularities in angular distributions, as direct proofs of multicluster structure of nuclei.
First proof. In experimental angular distributions of differential cross sections of elastic scattering two new effects are found: 1) experimental angular distribution splits on two diffraction modes – the first with the small period of oscillations on the nucleus as whole; the second – on the alpha cluster substructures with large periods of the oscillations; 2) rise in cross sections above the Rutherford for light and medium nuclei due to addition of amplitudes of two diffraction processes stated above is found. Both effects are rather well described theoretically within the parametrized phase analysis with Fermi distribution of density of a nuclear matter.
Second proof. The direct experimental method of detection of intranuclear multiclusters on the basis of unique kinematic features of elastic scattering of identical particles, and also the heavy accelerated particle on light target nucleus is for the first time found in this work. The specified uniqueness consists that angular distribution of elastically scattered identical particle, and also a "heavy" particle in laboratory system of coordinates rests against a critical angle θcrit: , where a - mass of the incident (accelerated) particles; A - the mass of the target nucleus, giving either angle 90 (identical particles), or "kinematic loop" with θcrit. Such kinematic features are found by us in the kinematics of elastic scattering of incident α-particles with energy of Eα=29.0 MeV on the nucleus Mg-24 on beams of Kazakh accelerator U-150m. It is clear, that in nucleus Mg-24 with uniform nucleon distribution of a nuclear matter no features can be. In these experiments we found the following clusters: nucleons, deuterons, 3He, alpha particles.

2. New regularities in structure of the nucleus.
Third proof. By systematization parameters of nonsphericity for light and medium nuclei from Z and N (surface β(Z,N)) new regularity of change of a shape, so-called, 4n-cores from number of alpha clusters n is found, and also Z and N – periodic changes in the shape of extended spheroid cores (singβ>0) to the flattened (singβ<0) and back that is possible only at an alpha-cluster structure of nuclei.
This phenomenon is interesting in terms of understanding of an extremity of the Periodic table of chemical elements because of catastrophic development of non-sphericity of heavy-nuclei. It, perhaps, leads and to emergence of "Island of stability".
Fourth proof. Layering of nuclear space in experiments on measurement of angular distributions in direct (d,p)–reactions, in which the angular distributions are clearly distinguished by angular momenta, are found.

Conclusion
Finally pertinently to make some conclusions: 1) there are no doubts that the physics of microworld is on the threshold of the birth of new Riemannian nuclear physics with new infinitely difficult object – the nucleus and its curved space; 2) creation of new nuclear models on the principles of dense spherical packages and the corresponding symmetries of nuclear structure is necessary; 3) again the problem of designing modern nuclear accelerators in the range of the Coulomb barrier (15-20 MeV) to the threshold of the birth of the meson (150-200 MeV), allowing "spectroscopic" measurement of nuclear reaction products with multiple correlation of experimental schemes and simultaneous registration of the whole variety of secondary particle nuclear reactions is actualized.

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Comparison of Experimental Neutron Flux and Simulation of the Spallation Target QUINTA

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Experiment with the natural uranium spallation target called QUINTA was performed at the Joint Institute for Nuclear Research (JINR) in December 2013. The mass of the QUINTA setup is 512 kg. It consists of five hexagonal sections. The samples of Co-59 have been irradiated with deuteron beam in the field of secondary neutrons at the Nuclotron accelerator from JINR. Energy of the deuteron beam was 4 AGeV. The total beam integral was 6.1(6)·1012. During the experiment, samples were situated in different position inside the assembly and after irradiation were transported to YaSNAPP spectroscopy laboratory and measured at the high-purity germanium semiconductor detectors. Experimental reaction rates of residual nuclei were determined and compared with calculated reaction rates with the MCNPX 2.6 and MCNPX 2.7 codes. The experimental neutron flux was compared with simulations of the MCNPX codes.

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Polymers modification by electron-beam plasma

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Non-equilibrium plasma generated by the electron beam injection in dense media (so-called Electron-Beam Plasma (EBP)) is known to modify physical and chemical properties of materials inserted in it. The modification effects are resulted from the combined action of numerous factors inherent to the EBP namely:

* Fast electrons (high-energy electrons of the electron beam and secondary electrons of moderate energies);

* Heavy plasma particles (neural and ionized particles in ground and excited states) that are produced in the EBP due to the electron beam interaction with the gas;

* X-ray radiation (bremsstrahlung) that is generated when the fast electrons decelerate in gaseous medium and in solid matter.

