Infinite and Finite Nuclear Matter (INFINUM-2023)

Report of Contributions

https://indico.jinr.ru/e/3433

Contribution ID: **1** Type: **not specified**

Construction of the nuclear equation of state

Wednesday, March 1, 2023 2:30 PM (30 minutes)

Here

Primary author: Dr KOLOMEITSEV, Evgeni (BLTP, JINR, Dubna and Matej Bel University, Slovakia)

Presenter: Dr KOLOMEITSEV, Evgeni (BLTP, JINR, Dubna and Matej Bel University, Slovakia)

Contribution ID: **2** Type: **not specified**

Phase transitions in nuclear matter. Dreams and reality

Tuesday, February 28, 2023 2:40 PM (40 minutes)

Phase transitions in nuclear matter will de discussed.

Primary author: VOSKRESENSKY, Dmitry (BLTP, JINR, Dubna)

Presenter: VOSKRESENSKY, Dmitry (BLTP, JINR, Dubna)

Contribution ID: **5** Type: **not specified**

Nuclear pasta in neutron stars or Δ baryons in magnetars

Tuesday, February 28, 2023 3:20 PM (30 minutes)

The appearance of anisotropic nuclei in the crust of neutron stars, called the pasta phase, can impact several macroscopic properties, e.g. cooling, magnetic field evolution and gravitational wave emission. In this talk, we will discuss some properties of the pasta such as impurities, conductivity and whether nucleon correlations can inhibit its appearance in the context of relativistic mean field models.

or

Magnetars are a subclass of neutron stars with surface magnetic fields that can reach 10^{15} G. In the core, the high densities can induce the appearance of hyperons and Δ baryons. In this talk, we discuss the effect of Δ baryons and their anomalous magnetic moment in magnetars.

Primary author: REINKE PELICER, Mateus (Universidade Federal de Santa Catarina)

Presenter: REINKE PELICER, Mateus (Universidade Federal de Santa Catarina)

Contribution ID: **6** Type: **not specified**

Effective valence-space interactions for the nuclear shell model from many-body perturbation theory

Tuesday, February 28, 2023 10:40 AM (30 minutes)

The nuclear shell model [1] is a well developed theory for the calculation of finite nuclei properties. Its main idea is simple: a non-relativistic A-nucleon Hamiltonian, containing nucleonic kinetic energies and inter-nucleon interactions, is diagonalized in a spherically-symmetric harmonic-oscillator basis. For light nuclei, the model treats all A nucleons as active particles occupying a large-dimensional model space comprised from many oscillator shells, representing thus a fully ab-initio many-body approach referred to as no-core shell model [2]. However, a rapid growth of the basis dimension with the number of nucleons prohibits such calculations for heavier nuclei. A common practice to limit the number of basis configurations is proposed by the interacting shell model which assumes an inert core (usually being a doubly-closed shell nuclei) and treats only valence nucleons as active particles moving in a model space comprised from one or two oscillator shells. Such severe truncation of the Hilbert space requires a consistent derivation of the so-called effective interaction for valence nucleons. Phenomenological effective interactions, obtained from a fit to experimental data [1,3], usually demonstrate a high descriptive and predictive power of the shell model. Construction of microscopic effective interactions from realistic nucleon-nucleon potentials has been a long-standing problem of nuclear theory which stays challenging up to present [4,5]. In this talk I will present novel developments within many-body perturbation theory which allows derivation of effective valence-space shell-model interactions from a nucleon-nucleon potential for the first time beyond the conventional 3rd order. Both harmonic-oscillator basis and self-consistent Hartree-Fock basis were implemented to investigate convergence properties of the theory with respect to the model-space parameters. As an example of application, we will consider in detail effective interactions for the p-shell obtained from the Daejeon16 nucleon-nucleon potential [6]. Calculated ground state energies and spectra of A=6 systems will be compared with those obtained from the phenomenological p-shell interaction [3] and with the results from the no-core shell model [6]. Finally, I will show ground-state energies and spectra of selected p-shell nuclei obtained from the derived effective interactions.

[References]

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[2] B. R. Barrett, P. Navrátil, and J. P. Vary, ab initio No Core Shell Model, Progress in Particle and Nuclear Physics 69, 131 (2013).

[3] S. Cohen and D. Kurath, Effective Interactions for the 1p Shell, Nucl. Phys. 73, 1 (1965).

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[5] S. R. Stroberg, H. Hergert, S. K. Bogner and J. D. Holt, Non-empirical interactions for the nuclear shell model: an update, Ann. Rev. Nucl. Part. Sci. 69, 307 (2019).

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Primary author: LI, Zhen

Co-author: Prof. SMIRNOVA, Nadezda (Laboratoire de Physique des Deux Infinis Bordeaux (LP2I Bordeaux))

Presenter: LI, Zhen

Contribution ID: **8** Type: **not specified**

Crust of accreting neutron stars

Monday, February 27, 2023 3:20 PM (30 minutes)

The talk presents the results of a series of works [1-6] on modeling the outer layers (crust) of neutron stars in close binary systems with a low-mass companion star. The matter of the crust consists of atomic nuclei immersed in a background of degenerate electrons and, in the inner parts of the crust, neutrons. Due to accretion, the original crust is replaced by the accreted matter. The talk discusses the processes occurring in the crust of a neutron star during accretion. It is shown that the redistribution of neutrons in the inner crust, which is due to diffusion near the border of the outer and inner crust and due to neutron superfluidity in the rest of the inner crust, plays a major role in the formation of the crust composition. This effect was not taken into account in previous models, which have been developing for about 40 years. It radically changes the chains of nuclear reactions and the composition of the crust. In particular, the heating caused by nuclear reactions is several times less than previously thought. This is important for the interpretation of observations of the thermal radiation of accreting neutron stars during periods when accretion on the neutron star stops.
This work was supported by Russian Science Foundation [Grant No. 22-12-00048]
[1] A.I. Chugunov & N.N. Shchechilin, MNRAS, 495, L32 (2020).
[2] M.E. Gusakov & A.I. Chugunov, Phys. Rev. Lett. 124, 191101 (2020).
[3] M.E. Gusakov & A.I. Chugunov, Phys. Rev. D, 103, L101301 (2021).
[4] M.E. Gusakov, E.M. Kantor & A.I. Chugunov, Phys. Rev. D, 104, L081301 (2021).
[5] N.N. Shchechilin, M.E. Gusakov & A.I. Chugunov, MNRAS, 507, 3860 (2021).
[6] N.N. Shchechilin, M.E. Gusakov & A.I. Chugunov, MNRAS, 515, L6 (2022).

Primary author: CHUGUNOV, Andrey (Ioffe Institute)

Co-authors: Dr KANTOR, Elena (Ioffe Institute); Dr GUSAKOV, Mikhail (Ioffe Institute); Mr SHCHECHILIN, Nikolai (Université Libre de Bruxelles)

Presenter: CHUGUNOV, Andrey (Ioffe Institute)

Contribution ID: **9** Type: **not specified**

Resonance production in heavy-ion collisions

Tuesday, February 28, 2023 11:30 AM (40 minutes)

The short-lived resonances are playing an important role in the physical programs of heavy-ion experiments. The resonances measured in the hadronic decay channels probe the strangeness production, the hadronization mechanisms at intermediate and high transverse momenta, rescattering and regeneration effects in the hadronic phase and the spin alignment of vector mesons in heavy-ion collisions. In this presentation, we review status of resonance measurements in heavy-ion collisions at SPS, RHIC and the LHC and discuss how measurements of resonances can contribute to the physical program of experiments at NICA. Results of feasibility studies for reconstruction of resonances in the MPD experimental setup will also be presented and discussed.

Primary author: Dr RIABOV, Viktor (PNPI)

Presenter: Dr RIABOV, Viktor (PNPI)

Contribution ID: **10** Type: **not specified**

Thermal effects on weak-interaction nuclear reactions in stellar conditions

Tuesday, February 28, 2023 4:30 PM (30 minutes)

By the example of selected iron group nuclei and neutron-rich nuclei with N≈50, the influence of temperature on the rates and cross sections for various weak-interaction reactions (electron capture, inelastic neutrino scattering, etc.), which play an important role in the late stages of massive star evolution, is studied. It is shown that thermodynamically consistent incorporation of thermal effects leads to a stronger temperature dependence of the rates and cross sections than predicted by the shell model calculations.

