# India-JINR workshop on elementary particle and nuclear physics, and condensed matter research

# Report of Contributions

https://indico.jinr.ru/e/3684

Contribution ID: **4** Type: **not specified**

# Unravelling self-assembly of hemoglobin in a lipid environment

*Wednesday 18 October 2023 15:30 (20 minutes)*

Understanding the intricate behavior of membrane proteins, their dynamics, insertion mechanisms, and investigating their adaptation to the lipid environment have been a popular field of study. Besides membranous proteins, deciphering the interaction between water-soluble, non-membranous proteins with lipids is equally important for fundamental biophysical investigations and potential applications in therapeutics and synthetic biology. Our current investigation primarily focuses on delving the nature of a non-membranous protein hemoglobin in a lipid environment after insertion. The investigation of hemoglobin within a lipid environment holds significant scientific merit, particularly in the field of lipid-protein interactions and can provide a deeper insight of its pathological effects of cell-free hemoglobin on surrounding cells in medical conditions such as hemolysis or also as an artificial oxygen carrier. In this study, we first reconstituted hemoglobin in 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphocholine (POPC) liposomes via detergent mediated method using n-octyl-β-d-glucoside (NOG) [1] and then prepared supported lipid bilayer on a glass substrate. Microscopic studies revealed that the protein could be visualized without any external labelling agents on the lipid bed. It was interesting to note that these water-soluble protein molecules assembled themselves to form supramolecular structures to encounter the high hydrophobic stress. UV-Vis, Fluorescence and Circular Dichroism (CD) measurement indicated minor structural change to expose the hydrophobic regions of the protein to adjust the hydrophobic stress whilst Small Angle Neutron Scattering (SANS) results indicated that the hemoglobin molecules retained their overall tetrameric form in the system. The presence of a hydrophobic atmosphere induced such protein-protein self-assembly to adapt in the given environment. Collectively, these findings bear considerable scientific significance, particularly in the realm of protein-protein self-assembly, providing valuable insights into the dynamics of proteins within lipid environments [2].

Keywords: Lipid-protein interaction, Self-assembly, Supramolecular structures, Haemoglobin, Supported Lipid Bilayer

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**Presenter:** GHOSH MOULICK, Ranjita (Amity University Haryana)

**Session Classification:** Section 4

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

# Critical effects on the evolution of Quark Gluon Plasma

*Monday 16 October 2023 15:50 (20 minutes)*

The study employs second-order viscous hydrodynamics with an equation of state featuring an embedded critical point to study the propagation of linear and nonlinear perturbations in the quark-gluon plasma (QGP). Notably, perturbations dissipate significantly when the QGP approaches the critical point. Consequently, the mach cone effects on away side jet particle correlations vanish. The presence of these dissipative effects also suppresses flow harmonics when the system nears the critical point. Isentropic trajectories near the critical point experience substantial influence, unlike trajectories moving away. This phenomenon could amplify fluctuations in elliptic and higher-order flow harmonics. As a result, the vanishing mach cone effects and the augmentation of flow coefficient fluctuations might serve as signatures for the critical point. This analysis bears relevance for the BES program at RHIC, FAIR energies, and JINR-NICA energies

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**Session Classification:** Section 1

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

# Study of Pion Interferometry in Au-Au collision in STAR Experiment at √sNN = 7.7 GeV

Pion Femtoscopy, a sophisticated technique in particle physics, is employed to unveil correlations among pion particles from the source's homogeneity region. Our analysis of collider data from the STAR BES II experiment, focusing on √sNN = 7.7 GeV collisions, explores the correlation function across centrality and transverse momentum (KT ) intervals. To ensure robust results, I meticulously manage track effects using tailored cuts derived from the splitting level and fraction of merged rows. My investigation extends to understanding the correlation function's behavior with varying numbers of Vz bins during event mixing, and its response to different Vz ranges for analysis. Integral to my study is fitting the Bowler-Sinyukov function to the correlation function. This yields essential parameters: radii characterizing the source's homogeneity region and correlation strength for positive and negative pions. These parameters offer insights into the particle-emitting environment's dimensions and inter-pion correlations. Additionally, I explore parameter variation in response to changing centrality conditions, deepening my understanding of collision characteristics'impact on the source's behavior.

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**Session Classification:** An extra day session

Contribution ID: **7** Type: **not specified**

# Natural and anthropogenic radionuclides concentration with heavy metals analysis of the sediments collected around Novaya Zemlya

*Tuesday 17 October 2023 15:40 (20 minutes)*

The Dispersal profile of the radioisotopes (Ra-226, Th-232, U-235, K-40, C-137s) along with potentially toxic elements (Cd, Co, Cr, Cu, Ni, Pb, V, Zn, and Hg) in the sediments around the Novaya Zemlya was determined. The task was fulfilled with the aid of HPGe gamma spectrometry, inductively coupled plasma optical emission spectroscopy, DMA-80 Direct Mercury Analysis System, X-ray diffraction and statistical tools. At most of the locations, the radionuclides activity was higher than the world average activity concentration for the respective nuclei, 40K being the most abundant. From all the potentially toxic elements detected, Cr and Ni were usually observed on higher levels compared to their background values, indicating the probability of the detrimental biological effects. Thus, the present situation at the studied area might be a threat to the neighboring marine life.

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**Session Classification:** Section 4

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

# Assessment of the elemental composition of areca nut and soil samples collected in Northeast India

*Tuesday 17 October 2023 15:20 (20 minutes)*

In areca nut and husk, fourteen elements (As, Ca, Cd, Cl, Co, Cu, K, Mg, Mn, Na, Rb, Sb, & Zn) were determined, while 34 elements including rare earth elements were detected in the corresponding soil samples using instrumental neutron activation analysis and Atomic Absorption Spectrometry methods, whereas the concentration levels of Hg in tested samples are negligible, perhaps, below the detection limits. No rare earth elements were detected in edible areca nut. The concentration levels of various essential elements and heavy elements such as As, Cd, and Cu present in areca nut are within the permissible levels, whereas Pb content is relatively higher than FAO/WHO's permissible levels. The order of bioaccumulation index for heavy metals in areca nut was Cd > Sb > Cu > Zn ≫ Mn ≫ Co > Pb ≫ As. Bioaccumulation index values are indicating that areca palm may not be able to accumulate other heavy elements in the edible areca nut, except for Cd. On the basis of pollution indices, Northeast Indian soil may be relatively unpolluted.

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**Session Classification:** Section 4

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

# Density and Pressure Distribution inside Proton

*Wednesday 18 October 2023 14:50 (20 minutes)*

One of the basic building blocks of the universe is protons, whose constituent particles are quarks and gluons. Gluons are the exchange particles for the strong force between quarks; we never found them in isolation. Recently in 2018, Burkert et al. [1] found very interesting pressure distributions inside the proton, whose peak value can reach up to 1035 pascals, which is even greater than the pressure of neutron star, obtained near the center of the proton up to 0.6 fm. In the next year (2019), Shanahan et al. [2] came to a similar conclusion by exploring the energy momentum tensor of protons. In this present work, we have explored the proton pressure from the knowledge of statistical mechanical understanding by considering the pressure inside the proton in terms of effective chemical potential, which is assumed to be a function of the radius of proton. We attempt to realize the picture in terms of degenerate quark gas tomography.

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**Session Classification:** Section 1

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

# Effect of Coriolis Force on Shear Viscosity : A Non-Relativistic Description

*Wednesday 18 October 2023 15:30 (20 minutes)*

We have addressed that during the transition from zero to finite rotation picture, a transition from isotropic to anisotropic nature of shear viscosity coefficients can be found due to Coriolis force as expected due to Lorentz force at a finite magnetic field in earlier studies on the topics of relativistic matter like quark-gluon plasma. We have done it for non-relativistic matters for simplicity, with a future proposal to extend it towards a relativistic description. Introducing the Coriolis force term in relaxation time approximated Boltzmann transport equation, we have found different effective relaxation times along the parallel, perpendicular, and Hall directions in terms of actual relaxation time and rotating time period. Comparing the present formalism with the finite magnetic field picture, we have shown the equivalence of roles between the rotating and cyclotron time periods, which define the rotating time period as the inverse of 2 times angular velocity.

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**Session Classification:** Section 1

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

# Effect of Coriolis Force on Electrical Conductivity: A Non-Relativistic Description

*Wednesday 18 October 2023 15:50 (20 minutes)*

Rotating quarks and hadronic systems, produced in peripheral heavy ion collisions, can experience Coriolis force and other forces due to rotational motion. Considering only the effect of Coriolis force, we have calculated the electrical conductivity for non-relativistic rotating matter using the Relaxation Time Approximation based Boltzmann transport equation. A similarity in mathematical calculations of electrical conductivity at finite rotation and finite magnetic fields is exposed, where an equivalence role between Coriolis force on massive particle's motion and Lorentz force on charged particle's motion is noticed. As the beginning level step, we consider only the Coriolis force in the non-relativistic formalism, which will be extended in the future towards the relativistic case, and to adopt other forces for a more realistic description of the rotating quark and hadronic system.

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**Session Classification:** Section 1

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

# In search of Physics of Interactions for Silver ion with single-strand DNA scaffold: A combined Molecular Dynamics Simulations and Experimental Analysis

Understanding the physical and molecular mechanism of the interaction of surfaces, nano- and microparticles with DNA represents a great interest in today's biomedical applications. Nucleic acids have crucial biological functions in gene storage, replication, repair, and gene regulation. Due to the negatively charged phosphate backbones of ss-DNA, it is intrinsically polyanionic in nature. This intra-strand repulsion between specific phosphate residues in single-stranded DNA makes the whole structure stable against folding. However, charged cations (like Ag+, Hg2+, Ca2+, Na+, Mg2+, etc.…) block this electrostatic attraction and aid in the structural breakdown of single-stranded DNA.