It is very important to separate the modification effect caused by each of the above factors and to find the factor of the greatest importance.

The experiments regarding to this problem are described in the present paper. The modification of hydrophilic-hydrophobic properties and surface morphology of polymethylmethacrylate (PMMA) under various conditions of the EBP-material interaction is compared. Contact angles between water droplet and PMMA surface was measured and the atomic force microscope was used to study the surface structure of the polymer before and after the plasma treatment.

The studies showed the heavy plasma particles to be responsible for the increase of PMMA wetability whereas the irradiation by fast electrons and X-rays does not practically influenced on the PMMA hydrophilic-hydrophobic properties. However the bremsstrahlung is able to change the nano-roughness of the sample surface.

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Metal uptake by cyanobacteria Spirulina platensis from single-and multi-component systems

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The process of lanthanum, chromium, uranium and vanadium accumulation and sorption by Spirulina platensis biomass from single- and multi-component systems was studied for biotechnological purposes. The influence of multi-component system on the spirulina biomass growth was less pronounced in comparison with the single-component ones. To trace the uptake of metals by spirulina biomass the neutron activation analysis was used. In the experiment on the accumulation the efficiency of studied metal uptake changes in the following order La(V) > Cr(III) > U(VI) > V(V) (single-metal solutions) and Cr(III) > La(V) > V(V)> U(VI) (multi-metal system). The process of metals biosorption was studied during a two-hour experiment. The highest rate of metal adsorption for single-component systems was observed for lanthanum and chromium. While for the multi-component system the significant increase of vanadium and chromium content in biomass was observed. The results of present work show that spirulina biomass can be efficiently applied for metal removal from industrial wastewater.

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Development and support of the project «Paralleling features» in the GitLab system as part of the services provided to users of the cluster HybriLIT

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The heterogeneous computing cluster HybriLIT was put into operation in 2014 in the Laboratory of Information Technologies of JINR [1]. An essential condition enabling efficient use of the cluster is the quick user access to the features enabling the development of parallel applications under the different computing architectures which are available on the cluster. The system GitLab [2] provides a convenient interface to such a service. It allows the users to share with each other their experience on the software development as well as on its effective use on specific scientific applications.

The project «Parallel features» [3] was created within the GitLab framework with a threefold purpose:

- to carry out co-development of software packages and programs by independent user groups;
- to provide more effective consultancy to the cluster users and to people foreseeing future development and implementation of parallel programs for calculations on multicore systems (based on MPI, OpenMP, OpenCL) and coprocessors (CUDA for graphics processing units (GPU) NVIDIA, OpenMP for Intel Xeon Phi coprocessors);
- to develop parallel applications and methodical examples on their base.

The report discusses an instance of parallel computations using the scheduling system SLURM on sequential tasks that require massive calculations for different values of input parameters. The need of such an algorithm rose from the investigation of the Josephson junctions in high temperature superconductors subject to external radiation [4]. The project already solved the problem to get optimization keys for different compilers installed on the HybriLIT cluster.

The project «Paralleling features» under discussion can serve as a pattern toward the systematic development of parallel applications implemented on different computing platforms containing GPU NVIDIA and Intel Xeon Phi coprocessors. It may also be used for the creation of more efficient applications by the cluster users from various JINR laboratories, by students and by participants to training courses conducted on the heterogeneous cluster HybriLIT.

This work is supported by the RFBR grant No 15-29-01217.

[1] http://hybrilit.jinr.ru/
[2] https://gitlab-hybrilit.jinr.ru/
[3] https://gitlab-hybrilit.jinr.ru/hybrilit/ParallelingFeatures
[4] Yu.M. Shukrinov, I.R. Rahmonov, A. Plecenik, O.I. Streltsova, M.I. Zuev, G.A. Ososkov, EPJ-Web of Conferences. Vol. 108. 02042 (2016). DOI: 10.1051/epjconf/201610802042.

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Classification of the quantum primary spatial rainbows in the positron transmission through a short carbon nanotube

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This article is devoted to study of a quantum mechanical aspects of the spatial rainbows occurring in positron transmission through a short (11, 9) single-wall carbon nanotube. The positron energy is 1MeV, and nanotube the length is 150 nm. The positron – nanotube interaction potential is deduced from the Molière's interaction potential using the continuum approximation. The initial positron beam is assumed to be an ensemble of non-interacting Gaussian wave packets. The investigation begins with an analysis of the classical rainbows, and continues with an investigation of the quantum amplitude and phase function families of transmitted positrons. These analyses enable one to identify the principal and supernumerary primary rainbows appearing in the transmitted distribution. As a result, the explanation of their generation is given.identify the principal and supernumerary primary rainbows appearing in the transmitted distribution. They also result in an explanation of their generation.