Primary author: DZHIOEV, Alan (Joint Institute for Nuclear Research, Bogoliubov Laboratory of Theoretical Physics)

Presenter: DZHIOEV, Alan (Joint Institute for Nuclear Research, Bogoliubov Laboratory of Theoretical Physics)

Contribution ID: **11** Type: **not specified**

Effects of partial restoration of chiral symmetry on particle production in heavy-ion collisions

Thursday, March 2, 2023 4:10 PM (30 minutes)

QCD predicts that with increasing baryon density the chiral symmetry gets
gradually restored due to the disappearance of the scalar $\bar{q}q$ condensate. This should result in the appearance of the parity doublets in the spectrum of hadrons, like (π, σ), (ρ, a_1), $(N, N^*(1535))$ etc. In order to connect this prediction with observables one needs to properly modify relativistic mean fields used in many hadronic transport models which usually resort on Walecka-type descriptions. This talk is based on the paper [1] which represents one of the first such attempts. We apply the linear σ-model with $SU(2)_R \times SU(2)_L$ symmetry in the mirror assignment, that is called the parity-doublet model (PDM) C.E. DeTar, T. Kunihiro, 1989; D. Jido et al., 2001. We implement the PDM model in the Giessen Boltzmann-Uehling Uhlenbeck (GiBUU) transport model as an option in the calculation of relativistic mean fields. Within this chiral approach we study heavy-ion collisions at the beam energy of 1-2A GeV focusing on the production of η mesons. A strong dropping of the Dirac mass of the $N^*(1535)$ in the high-density stage of a collision leads to a considerable enhancement in the production of this resonance as compared to the non-linear Walecka model. As the system expands, the Dirac masses of these abundant soft $N^*(1535)$ resonances gradually increase and ultimately cross the $N\eta$ decay threshold. As a result, an enhanced low-energy η production is observed in the calculations with chiral mean fields. Comparing with TAPS data on η production we find that the chiral model improves the agreement for the m_t-spectra of η's at small m_t in heavy colliding systems. A similar enhancement is also observed in the soft ρ production resulting in slightly larger dilepton yields.

[1] A.B. Larionov, L. von Smekal, Phys. Rev. C 105, 034914 (2022)

Primary author: LARIONOV, Alexei (Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia)

Co-author: VON SMEKAL, Lorenz (Justus-Liebig University Giessen)

Presenter: LARIONOV, Alexei (Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia)

Contribution ID: **12** Type: **not specified**

Reduction of shear modulus by nuclei finite size in the neutron star inner crust

Friday, March 3, 2023 11:30 AM (30 minutes)

The elastic properties of neutron star crust can play important role for interpretation of observations (e.g., quasi-periodic oscillations in the tails of magnetar flares). To calculate the elastic properties one should rely on theoretical models. The most popular model is Coulomb crystal (system of point-like charges on neutralizing uniform background). However, in the innermost layers of crust nuclei size becomes comparable with the internuclear spacing and validity of Coulomb crystal approximation becomes unclear. Indeed, we argue that crust deformation induces non-spherically symmetric potential in a vicinity of the lattice sites and this potential affects nuclei shape. We analyze this problem analytically within compressible liquid drop model. In particular, we have demonstrated that nuclei deformation indeed takes place and reduces the effective shear modulus. Within applied approach, the result is universal, i.e. it does not depend on the applied nucleon interaction model. For the deepest layers of inner crust reduction of the shear modulus reaches ~ 25 percent. The results are published [MNRAS 518, 3813 (2023)].

Primary authors: Mr ZEMLYAKOV, Nikita; Dr CHUGUNOV, Andrey (Ioffe Institute)

Presenter: Mr ZEMLYAKOV, Nikita

Contribution ID: **13** Type: **not specified**

Various corners of QCD phase diagram

Monday, February 27, 2023 12:10 PM (30 minutes)

QCD phase diagram and in particular color superconducting phenomnon has been considered with non-zero chiral imbalance in the framework of effective model. Isospin as well as two types of chiral imbalance has been considered. It is a continuation of our studies of the same situation but in 2 color QCD, JHEP 06 (2020) 148, Phys.Rev.D 106 (2022) 4, 045008.

It was investigated how the chiral imbalance affects the phase of the color superconductivity. It has been shown that chiral imbalance leads to the appearance of color superconductivity in dense quark matter at lower values of baryon chemical potentials than in a chirally symmetric medium.

It is shown that the behavior of the color superconductivity phase in QCD, in the three color case N_c=3 qualitatively coincides with the behavior of diquark condensation in the 2 color case N_c=2 in a more complex mode when there are several different non-zero chemical potentials.

It was shown that the phenomenon of color superconductivity, which plays an important role in region of high baryonic densities, does not violate the previously found duality between chiral symmetry breaking and charged pion condensation.
Moreover, in connection with this duality, the chiral imbalance mu_I5 and the isotopic mu_I imbalances have exactly the same effect on the diquark condensation phenomenon.
Despite the fact that the thermodynamic potential in the case of N_c=3 does not have properties of dualities between the phenomena of pion and diquark condensation and between chiral symmetry breaking and diquark condensation phenomena found at study of the phase portrait in the two-color case, it turned out (that it is enough
surprising) that the phase portrait qualitatively contains duality (the dualities are not exact as in N_c=2, but they are unambiguously guessed in the phase portrait).

Primary author: Dr ZHOKHOV, Roman (IHEP, IZMIRAN)

Presenter: Dr ZHOKHOV, Roman (IHEP, IZMIRAN)

Contribution ID: **14** Type: **not specified**

Quasi-deuteron clusters in the ^{12}C and short-range NN correlations in the reaction ^{12}C+p$\rightarrow^{10}$A+ pp+N

Friday, March 3, 2023 12:20 PM (30 minutes)

Short-range correlated (SRC) NN pairs play an important role in structure of atomic nuclei and are studied using mainly electron beams [1]. A new step was done at BM@N in JINR [2] where the reaction 12C+p⟶10A+pp+N is studied using the ^{12}C beam at energy of 4 GeV/nucleon in inverse kinematics providing interaction with the hydrogen target to probe the SRC pairs in the ^{12}C. In theoretical analysis [3] of the SRC effects in this reaction is used a properly modified approach developed earlier (see Ref. [4] and references therein) to describe the quasi-elastic knock-out of fast deuterons from the light nuclei ^{12}C and ^{7,6}Li by protons in the reactions (p,pd) and (p,nd) [5]. Elementary sub-processes in the (p,Nd) were the backward quasi-elastic scattering of the proton on the two-nucleon clusters p{pn}⟶pd and p{nn}⟶nd at the proton beam energy 670 MeV. As in Ref. [4], the spectroscopic amplitudes for NN-pairs in the ground state of the 12C nucleus are calculated here within the translation-invariant shell model (TISM) with mixing configurations. Factorization of the two-nucleon momentum distribution over the internal n_{rel} (q_{rel}) and the c.m.s. ncm ($k_{c.m.}$) momenta is assumed and for nrel (q_{rel}) the squared deuteron (or singlet deuteron) wave function the CD Bonn NN-interaction potential is used. Relativistic effects in the sub-process p+{NN}⊠p+N+N of quasi-elastic knockout of nucleon from the SRC pair are taken into account in the light-front dynamics. We found that the c.m. distribution of the deuteron clusters obtained within the TISM and used in [4], [5] to describe the (p,Nd) data [4] has to be modified considerably [6] to describe the kc.m. distribution of the SCR NN pairs measured in the electron data [6]. The ratio of the spin-singlet to spin-triplet pairs $\{pp\}_s/\{pn\}_t$ is calculated [7] and found to be in agreement with existing data. Here the initial and final state interaction effects are estimated within the eikonal approximation using the Glauber model for the N^{10}A scattering [8]. The one-loop approximation with elastic N^{10}A rescatterings is applied and the effect is found to be moderate.

This work was supported in part by the RFBR grant № 18-02-40046.

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8. Yu. Uzikov, Acta Phys. Pol. B Proc. Suppl. 14 , № 4, (2021) 793.