The structure and dynamics of negatively charged nucleic acids strongly correlate with the concentration and charge of the oppositely charged counterions. It is well known that the structural collapse of DNA is favored in the presence of additional salt, a source of excess oppositely charged ions. Under such conditions stranded DNA adopts a collapsed coil-like conformation, typically characterized by stacking base pairs. The dynamics further take an interesting turn when the system is introduced on a highly reactive oxide nano-surface like MoS2. The nanostructured surface affects the overall charge dynamics at the surface and the single-stranded DNA conformation. Using atomistic molecular dynamics simulation as well as experiment, we would like to explore the effect of varying salt concentration (Ag+) on the (small base sequence) single-stranded DNA conformation. In a nutshell, our experiment and simulation will explore how in the presence of silver ions, non-sequential base stacking and overcharging compete and affect single-stranded DNA dynamics.

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

# Improvement of oxygen permeability in cerium and yttrium doped perovskite-type ABO3-δ membranes

Numerous technical applications of perovskite-type (ABO3-δ) oxides exist, such as oxygen sensors, solid oxide fuel cells, oxidative coupling of methane, oxygen pumps, solar cells, hydrogen storage, and gas separation [1-6]. By appropriately partly replacing cations A and B, their characteristics can be controlled accurately. Cerium and zirconium-doped (BaSr)(Fe1-x-yCexZry)O3-δ (x = y= 0 –1.0) oxygen-permeable membranes were synthesized using an oxalate-based sol-gel route. In the case of cerium doping, Rietveld refinement shows the structural transformation from cubic (for x = 0) to orthorhombic (for x = 0.80 –1.0) via a mixture of these phases (for x = 0.10 –0.60). The amount of cubic phase decreases from 100% to 24% with cerium content (x) = 0 –0.60 and complete transformation to the orthorhombic phase occurred at x = 0.80. Perovskite-type (BaSr)(Fe1-xAx)O3-δ (A = Ce, Y) oxides exhibit a cubic phase and mixture of cubic and orthorhombic phases (space group Pm3m, Pmmm) for x = 0 - 0.10 and x > 0.10, respectively. Raman and photoluminescence spectra display excellent features. The oxygen permeability (Jo2) of the disc membrane lies in the range of ~ 1.474 –2.204 ml/cm2.min at 950 °C (Input feed air ~ 400 ml/ml, carrier argon gas ~ 40 ml/min) for cerium (x) = 0 - 1.0. Molecular simulation dynamics studies will be performed soon to find out its molecular interaction with oxygen. These findings suggest applications in the oxygen separation industry.

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

# Microstructure modification of the Prussian White cathode material and its effect on the electrochemical performance of sodium-ion batteries

*Monday 16 October 2023 15:50 (20 minutes)*

Electrochemical characteristics (e.g. capacity, power, charge/discharge rates etc.) tend to correlate with structure and microstructure of cathode material. Theoretically, current values can be increased by reducing particle size of the material. The smaller particle size results in the shorter ion diffusion paths and the larger surface area of the active material being in contact with the conductive additives and electrolyte [1]. It is known that particle size reduction correlates well with electrochemical properties improvement for lithium-ion batteries materials [2-4].
In this work we investigated how the ball-milling effect on microstructure affects electrochemical properties 2 Fe[Fe(CN) 6 ]·2.2 H2O of the commercial sodium hexacyanoferrate Na 1.8-(Prussian White, PW), cathode material for sodium-ion batteries. The pristine powder consists of cubic particles with a side length of 50-200 μm. Under
ball-milling with acetone, the initial cubic particles are destroyed to fragments of cubic morphology with a size of 55 μm, 20 μm, and less than 10 μm for the powders milled for 1, 3, and 6 hours, respectively. X-ray diffraction on powders after their drying at 120℃ revealed the coexistence of two cubic phases (sp. gr. Fm-3m) and a dehydrated rhombohedral phase (sp. gr. R-3), the contents of which depend on the milling time. Long milling time leads to an increase in the fraction of the rhombohedral phase, which is the result of better dehydration of a finely dispersed sample compared to the samples with larger cubic particles (in pristine PW) or their fragments (1h-milled and 3h-milled PW powders). Electrochemical cycling of coin cells assembled with the milled powders as an active material and sodium anode shows the less capacity drop at high charge/discharge rates for the 6h-milled PW material.
This work was financially supported by Russian Science Foundation (project No. 21-12-00261).
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**Presenter:** DONETS, Marina

**Session Classification:** Section 4

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

# Relativistic spin-(magneto)hydrodynamics

*Tuesday 17 October 2023 10:00 (30 minutes)*

Relativistic dissipative hydrodynamics has been applied quite successfully to understand the space-time evolution of strongly interacting hot and dense matter formed in high energy heavy-ion collisions. Recent relativistic heavy-ion collision experiments have also found evidence for the generation of strong magnetic field and global angular momentum. The presence of these effects requires us to revisit our formulation of relativistic hydrodynamics.

I will outline our contribution in the development of hydrodynamic formulation for evolution of a dissipative fluid having global angular momentum and in the presence of a magnetic field.

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**Session Classification:** Plenary

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

# SU(3) Dual QCD Quark-hadron phase transition at finite temperature & chemical Potential

*Tuesday 17 October 2023 15:30 (20 minutes)*

A Dual QCD formulation for SU(3) color gauge has been developed in terms of dual gauge potentials and taking into account the local as well as topological structure of the color gauge group into its dynamics. For the purpose of examining the nonperturbative characteristics of QCD, the dynamical configuration of the resulting dual QCD vacuum and its flux tube configuration have been examined. The thermal behavior of the nonperturbative QCD vacuum has been investigated for exploring the dynamics of quark-hadron phase transition at finite chemical potential. Related thermodynamic quantities and equation of state (EoS) to characterize quark matter have also been discussed within the framework of dual QCD-based hadronic bag which guarantees the critical parameters and the associated critical points for quark-hadron phase transition. These thermodynamic quantities are expected to play important roles in understanding the order of quark-hadron phase transition and are likely to predict the features of a first-order quark-hadron phase transition for finite chemical potential. Moreover, we have investigated the bulk properties of quark matter by constructing the free energy change and the associated surface tension for quark-hadron phase transition. For consistency and compatibility check, we have also compared our results with state-of-the-art three-loop Hard Thermal Loop perturbative results and available lattice QCD results and in the process found reasonable agreements.

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**Session Classification:** Section 1

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

# Atmospheric Deposition of Trace Elements and Radionuclides in Europe, Asia and the Pacific Region Based on Moss Analysis

*Tuesday 17 October 2023 14:30 (30 minutes)*

The application of mosses as biomonitors of trace elements and radionuclides in selected rural and urban areas affected by intense anthropogenic activity is reviewed. This technique is widely used in many countries in Europe (https://icpvegetation.ceh.ac.uk/), whereas it is scarcely used in Asia. The aim of the UNECE International Cooperative Program (ICP) Vegetation in the framework of the United Nations Convention on Long-Range Transboundary Air Pollution (CLRTAP) is to identify the main polluted areas of Europe, produce regional maps and further develop the understanding of the long-range transboundary pollution [1, 2]. The idea of transferring this technology to the countries of Asia and the Pacific region is being discussed. In addition to terrestrial passive moss biomonitoring, potentialities of applying active moss biomonitoring (moss bags technique) are demonstrated. The results obtained at a local scale in the areas experiencing environmental stress can be used to establish levels of pollutant emissions and provide information to public health authorities.

**Keywords:** Moss biomonitoring, trace elements, radionuclides, anthropogenic impact

**References:**

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2. Frontasyeva M., Harmens H., Uzhinskiy A., Chaligava O. and participants of the moss survey. Mosses as biomonitors of air pollution: 2015/2016 survey on heavy metals, nitrogen and POPs in Europe and beyond. Report of the ICP Vegetation Moss Survey Coordination Centre, Joint Institute for Nuclear Research, Dubna, Russian Federation, pp. 136. ISBN 978-5-9530-0508-1. http://www1.jinr.ru/Books/Books_rus.html

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**Session Classification:** Section 4

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

# Determination of Elemental Profile of Tobacco Plant and Soil using Neutron Activation Analysis

*Tuesday 17 October 2023 15:00 (20 minutes)*

Even when cultivated in uncontaminated soils, tobacco plant has higher propensity to extract and accumulate trace elements. The concentrations of essential elements (K, Ca, Mg, Na, Cl, Mn, Fe, Cu, and Zn) and 28 non-essential elements in tobacco plant (leaves, stem, and root) of Northeast India and their respective soils were quantitatively measured. The concentrations of Hg in all samples analyzed were found to be < 10 mg/kg. The bioconcentration factor values indicated that Cd (7) is selectively absorbed and translocated in the tobacco leaves compared to Zn (1.7), Cu (1.5), Ni (0.12), and Pb (0.1). Under acidic soil conditions, tobacco plant efficiently absorbed and translocated Cl– ion with great ease, whereas it may be a very low accumulator of rare-earth elements. The concentrations of Mn, Cu, Sb, Cs, Rb, and Pb are very similar to the "reference plant,"whereas significantly higher concentrations of Al, Sc, Ti, Zr, Hf, Ta, Th, and U are present in the roots of tobacco plant relative to the "reference plant."Principal component analysis has revealed that Northeast Indian tobacco can be clearly differentiated from other varieties of tobaccos used in different countries because of their element profiles.