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Electromagnetic compatibility - an important aspect of measuring equipment

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Sensitive measuring equipment used in scientific research is susceptible to phenomena originating from the disturbances of electromagnetic environment. Electromagnetic compatibility (EMC) tests analyze the ability of an electric or electronic devices to properly operate in given electromagnetic environment and to avoid the emission of electromagnetic field disturbances interfering with the operation of other devices in this environment. They are performed in order to recognize and quantify those disturbances. They also allow to seek solution to possible problems resulting from measurement errors.
In the elaborated presentation the general idea of EMC will be shown. Some EMC phenomena will be presented along with the methods used to test them. The ability of measuring devices to withstand electromagnetic disturbances will be generally assessed. Especially the information about the continuous electromagnetic field immunity test of measuring apparatus in Semi-Anechoic Chamber (SAC) according to standard EN 61000-4-3 will be shown. Measuring equipment can be subjected to various kinds of electromagnetic disturbances caused by radiated electromagnetic field.

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Combinatorial Design of Complexones of Rare Earth Elements Using Phenanthroline Derivatives

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In this paper, using methods of chemoinformatics, original approaches to the creation of combinatorial libraries complexes of rare earth elements with phenanthroline-derived organic ligands were developed. The libraries were generated using the ChemAxon package by expanding Markush structures followed by 3D-structure generation using metric geometry and molecular mechanics approaches. Using semi-empirical quantum-chemical methods (PM3, PM6, PM7; AM1) implemented in the software package MOPAC2012 quantum-chemical modeling of the electronic structure of the complexes was carried out, and their equilibrium spatial structure was determined. Key geometric characteristics of the complexes (lengths of coordination bonds and torsion angles) were analyzed and compared with results of high-level ab initio quantum-chemical simulations. The binding energy of all ligands to cations of rare earth metals was computed. The results of the calculations along with all libraries created in the study will be used for predicting the characteristics of complexes using the QSPR methodology for discovering via virtual screening highly selective ligands for separation of lanthanides in order to produce high-purity rare earth metals.

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Theoretical investigation of the resonance states of low-dimensional two-body system in external electric field

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The model of a two-dimensional (2D) hydrogen atom in external electric field is investigated.
Due to the anisotropy of the influenced interaction the partial wave analysis is ineffective. The algorithm for the numerical solution of the 2D time-dependent Schroedinger equation with anisotropic interaction is proposed. The good convergence and advantages of the algorithm are presented. The good agreement of the numerical results with perturbative theory results for the 2D hydrogen atom in weak external static electric field was obtained.
Two methods of the time-dependence of the wave function integration were compared - the split-operator method is much faster than the conventional Crank–Nicolson scheme and has the same accuracy. The verified algorithm can be applied to the investigation of the shape and structure of resonance states, e.g. their energies and widths, of the 2D hydrogen atom in external electric field (Stark effect).

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Theoretical investigation of the resonance states of low-dimensional two-body system in external electric field

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Decay of Δ-isobars in covariant model of quarks.

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We investigated the decay of Δ-isobar in covariant model of quarks with infrared confinement. We take into account four types of Δ-isobar: Δ++ (uuu), Δ+ (uud), Δ0(udd), Δ-(ddd). We also analytically calculated mass operator to two-point quark loop case. We numerically calculated the decay width of all types of Δ-isobar. It was shown that in case with confinement, loop is real, smooth and without any cusp in the quarks-producing threshold. We get the branching ratio of the decay of Δ-isobar.

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Reconstruction of diffractograms in X-ray imaging of biological objects using Bragg Magnifier

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We present the wave propagator determination and improved phase retrieval algorithm invented specifically for imaging of biological objects using Bragg Magnifier Microscope (BMM). The robustness of the algorithm is tested on different samples and the results are shown. First, it is applied to the experimentally measured diffractograms of well-defined samples of polystyrene spheres and siemens star. After achieving success with their analytical forms, we present the reconstruction of the more complex biological object - model organism Tardigrade, where we also deal with the phenomenon of phase wrapping. The obtained resolution of the reconstructed images is determined to be between 0.5 and 1 μm. To speed up our numerical tool, we implemented it on GPU allowing us to reconstruct a single image in few minutes. Results confirm the potential of imaging of biological objects using BMM with the submicron resolution.