Primary author: UZIKOV, Yury (Joint Institute for Nuclear Researches)

Presenter: UZIKOV, Yury (Joint Institute for Nuclear Researches)

Contribution ID: **15** Type: **not specified**

Double-folding nucleus–nucleus interaction potential based on the self-consistent calculations

Thursday, March 2, 2023 10:30 AM (30 minutes)

The nucleon density profiles of spherical nuclei are calculated within the self-consistent HFB approach based on the non-covariant energy density functional. For the reactions with light nuclei, the nucleus–nucleus interaction potentials are calculated in the double-folding form with these nucleon densities. The characteristics of the Coulomb barriers obtained are in good agreement with those required to describe the sub-barrier complete fusion. The energy density functional used provides a reliable basis to calculate the nucleus–nucleus potential in the reactions of astrophysical interest. A simple parametrization for the nuclear part of the nucleus–nucleus interaction is proposed to estimate the height, position, and curvature of the Coulomb barrier.

Primary author: ANTONENKO, Nikolai (BLTP, JINR)

Presenter: ANTONENKO, Nikolai (BLTP, JINR)

Contribution ID: **16** Type: **not specified**

Hyperon polarization asymmetry and vortical effects in in relativistic heavy-ion collisions

We discuss the enhancement in the spin polarization of anti-hyperons compared to the polarization of the hyperons in noncentral relativistic heavy-ion collisions at low energies. We argue that this enhancement arises from an interplay between the chiral vortical effect and its helical counterpart. Furthermore, we show that the chiral/helical mechanism can reasonably well describe, without any fitting parameters, the ratio of the (anti)hyperon spin polarizations obtained by the STAR group.

Primary author: CHERNODUB, Maxim (Institut Denis Poisson, University of Tours, France)

Presenter: CHERNODUB, Maxim (Institut Denis Poisson, University of Tours, France)

Contribution ID: **17** Type: **not specified**

Prospects of the low-energy nuclear physics in Russia; Selected problems in the studies of light exotic nuclei.

TBA

Primary author: GRIGORENKO, Leonid (FLNR, JINR)

Presenter: GRIGORENKO, Leonid (FLNR, JINR)

Contribution ID: **18** Type: **not specified**

Λ Polarization and Vortex Rings in Heavy-Ion Collisions at NICA Energies

Tuesday, February 28, 2023 12:10 PM (30 minutes)

We review recent studies of vortical motion and the resulting polarization of Λ hyperons in heavy-ion collisions at NICA energies, in particular, within the model of three-fluid dynamics (3FD). This includes predictions of the global Λ polarization and ring structures that appear in Au+Au collisions. The global Λ polarization in Au+Au collisions is calculated, including its rapidity and centrality dependence. Contributions from the thermal vorticity and meson-field term (proposed by Csernai, Kapusta and Welle) to the global polarization are considered. The results are compared with data from recent STAR and HADES experiments. It is predicted that the polarization maximum is reached at $\sqrt{s_{NN}} \approx 3$ GeV, if the measurements are performed with the same acceptance. It is demonstrated that a pare of vortex rings are formed, one at forward and another at backward rapidities, in ultra-central Au+Au collisions at $\sqrt{s_{NN}} > 4$ GeV. The vortex rings carry information about early stage of the collision, in particular about the stopping of baryons. It is shown that these rings can be detected by measuring the ring observable R_Λ even in midrapidity region $\%0 < y < 0.5$ (or $-0.5 < y < 0$) on the level of 0.5–1.5\% at $\sqrt{s_{NN}} = 5 - 20$ GeV. At forward/backward rapidities, the R_Λ signal is expected to be stronger. Possibility of observation of the vortex-ring signal against background of non-collective transverse polarization is discussed.

Primary author: Prof. IVANOV, Yuri B. (BLTP JINR)

Presenter: Prof. IVANOV, Yuri B. (BLTP JINR)

Contribution ID: **19** Type: **not specified**

Sound propagation in a neutron star with quark matter droplets

Wednesday, March 1, 2023 12:30 PM (30 minutes)

Sound propagation in a neutron star with quark matter droplets immersed into it displays a highly nonlinear behavior. The sound speed has a dip-bump structure and may reach the conformal limit

Primary author: Prof. KERBIKOV, Boris (ITEP and Lebedev)

Presenter: Prof. KERBIKOV, Boris (ITEP and Lebedev)

Contribution ID: **20** Type: **not specified**

Long-range multiparticle interactions induced by neutrino exchange in neutron star matter

Monday, February 27, 2023 4:10 PM (30 minutes)

Forces with a large radius of interaction can have a significant impact on the equation of state of matter. Low-mass neutrinos generate a long-range potential due to the exchange of neutrino pairs.We discuss a possible relationship between the neutrino masses, which determine the interaction radius of the neutrino-pair exchange potential, and the equation of state of neutron matter. Contrary to previous statements, the thermodynamic potential, when decomposed into the number of neutrino interactions, vanishes in any decomposition order, except for the interaction of two neutrons. In the one-loop approximation, long-range multiparticle neutrino interactions are stable in the infrared region for all neutrino masses and do not affect the equation of state of neutron matter or the stability of neutron stars. JETP Letters, Vol. 117, No. 2, pp. 98–101 (2023) http://jetpletters.ru/ps/2407/article_35504.shtml

Primary author: KRIVORUCHENKO, Mikhail (Institute for Theoretical and Experimental Physics; B. Cheremushkinskaya 25 117218 Moscow, Russia)

Presenter: KRIVORUCHENKO, Mikhail (Institute for Theoretical and Experimental Physics; B. Cheremushkinskaya 25 117218 Moscow, Russia)

Contribution ID: **21** Type: **not specified**

Electric dipole vorticity in nuclei

Wednesday, March 1, 2023 11:30 AM (30 minutes)

ELECTRIC DIPOLE VORTICITY IN NUCLEI V.O. Nesterenko Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, Moscow region, 141980, Russia During last decades, the intrinsic nuclear vorticity associated with toroidal E1 excitations attracts a high attention. We briefly discuss some basic aspects and recent progress in this activity: relation of the toroidal E1 resonance with Hill's vortex ring, interplay of the toroidal and pygmy dipole resonances [1-3], individual low-energy E1 toroidal states in light deformed nuclei [4]-[8], relation with cluster modes in light nuclei [7], possible ways for identification of individual toroidal states in experiment [8]. [1] A. Repko, P.-G. Reinhard, V.O. Nesterenko, and J. Kvasil, Phys. Rev. C 87, 024305 (2013). [2] V.O. Nesterenko, J. Kvasil, A. Repko, W. Kleinig, and P.-G. Reinhard, Phys. Atom. Nucl. 79, n.6, 842 (2016). [3] A. Repko, V.O. Nesterenko, J. Kvasil, and P.-G. Reinhard, Eur. Phys. J. A 55, 242 (2019). [4] V.O. Nesterenko, A. Repko, J. Kasil, and P.-G. Reinhard, Phys. Rev. Lett. 120, n.18, 182501 (2018). [5] V.O. Nesterenko, J. Kvasil, A. Repko, and P.-G. Reinhard, Eur. Phys. J. Web of Conf. 194, 03005 (2018). [6] Yoshiko Kanada-En'yo and Yuki Shikata, Phys. Rev. C 95 064319 (2017). [7] P. Adsley, V.O. Nesterenko, et al, Phys. Rev. C 103, 044315 (2021). [8] V.O. Nesterenko, A. Repko, J. Kvasil, and P.-G. Reinhard, Phys. Rev. C 100, 064302 (2019).