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**Session Classification:** Section 4

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

# Probing Dynamics of Fusion-Fission Process in heavy to very heavy nuclei

*Tuesday 17 October 2023 14:30 (20 minutes)*

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This talk will primarily draw from the measurements carried out at IUAC, New Delhi using the HYRA recoil separator coupled with the TIFR 4π Sum-Spin spectrometer. We will provide a brief introduction to the subject of heavy-ion induced fusion followed by fission process and its wider ramifications in low and medium energy nuclear physics. We will summarise what we have learnt so far and what are the unresolved mysteries. Example to support the current understanding of the subject will be primarily from our very recent measurements of angular momentum gated Evaporation Residues from the heavy 186Pt and very heavy 240Cf nuclei. Detailed analysis using Statistical Model analysis and Dynamical approach will also be presented. This is the first measurements of spin gated evaporation residues from the 186Pt compound nucleus. This is also the very first attempt to measure the evaporation residues from the very heavy 240Cf nucleus. The theoretical DNS calculation is the result of a close collaboration with the group from Bogoliubov Laboratory of Theoretical Physics, JINR, Dubna.

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**Session Classification:** Section 3

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

# Studies of Nuclear Reaction Cross-sections for Reactor and Astrophysical Applications

*Thursday 19 October 2023 09:00 (20 minutes)*

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The development of reactor technology demands high-quality nuclear data for the materials used in the reactors. There are several materials used in a reactor such as fuel, cladding, structure, coolant, moderator, reflector, shielding, etc. We have been involved in the measurements of reaction cross-sections for several years and have measured several nuclear reaction cross-section data for neutron-induced reactions such as (n,ɣ), (n,p), (n,2n), (n, α), and proton induced nuclear reactions (p, n), (p, ɣ), etc., which are important for the different reactor materials. It is also observed in the EXFOR data library that there is a scarcity of data or a large discrepancy in the measured data. Including the reactions for the reactor technology, in recent times activity has been initiated for the reactions for astrophysical applications in order to understand the productions of the various isotopes in the stellar environment. The measurements were performed at the TIFR Pelletron facility, Mumbai, India. The method of analysis was standard activation analysis in which materials are irradiated with the interested particle beam and then the activity produced is measured with a high-purity HPGe detector. The measured data were supported with the nuclear modular codes predicted data such as TALYS and EMPIRE codes. The data/results are also useful to understand the predictability of the several models available in such codes. I will present the results of (n, ɣ) and (p, ɣ) nuclear reactions in this workshop.

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**Session Classification:** An extra day session

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

# Experimental studies of nuclear clusters via the dissociation of relativistic nuclei

*Thursday 19 October 2023 11:10 (20 minutes)*

The existence of spin-paired proton and neutron quartets in light nuclei is a key factor that drives the formation of alpha particles in nuclear reactions and decays [1]. The investigations of ensembles with several alpha particles can clarify the $^{8}$Be and $^{9}$B and their analogues states and it make possible to study the $3\alpha$ Hoyle state (HS). In this prospects, the BECQUEREL experiment is devoted to answer the topical problems of nuclear physics. The phenomenon is dissociation of relativistic nuclei observed in the Nuclear Track Emulsion (NTE) with a unique completeness and making it a valuable tool for studying ensembles of nucleons and lightest nuclei [1]. The current focus of theoretical research is on the $\alpha$-particle Bose-Einstein Condensate ($\alpha$BEC), an ultra-cold state of several S-wave $\alpha$-particles near coupling thresholds [see ref [3] and references herein]. The n$\alpha$-tuple nuclei that are excited to states just above the $\alpha$-particle binding energies may exhibit $\alpha$BEC behaviour. The unstable $^{8}$Be nucleus and the $^{12}$C($0_2^+$) or Hoyle state are described as $2\alpha$BEC and $3\alpha$BEC. The decay of $^{8}$Be $\rightarrow 2\alpha$ and $^{12}$C($0_2^+$) $\rightarrow$ $^{8}$Be$\alpha$ can be viewed as signatures of more complicated decays of n$\alpha$BEC states.

The consideration of $\alpha$BEC as an invariant phenomenon makes it a promising candidate for search in relativistic fragmentation [1]. To address these challenges, the NTE longitudinally exposed to relativistic nuclei and the invariant mass ensembles H and He are produced within very narrow cone. Owing to extremely low energy and widths, $^{8}$Be, $^{9}$B and Hoyle state decays manifest themselves as pairs and triples of He and H relativistic fragments with smallest opening angles. This approach has been used to identify $^{8}$Be and HS, and to search for more complex states of $\alpha$BEC in the fragmentation of medium and heavy nuclei. Moreover, these fragments release neutrons, which manifest themselves as secondary neutron stars. The frequency of these neutron stars should increase with the number of lightest nuclei in the fragmentation cone [2]. Recently, an increase in the probability of detecting $^{8}$Be in an event with an increase in the number of relativistic $\alpha$-particles was found, based on the statistics of dozens of $^{8}$Be decays. This suggests that the contributions of $^{9}$B and HS decays also increase. The exotically large sizes and lifetimes of $^{8}$Be and HS allow us to suggest the possibility of synthesizing $\alpha$BEC by successively connecting the emerging $\alpha$-particles [3]. In the near future, the BECQUEREL experiment will focus on the analysis of $^{84}$Kr-Emulsion interactions at 950 MeV per nucleon, to their unstable states of $4\alpha$BEC and induced neutron events. In addition to understand the mechanism of nuclear dissociation, it is proposed to analyse the fragmentation of NTE nuclei by relativistic muons until they are completely destroyed.

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**Session Classification:** An extra day session

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

# QCD mesonic screening masses using Gribov quantization

*Wednesday 18 October 2023 14:30 (20 minutes)*

The screening masses of mesons provide a gauge invariant and definite order parameter of chiral symmetry restoration. Different mesonic correlation lengths for flavor non-singlets, at least up to NLO, are well-defined gauge invariant physical quantities calculated earlier using the perturbative resummation techniques. The NLO perturbative results match the available non-perturbative lattice QCD results at the high-temperature regime. We have studied the spatial correlation lengths of various mesonic observables using the non-perturbative Gribov resummation, both for quenched QCD and (2 + 1) flavor QCD. The study follows the analogies with the NRQCD effective theory, a well-known theory for studying heavy quarkonia at zero temperature.

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**Session Classification:** Section 1

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

# Characterization of Tobacco stalk Ash

*Wednesday 18 October 2023 14:30 (20 minutes)*

During the production of 'tuibur', an indigenous 'liquid'nicotine delivery medium of Mizoram, India, the tobacco stalk ash ('spent'tobacco generated from the combustion of tobacco stem, petiole, and midrib) is typically dispersed in a haphazard manner. The tobacco stalk ash was investigated for the elucidation of particulate matter, polycyclic aromatic hydrocarbon (PAH) compounds and nicotine using field emission scanning electron microscopy with energy-dispersive x-ray spectroscopy (FESEM-EDX), x-ray powder diffraction (XRPD), SEM mapping, x-ray photoelectron spectroscopy (XPS), micro-Raman Spectroscopy and induction coupled plasma-atomic emission spectrometry (ICP-AES) methods. The concentration levels of Al, Cd, Co, Cr, Cu Fe, Mn, Ni, Pb, and S were determined using ICP-AES methods. XRPD analysis of tobacco ash samples indicated the presence of crystallites of calcite, magnesium calcite, potassium chloride, potassium aluminosilicate and calcium silicate hydrate. SEM analysis indicated the presence of sub-micron crystals of calcium carbonate, and calcium silicate hydrate in tobacco ash. XPS analysis indicated Al, C, Ca, Cl, Fe, Hg, Mg, O, and P species at different electronic environments. Micro-Raman spectroscopy analysis showed the vibrational frequencies corresponding to calcite, nitrate and metal oxides. With the detection of disordered and graphitic bands in the micro-Raman spectral features, the presence of PAHs was confirmed. surface-enhanced Raman scattering (SERS) mapping of dried tobacco ash extract also revealed the distribution of nicotine at lower concentrations within the heterogeneous mixture. Nicotine was also detected in the aqueous and ethanol extract of tobacco ash using SERS method

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**Presenter:** R BOSE, Muthukumaran (Mizoram University)

**Session Classification:** Section 4

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

# Impact of finite magnetic field on asymmetric quark matter

*Tuesday 17 October 2023 15:50 (20 minutes)*

In this work, we inspect the susceptibilities of the conserved charges like charge number, baryon number, and strangeness number using the Polyakov loop extended quark meson model. The effect of a finite magnetic field is studied on the fluctuations for the zero value of the chemical potential by employing Taylor's series expansion method. The impact of the finite magnetic field on the positioning of the QCD critical point has been discussed. The phase boundaries of the chiral and deconfinement transitions are modified as a consequence of magnetic field inclusion.

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**Session Classification:** Section 2

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

# Investigating a non-extensive QCD medium in extreme conditions

*Tuesday 17 October 2023 15:50 (20 minutes)*

Investigating the properties of a non-extensive quantum chromodynamics (QCD) medium, created in heavy-ion collisions (HICs) is one of the most important topics. In this talk, we discuss some of the important properties of this particular medium like phase transitions etc in the presence of extreme conditions. We further talk about the effect of the nonextensive measure on the system's properties.

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**Session Classification:** Section 1

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

# Biochemical and Biophysical Characterization of Synthetic anti-VEGF Antigen Binding Fragment for Treating Wet-AMD and Diabetic Retinopathy

*Wednesday 18 October 2023 11:30 (30 minutes)*

Wet Age-related macular degeneration (wet-AMD) is a progressive neurodegenerative disease of the retina, affecting the central vision. Wet-AMD and Diabetic Retinopathy (DR) is a leading cause of irreversible vision loss, worldwide affecting the population older than 50 years. Products that significantly addresses market access representing a global ocular market of >$25B and >200M patients globally.

The vision behind FAB201 development is to provide an efficacious and cost-effective treatment for wetAMD patients. Currently approved anti-VEGF drugs like Lucentis and Eylea in the market are expensive and

not widely accessible in developing countries. Keeping this in mind to meet the unmet medical needs and to provide affordable treatment to developing countries.