Primary author: NESTERENKO, Valentin (BLTP, Joint Institute for Nuclear Research)

Presenter: NESTERENKO, Valentin (BLTP, Joint Institute for Nuclear Research)

Contribution ID: **22** Type: **not specified**

Results of BES at STAR

Wednesday, March 1, 2023 10:00 AM (40 minutes)

TBA

Primary author: NIGMATKULOV, Grigory (National Research Nuclear University MEPhI (Moscow Engineering Physics Institute))

Presenter: NIGMATKULOV, Grigory (National Research Nuclear University MEPhI (Moscow Engineering Physics Institute))

Contribution ID: **23** Type: **not specified**

Experimental study of cold dense nuclear matter

Friday, March 3, 2023 10:30 AM (40 minutes)

The fundamental theory of nuclear interactions, Quantum Chromodynamics (QCD), operates in terms of quarks and gluons at higher resolution, and at lower resolution the relevant degrees of freedom are nucleons. Two-nucleon Short-Range Correlations (SRC) help to interconnect these two descriptions. SRCs are temporary fluctuations of strongly-interacting compact pairs of nucleons. The distance between the two SRC nucleons is comparable to their radii and individual momenta are larger than the fermi sea level. According the electron scattering experiments held in the last decade, SRCs have far-reaching impacts on many-body systems, the nucleon-nucleon interactions, and nucleon substructure. The modern experiments with ion beams open new pathways in SRC research. Inverse kinematics with ion beams and cryogenic liquid hydrogen target makes possible to study properties of the nuclear fragments after quasi-elastic knockout of a single nucleon or SRC pair. The first SRC experiment at BM@N (2018) with a carbon beam has shown that detection of an intact 11B nucleus after the interaction selects out the quasi-elastic knockout reaction with minimal contribution of initial- and final-state interactions. Also, 23 events of SRC-breakups showed agreement in SRC properties as known from electron beam experiments. The analysis of the second measurement of SRC at BM@N in 2022 with an improved setup is currently ongoing.

Primary author: PATSYUK, Maria (MIT)

Presenter: PATSYUK, Maria (MIT)

Contribution ID: **24** Type: **not specified**

Kinematical vortical effect

Thursday, March 2, 2023 12:50 PM (20 minutes)

We consider a relativistic quantum fluid moving with vorticity and acceleration. It is shown that despite the space flatness, there is an effect directly related to gravity. Namely, an axial current arises, which depends on the acceleration and vorticity of the medium, and the conductivity in this current is determined by the gravitational quantum anomaly. This effect was called the Kinematic vortical effect and was derived by us in the general case. The general analysis has been then tested for quantum field theories with spins 1/2 and 3/2. In particular, using spin 3/2 as an example, it is clearly shown that the cubic spin dependence of the gravitational chiral anomaly is reproduced in hydrodynamics.

Primary author: PROKHOROV, George (Dubna, BLTP)

Presenter: PROKHOROV, George (Dubna, BLTP)

Contribution ID: **25** Type: **not specified**

The double gamma decay of the quadrupole state of spherical nuclei

Thursday, March 2, 2023 4:40 PM (30 minutes)

The γγ-decay reactions are formally analogous to neutrinoless double-β decay processes where in the latter two β-particles and in the former two γ-quanta appear in the final state and share the total energy of the nuclear transition. This paper reports on the situation, in which the γγ-decay of the low-energy quadrupole state occurs in a nuclear transition which could proceed by a single-γ decay in competition. To describe the γγ-decay, a formalism relates the electromagnetic interaction up to second order in the electromagnetic operators and two-quantum processes in atomic nuclei. The coupling between one-, two- and three-phonon terms in the wave functions of excited nuclear states is taken into account within the microscopic model based on the Skyrme energy density functional. It is shown that the γγ-decay width is sensitive to the interaction between one- and two-phonon configurations. The maximal branching ratio of the competitive γγ-decay relative to its single γ-decay is predicted as 10^{-8}. This prediction can be tested experimentally.

Primary author: SEVERYUKHIN, Alexey (BLTP, JINR)

Presenter: SEVERYUKHIN, Alexey (BLTP, JINR)

Contribution ID: **27** Type: **not specified**

Chiral Phase Structure and Magentic Propeties of QCD Phase Diagram at NICA Energies

Monday, February 27, 2023 12:40 PM (30 minutes)

In SU(3) Polyakov linear sigma model (PLSM), in which the chiral symmetry and gluomic degrees of freedom are integrated in the hadronic and partonic phase, the QCD phase structure and its magnetic properties are analyzed in thermal and dense medium, at finite magnetic field. Both Landau quantization and magnetic catalysis are implemented so that magnetization, magnetic susceptibility and permeability have been estimated. We find that the partonic phase has higher values of magnetization, magnetic susceptibility, and permeability than the hadronic phase. We also study the chiral phase structure of: a) pseudoscalars (Jpc=0−+), b) scalars (Jpc=0++), c) vectors (Jpc=1−−), and d) axial-vectors (Jpc=1++) meson states, at finite temperature, baryon chemical potential and magnetic field. The in-medium (thermal and density) characteristics of nonet meson states normalized to the lowest bosonic Matsubara frequencies are also analyzed. We noticed that the meson masses normalized to normalized become temperature independent at characterizing critical temperatures. We observe that the chiral and deconfinement phase transitions are shifted to lower quasicritical temperatures with increasing chemical potential and magnetic field. We also find that increasing chemical potential enhances the mass degeneracy of the various meson masses, while increasing the magnetic field seems to reduce the critical chemical potential, at which the chiral phase transition takes place. Our mass spectrum calculations, at vanishing temperature, agree well with PNJL, lattice QCD calculations, QMD/UrQMD simulations, and the recent PDG compilations.

Primary author: Prof. TAWFIK, Abdel Nasser

Presenter: Prof. TAWFIK, Abdel Nasser

Contribution ID: **28** Type: **not specified**

Polarization, handedness and flows

Friday, March 3, 2023 10:00 AM (30 minutes)

Various sources of collective behaviour leading to global polarization are considered. It may emerge due to the binary scattering of quarks and hadrons in the presence of flows. The vector and tensor polarization are related to directed and elli[tic flow, respectively. The relations of P-odd effects in coordinate and momentum space, like vorticity and handedness, are discussed.

Primary author: TERYAEV, Oleg (JINR)

Presenter: TERYAEV, Oleg (JINR)

Contribution ID: **29** Type: **not specified**

Stripping model for short GRB: nuclear data needed

Monday, February 27, 2023 4:40 PM (30 minutes)

I shortly review the current status of stripping model for short gamma-ray bursts. The focus will be on the nuclear data needed to accurately simulate the various steps of the model. Namely: to describe a) the slow decompression of the neutron star matter during the stripping itself and b) the rapid decompression of the rest of the NS matter during its explosion. In addition, I will talk about the nuclear data needed to calculate the nucleosynthesis process (r-process) that accompanies the explosion of a light NS.

Primary author: YUDIN, Andrey (Vladimirovich)

Presenter: YUDIN, Andrey (Vladimirovich)

Contribution ID: **30** Type: **not specified**

Nonanalytic relativistic r-mode instability windows

Wednesday, March 1, 2023 4:10 PM (30 minutes)

Detectability of the r-mode gravitational-wave signal depends on the interplay between the mode amplification by the CFS instability and its damping by dissipative mechanisms, operating in the stellar matter. Those stellar parameters - usually, the angular velocity, Ω, and redshifted temperature, T^{∞}, - for which the mode is unstable, define the r-mode instability window. We revisit this problem in nonbarotropic neutron stars, accounting for the previously overlooked relativistic r-mode nonanalytic behavior (in Ω) and enhanced energy dissipation due to diffusion in superconducting stellar matter. We show that, at slow rotation rates, relativistic r-modes are amplified by the CFS instability weaker than Newtonian ones, while their viscous and diffusive dissipation is, instead, significantly more efficient. At realistic rotation rates relativistic and Newtonian r-mode amplification by CFS mechanism and damping by shear viscosity become comparable, while the relativistic mode damping by diffusion and bulk viscosity remain significantly stronger than nonrelativistic ones. As a result, accounting simultaneously for diffusion and relativistic r-mode nonanalyticity drastically changes the r-mode instability window as compared to the Newtonian one. This effect is of paramount importance for the interpretation of the future gravitational-wave observations and understanding of the r-mode physics in general.

Primary authors: KANTOR, Elena (Ioffe Institute); KRAAV, Kirill (Ioffe Institute); GUSAKOV, Mikhail (Ioffe Institute)

Presenter: KRAAV, Kirill (Ioffe Institute)

Contribution ID: **31** Type: **not specified**

Partial probabilities and quark chemical potential

Friday, March 3, 2023 2:40 PM (20 minutes)

The importance of reconstruction of the net baryon number in each event
of heavy-ion collisions for the determination of the baryon chemical potential of the fireball is argued. A possibility of experimental determination of ratios between canoncal partition functions of quark-gluon matter as well as criteria of thermodynamical equilibrium of the fireball are discussed.

Primary author: ROGALYOV, Roman (IHEP)

Presenter: ROGALYOV, Roman (IHEP)

Contribution ID: **32** Type: **not specified**

Strange to non-strange ratios in the SU(3) NJL-like models

Thursday, March 2, 2023 2:40 PM (20 minutes)

A sharp peak in the ratio of strange to non-strange mesons in relativistic heavy-ion collision is discussed in the framework of the SU(3) Polyakov-loop extended NJL model with vector interaction. In the model, the K^+/π^+ ratio was calculated along the chiral phase transition line for different values of the vector coupling g_V. We showed that the value of the vector coupling had no significant effect on the K^+/π^+ behaviour. We present a comparison with the experimental pattern of kaon-to-pion ratios within the Beth-Uhlenbeck approach and using x-dependent pion and strange quark potentials. The brief discussion of the possibility to describe the Λ/π^- ratio in the frame of PNJL model is presented.

Primary author: FRIESEN, Alexandra (Joint Institute for Nuclear Research)

Presenter: FRIESEN, Alexandra (Joint Institute for Nuclear Research)

Contribution ID: **33** Type: **not specified**

Modified Fayans functional. Description of nuclear ground state properties and spin-isospin response.

Tuesday, February 28, 2023 12:40 PM (30 minutes)

Modified Fayans functional. Description of nuclear ground state properties and spin-isospin response.

The isovector volume term of Fayans energy density functional DF3-f [1] is extended. The corresponding parameter h-2 is determined in [2] making use of experimental and theoretical constraints derived recently for the parameters of nuclear matter equation of state: the symmetry energy J and its derivative L at equilibrium density [3]. We also discuss the relativistic correction to the EDF. The obtained equations of state for SNM and PNM are compared with the relativistic approaches [4].
An impact of the h-2 parameter on the Gamow-Teller strength function of reference doubly-magic nuclei 208Pb is studied. Also, the charge-exchange spin-dipole resonances in 208Pb are treated and the calculated sum rule is compared with the one derived from the (p, n) and (n, p) reactions [5]. This gives restriction on the value of the "neutron skin", which, in turn, correlates with the parameters of the equation of state J and L.
Within the same framework, the β-decay half-lives are calculated for spherical nuclei with Z = 81 - 83 and T1/2<240c. The available data are described up to a factor of 5, which is higher than the accuracy of the relativistic RHB+RQRPA approach [6].
The magnetic moments are calculated for the chains of Pt and Au isotopes. A joint analysis of the charge radii and such an isovector characteristic, as the magnetic moment, makes it possible to limit the possible values of the spins of the ground states of very neutron-rich nuclei that are not known experimentally.

1. I.N. Borzov, S.V. Tolokonnikov, Phys.At.Nucl 82(6), 560 (2019).
2. I.N. Borzov, S.V. Tolokonnikov, Phys.At.Nucl 86(3) (2023).
3. R. Essick, I. Tews, P. Landry, and A. Schwenk, Phys. Rev. Lett. 127, 192701 (2021).
4. S. Gandolfi et.al. Phys. Rev.C 79, 054005 (2009).
5. T. Wakasa et.al. Phys.Rev. C85, 064606 (2012).
6. T. Marketin et.al , Phys.Rev. C93, 025805 (2016).

Primary author: BORZOV, Ivan (NRC KI and JINR)

Co-author: Dr TOLOKONNIKOV, Sergej

Presenter: BORZOV, Ivan (NRC KI and JINR)

Contribution ID: **34** Type: **not specified**

Transport coefficients of magnetized neutron star cores

Monday, February 27, 2023 2:40 PM (40 minutes)

Neutron stars are considered as natural laboratories for testing the properties of cold and dense nuclear matter. Knowledge of various microphysical properties of such matter is necessary to link the nuclear matter theory with the astrophysical observations.
In this talk we consider kinetic coefficients (thermal conductivity, shear viscosity, momentum transfer rates) of the magnetized neutron star cores within the framework of the Landau Fermi-liquid theory [1]. We restrict ourselves to the case of normal (i.e. non-superfluid) matter and nucleonic composition. The magnetic field is taken to be non-quantizing. The presence of magnetic field leads to the tensor structure of kinetic coefficients. We find that the moderate ($B < 10^{12}$ G) magnetic field do not affect considerably thermal conductivity of neutron star core matter, since the latter is mainly governed by the electrically neutral neutrons. In contrast, shear viscosity is affected even by the moderate $B \sim 10^{8}$–10^{10} G.
The uncertainties in the results are illustrated utilizing 39 equations of state from the CompOSE database and several models of the in-medium nucleon interactions treated via the Brueckner-Hartree-Fock calculations of the in-medium scattering matrices.
We also provide a "poor man" approximation for the transport coefficients based on the in-vacuum nucleon cross-sections which allow to obtain qualitatively correct results for any given nucleonic equation of state of the neutron star core.
The work is supported by RSF #19-12-00133
[1] P.S. Shternin, D.D. Ofengeim, EPJA 2022, 58, id. 42.

Primary authors: SHTERNIN, Peter (Ioffe Institute); Dr OFENGEIM, Dmitry (Racah Institute of Physics, The Hebrew University of Jerusalem)

Presenter: SHTERNIN, Peter (Ioffe Institute)

Contribution ID: **35** Type: **not specified**

Chiral effects: new trends

Wednesday, March 1, 2023 12:00 PM (30 minutes)

Chiral effects were derived originally as a one-loop correction to vector and axial currents in media. Best known is the chiral magnetic effect which is a flow of electric current along an external magnetic field in chiral-imbalanced media. They reflect existence of the chiral gauge anomaly at short distances. Recently, interest has been shifted to the properties of infrared completions of the theory. The best candidate is a non- relativistic ideal fluid, with diffeomorphism as the intrinsic symmetry. There are specific dynamical features of the model such as the infrared copies of the anomalies, non-conservation (under certain conditions) of the electric current. The main emphasis is on generalizations to the case of chiral gravitational anomalies, elaborated in collaboration with G.Yu. Prokhorov and O.V. Teryaev. We concentrate on the interpretation of the so-called chiral kinematical effect and on generalizations of the equivalence principle to higher powers of gravitational acceleration.

Primary author: ZAKHAROV, Valentin

Presenter: ZAKHAROV, Valentin

Contribution ID: **36** Type: **not specified**

Electromagnetic conductivity of dense quark-gluon plasma

Thursday, March 2, 2023 11:50 AM (30 minutes)

In this report we present the results on the study of the electromagnetic conductivity in dense quark-gluon plasma obtained within lattice simulations with Nf=2+1 dynamical quarks. We employ stout improved rooted staggered quarks at the physical point and the tree-level Symanzik improved gauge action. The simulations are performed at imaginary baryon chemical potential, and the Tikhonov regularisation method is used to extract the conductivity from current-current correlators. Our results indicate an increase of QGP electromagnetic conductivity with real baryon density, and this dependence is quite strong.

Primary author: BRAGUTA, Victor (ITEP)

Presenter: BRAGUTA, Victor (ITEP)

Contribution ID: **37** Type: **not specified**

Cluster and hypernucleus production in heavy-ion collisions

Wednesday, March 1, 2023 10:40 AM (30 minutes)

The production of nuclei and hypernuclei is of interest for the experimental and theoretical studies: it is a big question how such weakly bound objects survive in a hot dense environment and which new insight on the heavy-ion collisions dynamics they can bring us. We present the results on the cluster production study using different transport approaches and clusterization algorithms at the energies of the future accelerator complex NICA.

Primary author: KIREYEU, Viktar (Joint Institute for Nuclear Research)

Presenter: KIREYEU, Viktar (Joint Institute for Nuclear Research)

Contribution ID: **38** Type: **not specified**

Cancellation of the sigma mode in the thermal pion gas by quark Pauli blocking

Thursday, March 2, 2023 12:20 PM (30 minutes)

We calculate the pressure of the interacting pion gas using the Beth-Uhlenbeck approach to the relativistic virial expansion with Breit-Wigner phase shifts for the sigma - and pi- meson resonances. The repulsive phase shift delta_20 is taken from quark interchange model of Barnes and Swanson [Phys. Rev. D 46 (1992) 131] in very good agreement with experimental data. In this work we show that the cancellation of the attractive (I = 0) and repulsive (I = 2) isospin channel contributions to the scalar pi-pi interaction in the low-energy region that is known for the vacuum phase shifts, takes place also at finite temperature. This happens despite the strong medium dependence of these phase shifts that enters our model by the temperature dependence of the sigma- meson and constituent quark masses because for these masses the relation m_sigma (T) = 2m_q(T) holds and the scattering length approximation is valid as long as the strong decay channel sigma -> pi pi is open. Exploiting the Nambu –Jona - Lasinio model for describing the dynamical breaking of chiral symmetry in the vacuum and its restoration at finite temperature, we justify with our approach that the -meson should be absent from the hadron resonance gas description at low temperatures because the above cancellation holds. However, since this cancellation breaks down in the vicinity of the hadronization transition, where due to chiral symmetry restoration the decay channel sigma -> pi pi closes and the sigma - meson becomes a good resonance, the latter should be included into the statistical model description of chemical freeze-out in heavy-ion collisions.