We have developed an anti-VEGF Fab molecule (FAB201 and FAB293) for wet-AMD and DR, filed US patent, successfully finished the discovery, proof of concept, development, pre-clinical toxicity studies and cGMP

manufacturing for our proprietary molecule. FAB201, that is close to going to Phase-1 trails in US and Australia for wet AMD and DR.

FAB201 and FAB293 are 48kDa synthetic human anti-VEGF Fab (Fragment Antigen Binding). It is a novel biologic (has unique CDRs in light chain & heavy chain) expressed in microbial system (E. coli BL21).

FAB201and FAB293 has been developed using Phage display library with several rounds of affinity maturation for selection of clones with highest binding affinity, followed by site directed mutagenesis in CDRs for improved antigen binding towards hVEGF (Vascular Endothelial Growth Factor).

The Fab molecules were engineered and fully characterized using advanced Biochemical & Biophysical

characterization techniques.

• Quantitation assayo ELISA (Synergy H1-M multimode plate reader from Biotek)

• In-vitro binding affinityo Quantikine Kit and Surface Plasmon Resonance (SPR) by- Biacore 3000 (GE Healthcare); CM5

Chip, research grade (Catalog No. BR- 1003-99, Biacore-GE Healthcare)

• In-vitro efficacy studyo VEGF induced hTERT-RPE1 proliferation assay by BioTek Multiscan reader)

o HUVEC by Fluorescence plate reader

• Protein/product characterizationo PI by Biorad Protean i12 IEF System

o Intact mass by ESI-Q-TOF instrument (Waters QTOF SYNAPT G2 Mass Spectrometer)

o Disulfide bond analysis by LC-MS/MS using a Waters QTOF SYNAPT G2 Mass Spectrometer

o Peptide mass fingerprinting (PMF) by LC-MS/MS using a Waters QTOF SYNAPT G2 Mass Spectrometer

o AAA sequencing by by LC-MS/MS using a Waters QTOF SYNAPT G2 Mass Spectrometer

o CD spectra by Jasco J-815 Spectropolarimeter

o CE-SDS Page by PA 800 Plus Protein Characterization System; Sciex with PDA detector

o Capillary Iso electric focusing (cIEF) by Rotein Simple Maurice C; GE Ettan IPGPhor3

o Protein crystallography by NMR-JEOL- 600 MHz (14.1T) NMR
o SVP analysis by Beckman HIAC 9703+ Liquid Particle Counter
o Epitope mapping by HDX-MS; LTQ-FTICR mass spectrometer (Thermo Fisher, Waltham, MA)
o Hydrodynamic size by DLS, Malvern Zetasizer
• In-process related impurity testingo Host Cell Protein (HCP) by Micro plate reader Thermo Fisher, Model No.-51119300
o Host Cell (Hc)-DNA by Quantitative PCR system Roche, Light Cycler 480 II
o Endotoxin by Endotoxin Kit KTA2 Charles River Laboratories; Synergy H1-M multimode plate reader from Biotek
o Protein L leachate by Medicago Protein L Ligand Leakage ELISA kit (Cat. No.: 10-0027/10-0028); Synergy H1-M multimode plate reader from Biotek
• Product related impurities testingo SDS-PAGE by Gel electrophoresis system, BioRad
o SEC-UPLC by Agilent 1260 Infinity II HPLC system with auto vial sampler
Column: TOSOH TSK gel UP-SW3000, 4.6 x 300 mm (I.D. x L); Particle size: 2 µm
o RP-HPLC by Agilent 1260 Infinity II HPLC system with auto vial sampler and Shimadzu LC2010C HT
Column: Agilent, ZORBAX SB-300, C8, 2.1 x 100 mm, 3.5 µm (861775-906)
Guard column: ZORBAX 300SB-C8 4-Pack, Narrow bore (2.1 x 12.5mm, 5 µm) (821125-918)
o SVP by Beckman HIAC 9703+ Liquid Particle Counter

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**Session Classification:** Plenary

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

# Complex molecular interactions involved in binding of fragmented nucleic acid molecules on magnetic nanoparticles for next generation sequencing applications

*Wednesday 18 October 2023 14:50 (20 minutes)*

Magnetic fluids or ferrofluids are stable colloidal suspension of magnetic nanoparticles in a carrier liquid that can be aqueous or oil-based. Magnetic nanoparticles have generated considerable research and commercial interest due to their unique properties and wide applicability. One of the key applications for using these nanoparticles is in the field of Genomics, particularly Next Generation Sequencing (NGS).

In the NGS workflow, an important step is selection of fragmented DNA which is then read using a sequencing platform like IlluminaTM or NanoporeTM. The principle behind size selection is that DNA molecules of differing molecular weight can be selectively precipitated using condensing agents like Polyethylene glycol (PEG) in the presence of a salt like NaCl. The binding of DNA to the beads is dependent on the concentration of the PEG and hence the ratio of the beads to the DNA remains critical. Higher volume of the binding mix helps to capture lower base pair fragments while lower volume captures higher base pair fragments.

Typically, magnetic nanoparticles without any coating do not offer high DNA recovery rate and therefore to compensate it, pH of the binding system should be maintained at high alkaline conditions. The nanoparticles in such alkaline conditions gains more negative charge on its surface and DNA being negatively charged, with the help of monovalent cation like Na+ serving as a bridge between the DNA and the beads while PEG enables in condensing the DNA from coil to globule shape. Thus, the DNA fragments get selectively precipitated and adsorbed to the surface of the uncoated nanoparticles. A typical profile of size selected DNA is shown below in Figure 1. We also optimized the volume of the binding buffer required for sequential capture of DNA fragments of varying sizes.

Several sophisticated techniques are involved in this workflow for Biophysical and Biochemical Characterization of uncoated nanoparticles and later to assess the binding chemistry between these nanoparticles and fragmented DNA. Some of these as listed below:

Characterization of magnetic nanoparticles

1. Thermogravimetric analyzer (TGA) and Diffuse Scanning Calorimetry (DSC) (makeMettler-Toledo, model TGA/DSC 1)
2. Fourier transform infrared spectroscopy, FTIR (Thermo Scientific NICOLET FTIR 6700 FTIR)
3. High Resolution Transmission Electron Microscopy (HRTEM) (JEOL JEM 2100 200-kV transmission electron) microscope (TEM) with a point resolution of 50X to 1.5MX

Assay of fragmentation of DNA and binding of DNA to Magnetic Nanoparticles

1. UV Spectrophotometer (Thermofisher Scientific NanoDrop™ 2000/2000c Spectrophotometer)
2. Tapestation (Agilent, 4200 TapeStation System)

Sequencing platforms

1. Short read sequencer (Illumina MiSeq)
2. Long read sequencer (Nanopore, Oxford Nanopore)

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**Session Classification:** Section 4

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

# Small-angle scattering investigations of ferrofluids with anisometric nanoparticles

*Monday 16 October 2023 15:10 (20 minutes)*

Ferrofluids are currently widely investigated for technical and biomedical applications including water treatment, energy harvesting and transfer, vibration control, magnetic electromagnetic wave absorption, energy storage applications, hyperthermia, magnetic drug delivery, biocatalysis, enzyme immobilization, DNA separation and purification, and magnetic resonance imaging, etc. Many of the chemical and physical properties associated to nanoparticles are strongly dependent on the nanoparticle shapes and dimensions. Recently, the fabrication of ferrite nanoparticles in controlled diverse shape has become another requirement of interest for researchers for magneto-optical applications.
In the present work, accomplished using small-angle neutron and X-ray scattering techniques (SANS and SAXS), and performed on the YuMO instrument of the IBR-2 reactor, RIGAKU (MPhTI) and XEUSS 3.0 stations (FLNP), respectively, XRD at Empyrean (PANalytical) X-ray diffractometer (FLNP), new ferrofluids with anisometric nanoparticles in aqueous media are investigated in terms of structural aspect.
Joint studies of SANS and SAXS, as well as the use of various solvents (H2O and D2O), made it possible to obtain new information about the systems being analyzed, such as the shape and size of nanoparticles, the distribution of surfactants on their surface [1, 2] of high importance for the development of preparation protocols.

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**Session Classification:** Section 4

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

# Twist-3 TMD factorization using Gaussian ansatz in the LFQDM.

*Tuesday 17 October 2023 15:10 (20 minutes)*

Transverse momentum-dependent parton distributions (TMDs) factorization is a peculiar theoretical framework in QCD which aids in understanding the high-energy scattering processes. Techniques such as collinear factorization, Qiu-Sterman, soft-collinear effective theory, lattice QCD and Gaussian approximation have been employed for factorization in bag model, light-front constituent quark model, spectator model and in basis light-front quantization approach. We have achieved the twist-3 TMD factorization using Gaussian ansatz in the light-front quark-diquark model. Specifically, we have utilized our results of the twist-3 T-even TMDs to obtain parton distribution functions along with the average square transverse momentum at the model scale. We have numerically compared the TMD results with a Gaussian ansatz and found that they are in good agreement. With few exceptions, we have found that even though the $x - p_\perp^2$ factorization is not explicit, the numerically generated TMDs from Gaussian ansatz show close agreement with the exact results.

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**Session Classification:** Section 2

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

# Optimization of the solid ISOL method for volatile reaction products of heavy ion beam reactions

Physicists were able to create new and unstable heavy elements in the 1940's. With the discovery and development of new superheavy materials, researchers' interest has not stopped, leading to concepts such as "Island of Stability" and "Sea of Instability." The MASHA (Mass Analyzer of Super Heavy Atoms) mass spectrometer at JINR was designed for the identification and measurement of physical properties of superheavy elements, such as decay energy and modes, mass and half-lives. A strong ISOL (Isotope Separation OnLine) system is used for the MASHA setup. These experiments are being carried out at the MASHA facility of the Flerov Laboratory of Nuclear Reactions (FLNR) of the Joint Institute of Nuclear Research (JINR).

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**Session Classification:** An extra day session

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

# Study Of Uranium Toxicity In Humans Due To Protracted Ingestion Of Groundwater In Bathinda District Of Punjab, India

*Wednesday 18 October 2023 15:50 (20 minutes)*

Monitoring of uranium content in groundwater of radiologically active areas is a vital step for establishing baseline of environment protection. In this regard, 64 groundwater samples collected post-monsoon from handpumps or dug wells in Bathinda district of Punjab were analysed by LED fluorimeter for analysis of uranium concentration and associated health risks. Uranium content varied from 5.19 to 579.28 μg L-1, with an average value of 106.41. 82% samples surpassed the limit of 30μg L-1 mandated by WHO(2011) while 46% groundwater samples exceeded the limit of 60μg L-1 set by AERB(2004). Radiological and chemical toxicity was also measured for different isotopes of uranium. The calculated average mortality and morbidity risks were lower than the actual prescribed limit. The average Lifetime Average Daily Dose (LADD) was calculated as 2.13, resulting in Hazard Quotient (HQ) above unity. Thus, the groundwater is not safe for drinking water consumption by members of the public in some areas. Using Hair Compartment Model for uranium, organ specific doses due to uranium radioisotopes in prime organs/tissues and excretion rates via urine, faeces and hair pathway are estimated.

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**Session Classification:** Section 4

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

# Charge distribution inside strange baryons in impact parameter space and transverse coordinate space.

To portray the internal structure of low-lying octet baryons, the understanding of the intrinsic properties of their building blocks i.e., quarks and gluons is indispensable. We present the study of spatial distribution of quark charges via generalized parton distribution in the impact parameter space. This structural anatomization is carried out by making the use of quark-scalar diquark model of hadrons in which feasible pairs of quark-scalar diquark has been considered to understand the behavior of each constituent quark of baryon. By transforming the light-front wave functions in coordinate space, we have also presented the charge distribution of quarks in transverse direction. This aids in the analyses of the distinct behavior of the charge distributions in both kind of spaces. We examine the charge distribution of octet baryons, one of the isospin partners of $\Sigma$ and $\Xi$ to observe the reliance of charge distribution on the presence of strangeness content in baryon.

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**Session Classification:** Section 2

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

# Prospects for Dilepton Measurements in MPD at NICA

*Monday 16 October 2023 15:50 (20 minutes)*

The Multi-Purpose Detector (MPD) experiment is a flagship heavy-ion experiment at the NICA facility under construction at JINR, in Dubna, Russia expected to start operation in 2025. The experiment will operate in the energy range √sNN = 4-11 GeV which covers the high net-baryon density region of the QCD phase diagram. Among the various physics topics covered by the MPD physical program, the measurements of dileptons have the potential to provide unique insights into the properties of the produced medium in heavy-ion collisions in this energy range. Once produced, dileptons leave the interaction region mostly unchanged. The slope parameter of the dielectron mass spectra in the intermediate mass region probe the initial temperature of the fireball. The yield of low-mass pairs and spectral shapes of the low-mass vector mesonsn carry information about the chiral symmetry restoration and the lifetime of the system.
In this presentation, we will report the current status of the NICA facility and the MPD detector. The plans for dilepton measurements together with selected physics performance studies will be presented.

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**Session Classification:** Section 2

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

# A proposal to realizing Majorana Fermions in strongly correlated nanowire without magnetic fields

*Monday 16 October 2023 15:30 (20 minutes)*

The topological superconductivity with Majorana zero modes (MZM) is of fundamental scientific importance, due to their proposed application in the braiding-based quantum computing [1]. The first theoretical proposal for the realization of the MZM was involved placing an one dimensional (1D) quantum wire with spinless electrons on a p-wave superconductors [2]. However, from the material science point of view this conceptually simple model is hard to realize as spinless electron does not exist in nature, and p-wave superconductors are, at best, rare. Later several proposals were put forward to eliminate these difficulties by ingeniously combining the proximity induced s-wave superconductivity, the Rashba spin-orbit coupling (RSOC), and the broken time reversal (TR) symmetry [3]. The RSOC is needed for the spin-momentum locking [4]. TR symmetry breaking is needed to create, in effect, the spinless electrons. Using aforementioned ideas, broadly three types of platforms have been engineered by placing [5]: (i) topological insulators on superconductor [6, 7], (ii) semiconductor with strong spin-orbit coupling on superconductor [8], or (iii) chain of magnetic atoms on superconductor[9, 10]. Despite these experimental successes, several concerns remain; mainly the requirements of the strong RSOC and the external magnetic field. The former limits the candidate materials which can be placed over the superconductor; the later limits the possible superconducting substrate. Moreover the crystal symmetry consideration greatly shrink the possible superconductors supporting topological characters [11]. The external magnetic field is the principal hindrance, as most of the experiments use s-wave superconductors in which strong enough magnetic field will destroy the superconductivity. Hence, naturally the question arises, can we get rid of the constraint possessed by the magnetic field? It is the goal of this work to suggest a different route to realizing MZM without magnetic field and RSOC.

We show that the 1D topological superconductivity can be placed in the context of phenomena associated with strongly correlated electron systems. Here we propose a system consisting of a one-dimensional chain of strongly correlated fermions placed on a superconducting (SC) substrate that exhibits a spin-singlet extended s-wave pairing. Strong electron correlation is shown to transform an extended s-wave SC into a topological SC. In contrast to the approaches based on the mean-field treatment, no Zeeman or exchange magnetic field is needed to produce such an effect.

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**Session Classification:** Section 4

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

# The Study of Multi-Nucleon Transfer Reactions for Synthesis of New Heavy and Superheavy Nuclei

*Thursday 19 October 2023 09:20 (20 minutes)*

Exotic nuclei are usually produced by projectile fragmentation or projectile fission at relativistic energies, or in complete fusion reactions at Coulomb barrier energies. These production methods and the available beam intensities determine the present boundaries of the chart of nuclides. However, it is estimated that several thousand further isotopes are expected to exist on the neutron-rich side, including most of the nuclei along the astrophysical r-process path. Multi-nucleon transfer (MNT) reactions could be a possible way to expand into this unknown territory. The results achieved so far provide an idea of the potential of MNT reactions for nucleosynthesis.
The development of techniques to separate and detect heavy transfer products is ongoing. Our results will be discussed together with previous measurements, and perspectives will be given for the application of MNT reactions to produce new heavy and superheavy isotopes [1-5]. The project of a new kinematic separator, the "Separator for Transactinide Research"(STAR), which will be designed to study MNT reactions at the Flerov Laboratory of Nuclear Reactions of the JINR, Dubna, will be discussed [5-6]. The project will be implemented together with the modernization of the U400 cyclotron (U400R).

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**Session Classification:** An extra day session

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

# Diffractive vector meson production at HERA using holographic light-front QCD

*Wednesday 18 October 2023 15:10 (20 minutes)*

We adopted the light-front holographic QCD approach for investigating diffractive vector meson production in electron-proton collisions at HERA. Specifically, our study focuses on Rho (ρ) and Phi (ϕ) vector meson production. Our findings involves developing holographic wave functions that capture the internal structure and dynamics of these vector mesons, incorporating non-perturbative QCD effects. These wave functions are then integrated into the diffractive QCD factorization framework, facilitating the prediction of essential observables like differential cross sections and angular distributions, crucial for experimental comparisons at HERA. Additionally, this holographic approach enables exploration of energy and momentum transfer dependencies in vector meson production, revealing insights into the interplay between perturbative and non-perturbative QCD effects, including gluon saturation, proton structure, and vector meson behavior in high-energy, small-x conditions.

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**Presenter:** GURJAR, Bheemsehan (IIT Kanpur)

**Session Classification:** Section 1

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

# Bulk of the particle production and collective behavior study for searching the QGP in small collision system

*Monday 16 October 2023 15:30 (20 minutes)*

The quark-gluon plasma (QGP), a new state of nuclear matter at extremely high temperature and pressure where quarks and gluons are deconfined can be produced in relativistic heavy-ion collisions. Experimentally QGP is regularly produced in the laboratory by colliding ions in relativistic energy to create such an extreme temperature and pressure. An extensive study of the formation of the QGP and its characterization in ion-ion (AA) collisions have been reported by many experiments (ALICE, STAR, CMS). Parallel developments of the theoretical and phenomenological aspects of QGP formation are notable. The bulk of the particle production, their collective behavior like radial flow, multi-strange particle production and strangeness enhancement, anisotropic flow with respect to the symmetry plane of the collision and quarkonia suppression and enhancement are signals of the QGP formation and its thermodynamical property study.

Recent studies show that particle production in high multiplicity pp and p—Pb collisions at LHC energies, exhibits features that mimic the behaviors observed in AA collisions (e.g. hardening of the transverse momenta spectra pT and radial flow, strangeness enhancement, azimuthal asymmetries in the particle productions with respect to the symmetry plane of the collision). These features are a typical sign of the formation of a deconfined state of matter (quark—gluon plasma). In this presentation, the comparative latest results of the light flavor hadron transverse momentum spectra, relative abundances in different collision systems and anisotropic flow measurements shall be discussed as crucial information on the collective behavior of the small collision system in relativistic energy.

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**Presenter:** PATRA, Rajendra Nath (INFN Bari)

**Session Classification:** Section 2

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

# Research activities at BHU and with JINR, Dubna

*Wednesday 18 October 2023 14:50 (20 minutes)*

Presently, a group of seven PhD students is working with me and they all are working on different nuclear research programmes. We are working on surrogate reaction studies, fusion-fission studies, Neural networks
in nuclear physics as well as neutron and alpha cross-section studies with covariance analysis.
Extensive work was done under Indo Russian bilateral research programme funded by the Department of Science and Technology, Govt of India. BHU group participated actively in the TANGRA establishment at JINR,
Dubna and co-authored more than a dozen papers in reputed journals. A group of PhD students from JINR,
Dubna also visited BHU in October 2019 and presented their research work in international conference on nuclear physics. The details about the research work and future possibilities will be shared during the
workshop.