Primary author: KALINOVSKY, Yuri (Joint Institute for Nuclear Research)

Presenter: KALINOVSKY, Yuri (Joint Institute for Nuclear Research)

Contribution ID: **39** Type: **not specified**

Dilepton production as a signal to explore QCD phase diagram

Wednesday, March 1, 2023 3:00 PM (30 minutes)

We discuss the behavior of the dilepton production rate near the QCD critical point and the critical temperature of color superconductivity. We show that the rate is anomalously enhanced there due to the development of the soft mode associated with the second-order phase transitions. Possible experimental observation of these enhancements in relativistic heavy-ion collisions will be discussed. Reference: [1] T. Nishimura, M. Kitazawa, T. Kunihiro, arXiv:2302.03191 [hep-ph]. [2] T. Nishimura, M. Kitazawa, T. Kunihiro, PTEP 2022 (2022) 9, 093D02

Primary author: KITAZAWA, Masakiyo (Osaka University)

Presenter: KITAZAWA, Masakiyo (Osaka University)

Contribution ID: **40** Type: **not specified**

Lee-Yang zeros and Roberge-Weiss phase transition

Friday, March 3, 2023 3:00 PM (20 minutes)

We study the Roberge-Weiss phase transition numerically. The phase transition is associated with the discontinuities in the quark-number density at specific values of imaginary quark chemical potential. We parameterize the quark number density by the polynomial fit function to compute the canonical partition functions. We demonstrate that this approach provides a good framework for analyzing lattice QCD data at finite density and a high temperature. We show numerically that at high temperature, the Lee-Yang zeros lie on the negative real semi-axis provided that the high-quark-number contributions to the grand canonical partition function are taken into account. These Lee-Yang zeros have nonzero linear density, which signals the Roberge-Weiss phase transition. We demonstrate that this density agrees with the quark number density discontinuity at the transition line.

Primary author: GERASIMENIUK, Nikolai (Far Eastern Federal University)

Presenter: GERASIMENIUK, Nikolai (Far Eastern Federal University)

Contribution ID: **41** Type: **not specified**

Production of twisted particles in noncentral heavy-ion collisions

Friday, March 3, 2023 3:20 PM (20 minutes)

The production of twisted (vortex) particles in noncentral heavy-ion collisions is rather ubiquitous. Photons emitted in such collisions due to the rotation of charges are highly twisted. Charged particles are produced in non-spreading multiwave states They have significant orbital angular momenta. We expect wide dissemination of emission of twisted particles in noncentral heavy-ion collisions.

Primary author: SILENKO, Alexander (Joint Institute for Nuclear Research)

Presenter: SILENKO, Alexander (Joint Institute for Nuclear Research)

Contribution ID: **42** Type: **not specified**

Bayesian Inference for analysis of EoS models based on multimessenger M-R data

Thursday, March 2, 2023 5:10 PM (20 minutes)

Bayesian Inference is a powerful statistical tool for analysis in case of rare and uncertainty data, which is applied for analysis of EoS models based on multimessenger M-R data. The aim of this analysis is to bring the quantitative measure for different physical models of stellar matter. One of the most common approaches to the implementation of Bayesian analysis is the study of the physical parameters of realistic models of the equation of state.

Primary author: Dr AYRIYAN, Alexander (JINR & AANL & Dubna State University)

Presenter: Dr AYRIYAN, Alexander (JINR & AANL & Dubna State University)

Contribution ID: **43** Type: **not specified**

Neutrons Stars Structure and Twins

Thursday, March 2, 2023 3:00 PM (30 minutes)

In the modern analysis of the nuclear matter, the question related to quark-hadron phase transitions at high densities is intriguing, and the existence of such an issue can be discussed for astrophysical objects such as pulsars. The possibility of the existence of a phase transition inside pulsars leads to the concept of the hybrid structure of neutron stars. This phenomenon can be observed as the existence of massive stars with the same mass and different radii (twins). To study this phenomenon, it is useful to develop and apply simplified constructions of the quark-hadron phase transition.

Primary author: GRIGORIAN, Hovik (JINR)

Presenter: GRIGORIAN, Hovik (JINR)

Contribution ID: **44** Type: **not specified**

Cold SuperDense Baryonic Component of Nuclear Matter and Stars

Wednesday, March 1, 2023 3:30 PM (20 minutes)

As a result of the elucidating the nature of cumulative processes the evidences have been obtained for the existence of a cold superdense component of nuclear matter - in ordinary nuclei there are nuclei of smaller mass (deuterons and tritons) are observed in the highly compressed state. The physical program to study the properties of the new state of nuclear matter in the planned experiments has been prepared. This state of the nuclear matter can drastically to change our point of view to possibly forms of the matter inside the massive stars.

Primary author: SHIMANSKIY, Stepan (JINR)

Presenter: SHIMANSKIY, Stepan (JINR)

Contribution ID: **45** Type: **not specified**

The heavy-ion program at the upgraded Baryonic Matter@Nuclotron Experiment at NICA

Thursday, March 2, 2023 10:00 AM (30 minutes)

The Nuclotron at JINR in Dubna is capable of accelerating beams of heavy ions such as xenon, gold and bismuth at energies up to 4A GeV and intensities up to 2.5·106 ions/s. These energies and collision systems are well suited for experiments devoted to the study of the properties of dense baryonic matter, such as the equation-of-state and new microscopic degrees-of-freedom which might emerge at neutron star core densities. To study those properties, a number of observables are commonly employed including the yields and multi-differential distributions of (multi-) strange particles, the collective flow of identified particles, fluctuation of conserved quantities, and hypernuclei. In order to perform such measurements in Xe+CsI collisions, the existing BM@N setup in the Nuclotron target hall will be upgraded with a highly granulated and fast hybrid tracking system, a set of TOF systems TOF-400 and TOF-700, a scintillation detector with a quartz hodoscope, a neutron detector, and a forward calorimeter for event plane determination. The BM@N physics program, the detector upgrades, and some results of physics performance studies will be presented.

Primary author: PARFENOV, Peter (MEPhI, Moscow)

Presenter: PARFENOV, Peter (MEPhI, Moscow)

Contribution ID: **46** Type: **not specified**

Lattice study of the thermal phase transitions in rotating QCD with dynamical quarks

Monday, February 27, 2023 5:10 PM (20 minutes)

Relativistic rotation causes a change of QCD critical temperatures. Various phenomenological and effective models predict a decrease of the critical temperatures in rotating QCD. Nevertheless, lattice simulations showed that the critical temperature in gluodynamics increases due to rotation. We extend the lattice study to the theory with dynamical fermions. In this report we present the first lattice results for rotating QCD with Nf=2 dynamical clover-improved Wilson quarks. We also study separately the effect of rotation on gluonic and fermionic degrees of freedom. It is shown that separate rotations of gluons and fermions have opposite effects on the critical temperatures. In aggregate, the pseudo-critical temperatures in QCD increase with angular velocity. Dependence of the results on the pion mass is also discussed.