**Author:** KUMAR, Ajay (Banaras Hindu University, Varanasi)

**Presenter:** KUMAR, Ajay (Banaras Hindu University, Varanasi)

**Session Classification:** Section 3

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

# QCD and gravity

*Monday 16 October 2023 12:30 (30 minutes)*

Selected topics manifesting QCD/gravity relations are briefly discussed

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**Presenter:** TERYAEV, Oleg (JINR)

**Session Classification:** Plenary

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

# Probing Fission Dynamics using Fission Fragment Spectroscopy

*Monday 16 October 2023 15:20 (20 minutes)*

Unlike other reaction mechanisms, fission process produces huge number of fragment nuclei; all being produced at the same instant of time. Thus γ-spectra following a typical fission reaction are found to be extremely complicated, and often become very challenging to carry out the unambiguous analysis. Although it is very challenging to make an unambiguous analysis of the complicated γ spectra of the fission fragments, a careful analysis of in-beam γ-spectroscopic data can bring out an overall picture of the underlying fission dynamics of the concerned fissioning system [1,2]. The results related to the multi-modal fission dynamics as obtained from the several prompt gamma ray spectroscopic experiments followed by the extensive analysis work carried out by our group will be presented [3,4,5]. The importance of a spectrometer, comprising of a large number of high-resolution gamma detectors, in unveiling the different competing fission modes through prompt gamma ray spectroscopy technique will be discussed.

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**Presenter:** CHAKRABORTY, A. (Department of Physics, Siksha Bhavana, Visva-Bharati University, West Bengal, India)

**Session Classification:** Section 3

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

# Thermal effects on weak-interaction nuclear reaction under supernova conditions

*Wednesday 18 October 2023 15:00 (20 minutes)*

The method of superoperators in Liouville space was applied to study equilibrium and excited states of hot nuclei. 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, was 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.

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

**Session Classification:** Section 2

Contribution ID: **48** Type: **not specified**

# Influence of relativistic rotation on QCD properties

*Monday 16 October 2023 11:00 (30 minutes)*

In this report the influence of relativistic rotation on QCD properties will be considered. This study is carried out within lattice simulation of QCD which is performed in the reference frame which rotates with the system under investigation. In this case rotation is reduced to external gravitational field. Within the report I am going to discuss the following topics: the moment of inertia and inhomegenious phase transitions in quark-gluon plasma.

**Author:** BRAGUTA, Victor (JINR)

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**Presenter:** BRAGUTA, Victor (JINR)

**Session Classification:** Plenary

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

# A new mechanism of incomplete fusion of nuclei.

*Wednesday 18 October 2023 14:30 (20 minutes)*

A study of the complete fusion mechanism of nuclei in nucleus-nucleus collisions is an actual task to find an unambiguous answer how fusion takes place: by nucleon transfer through the window between nuclei or as two droplets merge with each other.
The uncertainties in the experimental and theoretical estimations of the cross sections of complete fusion are related mainly with the $\sigma_{\rm fus.fiss}(E_{\rm c.m.})$ term of fusion-fission products in the fusion formula [1,2]:
\begin{equation}
\sigma_{\rm fus}(E_{\rm c.m.})=\sigma_{\rm ER}(E_{\rm c.m.})+
\sigma_{\rm fus.fiss}(E_{\rm c.m.})
\end{equation}
It is related with ambiguity in the identification of the fusion-fission products when they mix with the quasifission products in the measured data.

The analysis of the overlap of the mass and charge distribution of the binary reaction products by the dinuclear system (DNS) approaches have demonstrated that fusion of nuclei takes place by nucleon transfer through the window between nuclei. The possibility to describe incomplete fusion by the DNS model as a function of the orbital angular momentum of the entrance channel shows that yield of the $\alpha$ particle is the appearance of the intrinsic fusion barrier at the last stage of complete fusion [3]. At this moment the centrifugal force arising at the large values of the angular momentum pushes out the $\alpha$ particle from the other part of the DNS which has come to the very mass asymmetric shape as a result its evolution by the nucleon transfer. The hindrance to complete fusion of the $\alpha$ particle with the heavy part of the dinuclear system is caused by the increasing the centrifugal forces for the $\alpha$ particle for the large orbital angular momentum ($L > 30\hbar$) [3]. Indeed this is one of channels of the quasifission of the DNS.
This fact is confirmed by our calculations. The angular momentum distribution of the DNS and compound nucleus is calculated by the DNS model taking into account the possibility of the collisions of the nuclei with different orientation angles relative to the beam direction.
The excitation energy $E^*_Z$ of the DNS with the charge asymmetry $Z$, which is generated from the total kinetic energy loss at the capture of the projectile by the target nucleus. Another reason causing decrease of the excitation energy of the residual nucleus
is kinetic energy of the $\alpha$ particle emitted at large values of the DNS angular momentum.

Therefore, the residue nucleus formed in the incomplete fusion is less heated than the compound nucleus formed in the complete fusion. The observed yield of the $^{194}$Au in the $\alpha$0nchannel of the $^{22}$Ne+$^{176}$Lu reaction occurs only in collisions with the large orbital angular momentum. The measured cross sections of evaporation residues formed in the incomplete fusion and complete fusion channels have been reproduced well by the DNS model and the statistical model implanted in KEWPIE2 [4].

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**Presenter:** NASIROV, Avazbek (Joint Institute for Nuclear Research)

**Session Classification:** Section 3

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

# Probing role of deformed target on the mass-energy distributions of $^{224}$Th at above Coulomb barrier

*Thursday 19 October 2023 09:40 (20 minutes)*

One of the key ingredients for the synthesis of Super Heavy Elements (SHE) is the target-projectile combination of the reaction. The role of deformed target on the various Compound and non-Compound reaction mechanisms is yet to be explored [1,2]. The synthesis of SHE is further hindered by the Quasifission mechanism that competes with the formation of a Compound nucleus. The investigation of mass-energy distributions of heavy nuclei allows a detailed understanding of the associated various reaction mechanisms, and therefore is highly desirable to study the Quasifission process [3]. Furthermore, the region of neutron-deficient $Th$ nuclei has not been extensively studied for the multimodal fission phenomenon, which further builds on the primary motivation of the present study [4].

The experiment was performed at the Flerov Laboratory of Nuclear Reactions (FLNR), JINR, Russia, using an energetic $^{48}$Ca beam delivered from the $U400$ cyclotron. A thin target of $^{176}$Yb with thickness of about 214 $\mu$g/cm$^2$ on 1.5 $\mu$m thick Titanium backing was bombarded with the $^{48}$Ca beam at six different energies in the range of $E_{beam}$ = 188 to 272 MeV. The measurement of the reaction binary products was carried out by utilizing the double-arm time-of-flight (TOF) spectrometer CORSET [5]. Assuming the conservation of mass of the composite system of projectile and target, the double-velocity method was employed to determine the mass and energy of the reaction products.

The present reaction, $^{48}$Ca + $^{176}$Yb, leads to the formation of the composite system, $^{224}$Th above the Coulomb barrier. The Mass-Total Kinetic Energy (M-TKE) distributions of the primary binary fragments from $^{224}$Th have been obtained from the present measurement. The measured M-TKE distribution profiles have been deconvoluted with multiple Gaussian functions to extract the yield contributions of the symmetric and asymmetric components from the fission-like fragments. Due to a comparatively high Coulomb factor, $Z_1Z_2$ = 1400 and a mass asymmetry value of about 0.57, significant suppression of the compound nucleus, $^{224}$Th formation because of enhanced contribution from the Quasifission process is expected. The target nucleus, $^{176}$Yb being highly prolate deformed in the ground state ($\beta_2$ = 0.3) when bombarded with spherical projectile beam particles of doubly magic $^{48}$Ca will further allow to investigate the role of deformed target on the reaction mechanism.

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**Presenter:** DEY, Aniruddha (JINR)

**Session Classification:** An extra day session

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

# Disentangling the role of transfer channels on fusion dynamics

*Thursday 19 October 2023 10:20 (20 minutes)*

Heavy-ion fusion reaction dynamics in the vicinity of the Coulomb barrier have been an active field of investigation over the past few decades. The fusion and Multi-Nucleon Transfer (MNT) reactions are elemental for the synthesis of exotic nuclei away from the valley of stability. These studies can further be extrapolated to extremely lower energies, where the reaction dynamics can shed some light on the astrophysical significance of the heavy ion reactions in nucleosynthesis [1]. The fusion cross-sections at the sub-barrier energies are significantly enhanced as compared to one-dimensional barrier penetration model (1-D BPM) calculations. The coupling of various internal degrees of freedom with the relative motion viz. static deformation, surface vibrations, and nucleon transfer channels have been employed to explain the experimentally obtained fusion cross sections [2-4]. The unambiguous influence of multi-nucleon transfer channels on the sub-barrier fusion enhancement is still not properly understood. Further, based on the quantum tunneling concept, quasi-elastic scattering (a sum of elastic scattering, inelastic scattering, and transfer channels) serves as an alternative approach for extraction of the fusion cross section as the former is related to the reflection probability of a potential barrier while the latter is related to the penetration probability. Therefore, to address the aforementioned aspects of the heavy ion reaction dynamics, fusion, and its complementary, quasi-elastic excitation function measurements have been performed for 28Si + 116,120,124Sn systems using Recoil Mass Separator (RMS), Heavy Ion Reaction Analyzer (HIRA) at Inter University Accelerator Centre (IUAC) New Delhi, India [5]. The fusion crosssections for all three Sn isotopes are significantly enhanced over the predictions of 1-D BPM calculations. The Coupled-channels framework using CCFULL has been invoked to explain the underlying reaction mechanism [6]. The influence of Multi-nucleon transfer channels has been highlighted in the coupled-channel calculations [7]. The fusion and complementary quasi-elastic barrier distribution have also been extracted from the experimental data to reveal the identity of various channels coupled in the reaction [8]. Detailed analysis and results will be presented during the workshop.

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**Session Classification:** An extra day session

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

# The experimental study of MNT process in the reaction 136Xe+238U at energy above the Coulomb barrier

*Tuesday 17 October 2023 15:30 (20 minutes)*

During recent years it becomes more evident that multinucleon transfer (MNT) reactions can be considered as the promising way to synthesize and investigate heavy and superheavy elements which cannot be produced in other reaction mechanisms. The 238U ions are apparently optimal for bombarding particles in the synthesis of superheavy elements in MNT reactions. For deeper understanding of the MNT mechanisms and the best planning the future experiments on the production of new heavy isotopes in the reactions with 238U beam the theoretical calculation has to be checked with experimental data for the reactions like 136Xe+238U and 209Bi+238U.
Primary and secondary mass and energy distributions of projectilelike fragments formed in the reaction 136Xe+238U at 136Xe beam energy of 1.11 GeV have been experimentally investigated with the CORSET setup independently and in coincidence with survived heavy targetlike fragments. Since the heavy fragments formed in the reactions is highly excited, the masses, energies and the angles of the both fragments as products of sequential fission of excited heavy MNT fragments have been measured. Our study was organized using two independent experimental techniques, namely, double-arm Time-of-Flight measurements (ToF-ToF method) to investigate two body coincidences and three arms combining Time-of-Flight and energy measurements (ToF-E method) to investigate three body coincidences. The obtained experimental results will be presented and discussed.

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**Presenter:** KNYAZHEVA, Galina (FLNR)

**Session Classification:** Section 3

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

# Magic numbers in heavy nuclei

*Tuesday 17 October 2023 15:50 (20 minutes)*

The nuclear shell model plays an important role in the pre-formation of alpha particles. It shows the existence of magic numbers, which predicts the nucleus to form a strongly bound closed shell. When the protons number (Z) or the neutrons number (A-Z) is equal to 2,8,20,28,50,82 or 126, which are known as the "Magic Numbers". We have developed a model which we named as S-potential by smoothening the potential well inside the nucleus to the top of the coulomb barrier at the outer side of the potential well. We have studied the alpha decay of some even-even heavy nuclei and the half-lives obtained were found to be in a very good agreement with the experimental data available. The pre-formation factor and the penetration probability were determined by modifying the Gamow's theory of alpha decay by varying the potential. We have studied the microscopic structure properties for202-226Ra88 and 210-232Th90. It was observed that at N=126 the pre-formation factor and penetration probability decreases with increasing N which shows that the closed shell effects plays an important role in the alpha formation process.The S-potential was found to be a better model for obtaining the accurate half-lives of heavy nuclei.

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**Session Classification:** Section 3

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

# Gluon distributions in the proton in a light-front spectator model

*Tuesday 17 October 2023 15:30 (20 minutes)*

We formulate a light-front spectator model for the proton incorporating the gluonic degree of freedom. In this model, at high energy scattering of the proton, the active parton is a gluon and the rest is viewed as a spin-1/2 spectator with an effective mass. The light front wave functions of the proton are constructed using a soft wall AdS/QCD prediction and parametrized by fitting the unpolarized gluon distribution function to the NNPDF3.0nlo dataset. We investigate the helicity distribution of gluon in this model. We find that our prediction for the gluon helicity asymmetry agrees well with existing experimental data and satisfies the perturbative QCD constraints at small and large longitudinal momentum regions. We also present the transverse momentum dependent distributions (TMDs) for gluon in this model. We further show that the model-independent Mulders-Rodrigues inequalities are obeyed by the TMDs computed in our model.

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**Presenter:** CHOUDHARY, Poonam (IIT Kanpur)

**Session Classification:** Section 2

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

# Influence of entrance channel shell closure on dissipative nature of nuclear fission

*Thursday 19 October 2023 11:30 (20 minutes)*

Despite extensive efforts, comprehending the bulk rearrangement of nuclear matter during fission of a compound nucleus (CN) remains elusive. The main challenge is to unravel and subsequently model the role of various collective and intrinsic variables governing the process. Neutrons emitted from the CN as it goes through multiple shape deformations between the equilibrium state and the scission state prove to be an imperative observable to understand the fission dynamics. Neutron multiplicity measurements have illuminated various aspects of the phenomenon including the role of entrance channel dynamics on the fission timescale, the significance of shell-effects in fission barrier calculations and most importantly the dissipative nature of fission [1]. Dissipation transiently drives the collective fission degree of freedom and delays the journey of CN across the barrier, thus manifesting a reduced fission flux [2], an increased saddle to scission time [3] and an enhanced particle emission [4, 5]. A profound description of fission dynamics based on neutron multiplicities thus requires accurate estimation of dissipation strength within the existing macroscopic-microscopic models. Present work explores the role of entrance channel closure on fission dynamics, through pre-scission neutron multiplicity ($\nu_{pre}$) of three different even-even isotopes of Th:
$^{220,222,224}$Th. The reaction channels populating Th isotopes include doubly magic projectile $^{16}$O with the magic $^{204,206}$Pb and doubly magic $^{208}$Pb as targets. A new parameter ($\delta_{sh}$) is defined to denote the deviation of neutron and proton numbers in the target and projectile from the respective nearest magic numbers. Further, a systematic analysis of the $^{220,222,224}$Th vpre data ($\delta_{sh}$ = -4, -2, 0) along with $\nu_{pre}$ data of 28 other complete fusion reactions is performed (Details have already been given in [6]). Theoretical analysis is performed within the standard statistical model framework, where reduced dissipation strength ($\beta$) is used as a tuneable parameter. A strong correlation is observed between the extracted $\beta$ values and $\delta_{sh}$: a maximum at $\delta_{sh}$ = 0 with a symmetric decrease on either side. This implicates a more hindered fission pathway for reactions with shell closed nuclei in the entrance channel. Absolute $\beta$ values are also extracted by fitting the experimental ER cross-section for 12 reactions (Details have already been given in [6]). An inverse systematic dependence of $\beta$ on $\delta_{sh}$ is observed by fitting the ER cross-section data : minimum $\beta$ is required for $\delta_{sh}$ = 0 and then it gradually increases as δsh deviates from zero. The persistence of the same behavior of β over a wide range of excitation energy confirms that such dependence on the entrance channel magicity is independent of the compound nuclear shell structure and other finer details of the modeling.

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**Session Classification:** An extra day session

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

# BEC Stars in Rastall and Rainbow Gravities

*Wednesday 18 October 2023 15:40 (20 minutes)*

We study the global properties of a star made of self-gravitating Bose-Einstein Condensates Rastall, Rainbow and combined Rastall-Rainbow theories of modified gravity. By employing a relativistic and non-relativistic BEC equation of state we solve the stellar structure equations in these theories and quantify the mass and radius of the BEC stars. We also study the effect temperature on BEC stars in these modified theories.

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**Presenter:** SREEKANTH, V. (School of Physical Sciences, Amrita Vishwa Vidyapeetham, Coimbatore, INDIA)