Primary authors: BRAGUTA, Victor (BLTP JINR); KOTOV, Andrey; Dr ROENKO, Artem (JINR, BLTP); SYCHEV, Dmitrii (BLTP JINR, MIPT)

Presenter: Dr ROENKO, Artem (JINR, BLTP)

Contribution ID: **47** Type: **not specified**

Types of Mixed Nuclear Matter

Thursday, March 2, 2023 11:20 AM (30 minutes)

Classification is given of different types of mixed nuclear matter containing hadron and quark degrees of freedom, including the following types: (i) Nuclear matter with admixture of multi-quark clusters, (ii) Stratified quark-hadron mixture, (iii) Stratified hadron-hadron mixture, (iv) Multicomponent quark-hadron matter, (v) Heterophase quark-hadron matter. Methods of describing these systems are discussed. For correct analysis of experiments with nuclei and heavy-ion collisions, it is necessary to understand what kind of state has been formed in a fireball, that is which of the above phases are the most stable.

Primary author: YUKALOV, Vyacheslav (Bogolubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research)

Co-author: YUKALOVA, Elizaveta (Joint Institute for Nuclear Research)

Presenter: YUKALOV, Vyacheslav (Bogolubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research)

Contribution ID: **49** Type: **not specified**

The Casimir effect in Abelian and Non-Abelian lattice gauge theories: induced phase transitions and new boundary states

Tuesday, February 28, 2023 4:10 PM (20 minutes)

We investigate the vacuum structure of Abelian compact electrodynamics and Non-Abelian Yang-Mills theories in the presence of (chromo)metallic mirrors at zero temperature in 3+1 dimensions. By studying Abelian monopoles, responsible for linear confinement between opposite electric charges, we show that as the distance between plates diminishes, the vacuum of cQED between plates experiences a deconfining transition. While we found no thermodynamic signs of a Casimir-induced phase transition for the non-Abelian SU(3) gauge theory, we uncovered new excitation at the boundaries with the mass $m_{gt} = 1.0(1)\sqrt{\sigma} = 0.49(5)$ GeV which is more than three times lighter than mass of 0^{++} groundstate glueball. We call this excitation "glueton" and interpret it as a non-perturbative colorless gluonic state of two gluons bound to their negatively colored images in a chromometallic mirror. Additionally, we show that a heavy quark is attracted to the mirror, and it presumably forms a "quarkiton" ("quark exciton") colorless state with its anti-quark image in the chromometallic mirror.

Primary authors: CHERNODUB, Maxim (Institut Denis Poisson, University of Tours, France); Mr GOY, Vladimir (Pacific Quantum Center, Far Eastern Federal University); Dr MOLOCHKOV, Alexander (Pacific Quantum Center, Far Eastern Federal University); TANASHKIN, Aleksei (Pacific Quantum Center, Far Eastern Federal University)

Presenter: TANASHKIN, Aleksei (Pacific Quantum Center, Far Eastern Federal University)

Contribution ID: **50** Type: **not specified**

R-process with magnetized nuclei

Tuesday, February 28, 2023 5:00 PM (20 minutes)

Nucleosynthesis at large magnetic induction relevant for core-collapse supernovae, and neutron star mergers is considered. For respective magnetic fields of a strength up to ten teratesla atomic nuclei exhibit linear magnetic response due to the Zeeman effect. Such nuclear reactivity can be described in terms of magnetic susceptibility. Susceptibility maxima correspond to half-filled shells. The neutron component rises linearly with increasing shell angular momentum, while the contribution of protons grows quadratically due to considerable income from orbital magnetization. For a case j = l + 1/2 the proton contribution makes tens of nuclear magnetons and exceeds significantly the neutron values which give several units. In a case j = l –1/2 the proton component is almost zero up to g-shell. Respectively, a noticeable increase in the generation of corresponding explosive nucleosynthetic products with antimagic numbers is predicted for nuclei at charge freezing conditions. In the iron group region new seeds are cre-ated also for the r-process. In particular, the magnetic enhancement of the volume of 44Ti iso-topes is consistent with results from observations and indicates the substantial increase in the abundance of the main titanium isotope (48Ti) in the Galaxy's chemical composition. Magnetic effects are proved to result in a shift of the r-process path towards smaller mass numbers, and an increase in the volume of low mass nuclides in peaks of the r-process nuclei.
V. N. Kondratyev, Universe 7 (2021) 487

Primary author: KONDRATYEV, Vladimir (BLTP JINR)

Presenter: KONDRATYEV, Vladimir (BLTP JINR)

Contribution ID: **51** Type: **not specified**

What we can learn from particle flow in HICs?

Monday, February 27, 2023 10:30 AM (40 minutes)

TBA

Primary author: TARANENKO, Arkadiy (NRNU MEPhI)

Presenter: TARANENKO, Arkadiy (NRNU MEPhI)

Contribution ID: **52** Type: **not specified**

2

Contribution ID: **53** Type: **not specified**

3

Contribution ID: **54** Type: **not specified**

Hyperonic interactions and charge symmetry breaking in neutron stars

Thursday, March 2, 2023 3:30 PM (20 minutes)

Studying of the properties of baryonic interactions is one of the important problems of nuclear physics. Nowadays nucleon-nucleon interaction is studied much better than hyperonic interactions. There are some models of hyperonic interaction, based on experiments with hypernuclei, but substantial uncertainties still remain.

Studying of neutron stars can be promising for understanding the properties of hyperonic interactions. Wide range of extreme conditions is realised inside neutron stars, such as high densities and pressure. Since the structure of neutron stars is similar to the one of the nucleus, the methods from nuclear physics are applicable for neutron stars description, but at high densities there may be additional sensitivity to certain properties of the baryonic interaction.

In recent years there were many important discoveries in neutron stars physics: new neutron stars were observed, masses and radii were measured and the first gravitational signal from neutron stars merger was obtained by the LIGO-Virgo collaboration. Registration of gravitational waves provides us with the new measurable characteristic of neutron stars, called tidal deformability.

In the present work we build a model of neutron star matter consisting of nucleons, leptons, and Λ-hyperons with the Skyrme baryonic force. Using this model we calculate masses, radii and tidal deformabilities of neutron stars.

We study different properties of ΛN-interaction and their connection with characteristics of neutron stars. In particular we consider two alternative ways to describe nonlinear effects in ΛN-interaction: dependence on a nucleon density ($\sim \rho^\alpha$) and the three-body ΛNN force. This two ways are almost equivalent in hypernuclei, but can lead to different results in neutron stars. We also consider the charge symmetry breaking (CSB) effect in neutron stars and compare results with our calculations for
neutron-rich hypernuclei. Since neutron stars are neutron-rich systems, CSB effect definitely should affect them. Although it is often considered to be insignificant in the ΛN-interaction, its study can lead to some interesting physical conclusions. Finally, we attempt to find the best combination of Skyrme parametrizations of nucleon-nucleon, nucleon-hyperon and hyperon-hyperon interactions, considering both maximum mass and tidal deformability restrictions.

Primary authors: Mr NASAKIN, Artur (Faculty of Physics. M.V.Lomonosov Moscow State University); Mr LANSKOY, Dmitry (SINP MSU); Mr MIKHEEV, Semyon (Faculty of Physics. M.V.Lomonosov Moscow State University); SIDOROV, Semyon (Moscow State University named after M.V. Lomonosov); TRETYAKOVA, Tatiana (SINP MSU)

Presenter: Mr MIKHEEV, Semyon (Faculty of Physics. M.V.Lomonosov Moscow State University)

Contribution ID: **56** Type: **not specified**

Microscopic analysis of E1 and M1 in 156Gd

Friday, March 3, 2023 12:50 PM (20 minutes)

The dipole electric (E1) and magnetic (M1) strengths in strongly deformed 156Gd are investigated within a fully self-consistent Quasiparticle Random Phase Approximation (QRPA) with Skyrme forces. We inspect, on the same theoretical footing, pygmy dipole resonance and isovector giant dipole resonance in E1 channel and orbital scissors resonance and spin- ip giant resonance in M1 channel.

Primary author: VISHNEVSKIY, Petr

Presenter: VISHNEVSKIY, Petr

Contribution ID: **57** Type: **not specified**

Gravity and Nature of Nuclear Matter

Friday, March 3, 2023 4:20 PM (20 minutes)

All aspects of the Principle of General Covariance can be formulated on the basis of the seminal papers Einstein and Grossmann (1913) and Einstein (1914). This principle should be considered as the fundamental principle of nature and not just of general relativity, since there is too intimate connection between gravity and the rest to be considered separately. Really, one can show that the general covariant fundamental notion of the interval is determined not the Lorentz group but a general covariant bilateral symmetry. Among other things, this means that the Principle of General Covariance unravels the puzzle of time and predicts the duality of time. But the duality of time demonstrates that in certain sense the well-known idea of rotating rigid body (also mentioned as the Top) of classical mechanics is as fundamental as the idea of massive point particle, i. e., the first concept can be reduced to the second one at the fundamental (field–theoretical) level and this opens completely new possibilities to explain nature of nuclear matter – main subject of our message.

Primary author: PESTOV, ivanhoe (Bogoliubov Laboratory of Theorewtical Physics, JINR)

Presenter: PESTOV, ivanhoe (Bogoliubov Laboratory of Theorewtical Physics, JINR)

Contribution ID: **58** Type: **not specified**

Prospects of the low-energy nuclear physics in Russia; Selected problems in the studies of light exotic nuclei.

Monday, February 27, 2023 11:30 AM (40 minutes)

The talk consists of two parts: “official” and research. (1) We discuss several active projects in the fiels of fundamental low-energy nuclear physics aiming the development in RF the world-level large-scale research infrustructure. (2) We review the status of studies for several extreme neutron-rich systems - 4n, 6H, 7H, 26O - which both remain a challenge to experiment and require unusual approaches from theoretical side.

Primary author: GRIGORENKO, Leonid (FLNR, JINR)

Presenter: GRIGORENKO, Leonid (FLNR, JINR)

Contribution ID: **59** Type: **not specified**

Structure of heavy nuclei and nucleon-nucleon interaction

Tuesday, February 28, 2023 10:00 AM (40 minutes)

TBA

Primary author: JOLOS, Rostislav (JINR BLTP)

Presenter: JOLOS, Rostislav (JINR BLTP)

Contribution ID: **60** Type: **not specified**

Hyperonic interactions and charge symmetry breaking in neutron stars

Studying of the properties of baryonic interactions is one of the important problems of nuclear physics. Nowadays nucleon-nucleon interaction is studied much better than hyperonic interactions. There are some models of hyperonic interaction, based on experiments with hypernuclei, but substantial uncertainties still remain. Studying of neutron stars can be promising for understanding the properties of hyperonic interactions. Wide range of extreme conditions is realised inside neutron stars, such as high densities and pressure. Since the structure of neutron stars is similar to the one of the nucleus, the methods from nuclear physics are applicable for neutron stars description, but at high densities there may be additional sensitivity to certain properties of the baryonic interaction. In recent years there were many important discoveries in neutron stars physics: new neutron stars were observed, masses and radii were measured and the first gravitational signal from neutron stars merger was obtained by the LIGO-Virgo collaboration. Registration of gravitational waves provides us with the new measurable characteristic of neutron stars, called tidal deformability. In the present work we build a model of neutron star matter consisting of nucleons, leptons, and Λ-hyperons with the Skyrme baryonic force. Using this model we calculate masses, radii and tidal deformabilities of neutron stars. We study different properties of ΛN -interaction and their connection with characteristics of neutron stars. In particular we consider two alternative ways to describe nonlinear effects in ΛN -interaction: dependence on a nucleon density (~ $\rho\alpha$) and the three-body ΛNN force. This two ways are almost equivalent in hypernuclei, but can lead to different results in neutron stars. We also consider the charge symmetry breaking (CSB) effect in neutron stars and compare results with our calculations for neutron-rich hypernuclei. Since neutron stars are neutron-rich systems, CSB effect definitely should affect them. Although it is often considered to be insignificant in the ΛN -interaction, its study can lead to some interesting physical conclusions. Finally, we attempt to find the best combination of Skyrme parametrizations of nucleon-nucleon, nucleon-hyperon and hyperon-hyperon interactions, considering both maximum mass and tidal deformability restrictions.

Presenter: MIKHEEV, Semyon

Contribution ID: **61** Type: **not specified**

Influence of relativistic rotation on the equation of state of gluodynamics

Wednesday, March 1, 2023 4:40 PM (20 minutes)

Until recently the influence of relativistic rotation on the properties of quark-gluon plasma was studied analytically only via phenomenological and effective models. Now, with lattice methods becoming available, the properties of rotating QCD or rotating gluodynamics can also be probed numerically. For example, lattice simulations suggest an increase in the gluosynamics'critical temperature with rotation, contrary to predictions of the majority of effective models. In this report we present a lattice study of the equation of state of rotating gluodynamics and the corresponding moment of inertia. The results show the moment of inertia to be negative below a certain temperature in the deconfinement region, while turning positive at higher temperatures.

Primary authors: KOTOV, Andrey (Institute for Theoretical and Experimental Physics); SYCHEV, Dmitrii (BLTP JINR, MIPT); KUDROV, Ilya (IHEP, MIPT); BRAGUTA, Victor (ITEP)

Presenter: SYCHEV, Dmitrii (BLTP JINR, MIPT)

Contribution ID: **62** Type: **not specified**

Behavior of moment of inertia in highly deformed 24Mg and 20Ne

Friday, March 3, 2023 12:00 PM (20 minutes)

We suggest the self-consistent description of the ground-state moment of inertia (MI) in highly prolate light nuclei 24Mg and 20Ne (with experimental equilibrium axial quadrupole deformations beta_2=0.605 and 0.72, respectively [1]). These nuclei provide an interesting opportunity to explore dependence of MI on the pairing, ground-state correlations and nuclear shape at extreme deformations. The calculations are performed with Skyrme forces SVbas, SkM*, and Sly6 for deformation range 0.1 < beta_2 < 1.6. Three approaches are applied [2]: Inglis-Belyaev (within Hartree-Fock-Bogoliubov method), QRPA Thouless-Valatin (within Quasiparticle Random-Phase Approximation method [3]) and ATDHF (Adiabatic Time-Dependent Hartree Fock method). For Inglis-Belyaev and ATDHF calculations, the code SKYAX [4] was used. All three approaches show that, near the equilibrium deformation, the pairing in 24Mg and 20Ne vanishes and we get the maximum of MI. With further grow of the deformation above the equilibrium values, we see decrease of MI. Such behavior of MI is explained by rearrangement of single-particle levels with deformation. The analysis reveals main two-quasiparticle contributions responsible for the behavior of MI in different regimes.

Primary authors: MARDYBAN, Mariia; NESTERENKO, Valentin (BLTP, Joint Institute for Nuclear Research)

Presenter: MARDYBAN, Mariia

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Evolution of the collective potential along the chain of Zr isotopes

Friday, March 3, 2023 4:00 PM (20 minutes)

The properties of the collective low-lying states of Zr isotopes indicate that some of these states are mainly spherical and the other are mainly deformed ones. In our previous works, it was shown that the structure of low-lying collective states of 96Zr can be satisfactorily described within the framework of a geometric collective model based on the Bohr Hamiltonian with a potential that supports the existence of various forms of the nucleus. Based on these results, the question arises about the possibility of investigating the properties of low-lying collective states of 92–102Zr on the basis of a five-dimensional geometric quadrupole collective model. The quadrupole-collective Bohr Hamiltonian depending on both β and γ shape variables with a potential having spherical and deformed minima, is applied. The relative depth of two minima, height and width of the barrier, rigidity of the potential near both minima are determined so as to achieve the best possible description of the observed properties of the low-lying collective quadrupole states of 92–102Zr. Satisfactory agreement with the experimental data on the excitation energies and the E2 reduced transition probabilities is obtained. The evolution of the collective potential with increase of N is described and the distributions of the wave functions of the collective states in β–γ plane are found. It is shown that the low-energy structure of 92–102Zr can be described in a satisfactory way within the Geometrical Collective Model with the Bohr Hamiltonian. The β-dependence of the potential energy is fixed to describe the experimental data in a best possible way. The resulting potential evolves with N increase from having only one spherical minimum in 92Zr, through the potentials having both spherical and deformed minima, to the potential with one deformed minimum in 102Zr. A γ-dependence of the wave functions is presented in a set of figures illustrating their distribution over γ.

Primary author: MARDYBAN, Evgenii (Vasilevich)

Presenter: MARDYBAN, Evgenii (Vasilevich)

Contribution ID: **64** Type: **not specified**

Introduction

Monday, February 27, 2023 10:10 AM (15 minutes)

Presenter: Dr KOLOMEITSEV, Evgeni (BLTP, JINR, Dubna and Matej Bel University, Slovakia)

Session Classification: Opening