**Session Classification:** Section 2

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

# Welcome and Opening

*Monday 16 October 2023 08:50 (10 minutes)*

**Presenter:** NEDELKO, Sergei (Bogoliubov Laboratory of Theoretical Physics, JINR)

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

# Spin polarization as a signal of QCD critical point.

*Monday 16 October 2023 09:00 (30 minutes)*

**Presenter:** ALAM, Jan-e (VECC)

**Session Classification:** Plenary

Contribution ID: **63** Type: **not specified**

# Understanding the formation of a deconfined medium in small collision systems at the Large Hadron Collider

*Monday 16 October 2023 09:30 (30 minutes)*

**Presenter:** SAHOO, Raghunath (IIT Indore)

**Session Classification:** Plenary

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

# Status and physics capabilities of the MPD experiment at NICA

*Monday 16 October 2023 10:00 (30 minutes)*

**Presenter:** RIABOV, Victor (JINR, PNPI)

**Session Classification:** Plenary

Contribution ID: **65** Type: **not specified**

# Exploring gluon TMDs at electron ion collider

*Monday 16 October 2023 11:30 (30 minutes)*

**Presenter:** MUKHERJEE, Asmita (IIT Bombay)

**Session Classification:** Plenary

Contribution ID: **66** Type: **not specified**

# Deep Underground Neutrino Experiment (DUNE): Possible Indian Collaboration with JINR on Detector Development

*Monday 16 October 2023 12:00 (30 minutes)*

**Presenter:** BHUYAN, Bipul (IIT Guwahati)

**Session Classification:** Plenary

Contribution ID: **67** Type: **not specified**

# Fate of the attractor solution in an external force in the relativistic kinetic theory

*Monday 16 October 2023 14:30 (20 minutes)*

**Presenter:** ROY, Victor (NISER)

**Session Classification:** Section 1

Contribution ID: **68** Type: **not specified**

# Equivalence role between Lorentz force and Coriolis Force in QGP

*Monday 16 October 2023 14:50 (20 minutes)*

**Presenter:** GHOSH, Sabyasachi (IIT Bhilai)

**Session Classification:** Section 1

Contribution ID: **69** Type: **not specified**

# Impact of Memory on Heavy Quark Diffusion in Hot QCD Matter.

*Monday 16 October 2023 15:10 (20 minutes)*

**Presenter:** DAS, Santosh K. (IIT Goa)

**Session Classification:** Section 1

Contribution ID: **70** Type: **not specified**

# Heavy quarkonium potential in presence of magnetic field

*Monday 16 October 2023 15:30 (20 minutes)*

**Presenter:** HAQUE, Najmul (NISER)

**Session Classification:** Section 1

Contribution ID: **71** Type: **not specified**

# Study of heavy flavour hadrons through semi-leptonic decay channel with ALICE

*Monday 16 October 2023 14:30 (20 minutes)*

**Presenter:** ROY, Ankhi (IIT Indore)

**Session Classification:** Section 2

Contribution ID: **72** Type: **not specified**

# Kinetic freeze-out in low energy relativistic nuclear collisions

*Monday 16 October 2023 15:10 (20 minutes)*

**Presenter:** BHADURI, Partha P. (VECC)

**Session Classification:** Section 2

Contribution ID: **73** Type: **not specified**

# Exploring underlying events with transverse activity , $S_T$ observable

*Monday 16 October 2023 14:50 (20 minutes)*

**Presenter:** DASH, Sadhana (IIT Bombay)

**Session Classification:** Section 2

Contribution ID: **74** Type: **not specified**

# Coulomb excitation activities at IUAC, Past, Present and Future

*Monday 16 October 2023 14:30 (30 minutes)*

**Presenter:** KUMAR, Rakesh (IUAC)

**Session Classification:** Section 3

Contribution ID: **75** Type: **not specified**

# Binary fragmentation dynamics of few heavy systems

*Tuesday 17 October 2023 14:50 (20 minutes)*

Mass distribution studies play an important role in understanding the fusion–fission mechanism involved in the heavy-ion induced nuclear reaction. It is well established that quasi-fission plays an important role in the decay process of heavy and super-heavy systems. In my talk I shall present fission mass distribution studies 48Ti+208Pb and 48Ti+232Th systems. Results of width of mass distribution, correlation between the mass and TKE along with mass-angle distribution of the binary fragments will be presented.

**Presenter:** BEHERA, Bivash R.

**Session Classification:** Section 3

Contribution ID: **77** Type: **not specified**

# Toward large-scale calculation of nuclear fission process

*Monday 16 October 2023 15:00 (20 minutes)*

**Presenter:** SADHUKHAN, Jhilam (VECC)

**Session Classification:** Section 3

Contribution ID: **78** Type: **not specified**

# Isospin transport in heavy-ion reactions around the Fermi energy domain

*Wednesday 18 October 2023 15:30 (20 minutes)*

One of the most exciting challenges in modern nuclear physics and astrophysics is to understand the behavior of nuclear matter under extreme conditions. Heavy ion reactions around the Fermi energy domain provide a unique opportunity to enrich our knowledge about the nuclear equation of state (EoS) at sub-saturation densities [1]. Isospin transport in heavy ion reactions around the Fermi energy domain is directly correlated to the density dependence of the symmetry energy [2]. Recently Boltzmann-Uehling-Uhlenbeck transport model (BUU) of heavy ion reactions was upgraded by including a meta-modelling empirical equation of state based on a density development around saturation [3]. Based on this BUU transport model study, the sensitivity of evaporation residue observables, isospin transport ratio of quasi-projectile and free nucleons to the density dependence of the symmetry energy [3,4] will be discussed.
References:
[1] S. Das Gupta, S. Mallik and G. Chaudhuri, Heavy Ion Reaction at Intermediate Energies: Theoretical Models (World Scientific Publishers, Singapore, 2019).
[2] M. B. Tsang et al., Phys. Rev. Lett. 92, 062701 (2004).
[3] S. Mallik, G. Chaudhuri and F. Gulminelli , Phys. Rev. C 100, 024611 (2019)
[4] S. Mallik, F. Gulminelli and D. Gruyer, Jour. Phys. G: Nucl. Part. Phys 49, 015102 (2021).

**Presenter:** MALLIK, Swagata (VECC)

**Session Classification:** Section 3

Contribution ID: **79** Type: **not specified**

# Spin Reorientation and Rare-earth ordering in Rare-earth Orthoferrites and Orthochromites

*Monday 16 October 2023 14:30 (20 minutes)*

**Presenter:** MALIK, Vivek K. (IIT Roorkee)

**Session Classification:** Section 4

Contribution ID: **80** Type: **not specified**

# Quark Matter under magnetic field

*Tuesday 17 October 2023 09:00 (30 minutes)*

**Presenter:** SARKAR, Sourav (VECC)

**Session Classification:** Plenary

Contribution ID: **81** Type: **not specified**

# Production cross-sections of Heavy Quakonium states in magnetized strange hadronic matter at finite temperature

*Tuesday 17 October 2023 09:30 (30 minutes)*

**Presenter:** MISHRA, Amruta (IIT Delhi)

**Session Classification:** Plenary

Contribution ID: **82** Type: **not specified**

# Topical problems of nuclear physics solved at FLNR JINR

*Tuesday 17 October 2023 11:00 (30 minutes)*

**Presenter:** KARPOV, Alexander (JINR)

**Session Classification:** Plenary

Contribution ID: **83** Type: **not specified**

# Heavy-ion fusion and fission study at the low energy region

*Tuesday 17 October 2023 12:00 (30 minutes)*

Decades of effort in developing accelerator facilities, detector developments, and electronics have helped us better understand the heavy-ion reaction dynamics, particularly in the low-energy region. Various aspects of elastic and inelastic scattering, fusion, transfer, and influence of inelastic couplings in the scattering and fusion have been investigated in nucleus-nucleus interactions. Studies on breakup-fusion processes of the weakly bound or cluster-structured projectiles ( 6 Li, 7 Li, 9 Be, etc.) over a broad target mass range are also remarkable to shed light on the reaction dynamics and their dependence on the entrance channel parameters. However, it is worth mentioning that fusion-evaporation dominates in lighter systems, while evaporation competes with the fission process for heavy compound nuclear mass. Thus, post-fission observables, such as charge and mass yield distributions, are fascinating and are being extensively studied in low and intermediate energies. Besides basic science, the production of exotic neutron-deficient radionuclides is possible through heavy-ion reactions. The talk will discuss our efforts in exploring heavy-ion reaction dynamics and the proposition
of radionuclides for the applications. It will also highlight our joint effort (INDIA-JINR) on exploring the fission dynamics of sub-lead nuclei, particularly for the Hg isotopes.

**Presenter:** MAITI, Moumita (IIT Roorkee)

**Session Classification:** Plenary

Contribution ID: **84** Type: **not specified**

# Exploring Fission Valleys of HE and SHE

*Tuesday 17 October 2023 11:30 (30 minutes)*

**Presenter:** GHOSH, Tilak K. (VECC)

**Session Classification:** Plenary

Contribution ID: **85** Type: **not specified**

# Light, Large & Lustrous: The Many Accomplishments of Digital INGA @ VECC

*Wednesday 18 October 2023 09:30 (30 minutes)*

**Presenter:** GHUGRE, Sandeep S. (UGC-DAE csr Kolkata)

**Session Classification:** Plenary

Contribution ID: **86** Type: **not specified**

# Exotic hadrons from lattice QCD

*Tuesday 17 October 2023 14:30 (20 minutes)*

**Presenter:** MATHUR, Nilmani (TIFR)

**Session Classification:** Section 1

Contribution ID: **87** Type: **not specified**

# Effects of finite volume on the QCD phase diagram

*Tuesday 17 October 2023 14:50 (20 minutes)*

At high temperatures and densities, strongly interacting matter exists in a phase different from the hadronic phase. The phase diagram in the temperature and baryon number chemical potential plane is a topic of extensive theoretical and experimental investigations at present. In particular, the search for a critical point in the phase diagram involves the study of baryon number cumulants.

One issue with the experimental investigation of the phase diagram is the fact that the system created in relativistic heavy ion collision experiments is small, of dimension a few fm. We investigate the effect of the finite size on the phase diagram. In particular, we look at how the phase diagram shifts, and how the growth of the cumulants get affected, due to the small volume of the system.

**Presenter:** DATTA, Saumen (TIFR)

**Session Classification:** Section 1

Contribution ID: **88** Type: **not specified**

# Constructing the equation of state of strongly interacting matter. Self-consistent approaches

*Tuesday 17 October 2023 15:10 (20 minutes)*

**Presenter:** KOLOMEITSEV, Evgeni (JINR, MBU)

**Session Classification:** Section 1

Contribution ID: **89** Type: **not specified**

# The Spin Physics Detector project at NICA

*Tuesday 17 October 2023 14:30 (20 minutes)*

**Presenter:** GUSKOV, Alexey (JINR)

**Session Classification:** Section 2

Contribution ID: **90** Type: **not specified**

# Charge distribution inside strange baryons in impact parameter space and transverse coordinate space

*Tuesday 17 October 2023 14:50 (20 minutes)*

**Presenter:** DAHIYA, Harleen (NITJ)

**Session Classification:** Section 2

Contribution ID: **92** Type: **not specified**

# Proposal to develop an accelerator facility for NE region by CUPAC NE Collaboration

*Tuesday 17 October 2023 15:10 (20 minutes)*

The CUPAC NE Collaboration involves 20 universities, institutes and colleges from the North Eastern
states of India. Our collaborators from Indian national laboratories (BARC, IUAC, UGC-DAE CSR) and
International laboratories# bring much needed experience and expertise in experimental techniques and stellar model
codes critical to success of CUPAC mission. The long term goal of CUPAC is to construct a world class accelerator
facility in the NE region [1]. The proposed accelerator is a 5 MV Pelletron accelerator with an ECRIS injector.
Research domains include PIMS (Positive Ion Mass Spectrometry), nuclear astrophysics, neutron science including
AD-BNCT (Accelerator Driven Boron Neutron Capture Therapy) and SHIM (Swift Heavy Ions in Materials) with
high intensity inert/heavy ion beams.
□
□
The proposed accelerator could uniquely augment national research capabilities in investigation of nuclear
astrophysics reactions at (i) Gamow peak in ~200 keV to 100 MeV energy range and (ii) Inert isotopes like Ne,
Ar etc and providing high intensity heavy ion beams including group-VIII elements @ ~100 MeV for SHIM
studies.
Currently, the collaboration is implementing R &D projects in AD-BNCT, PIMS and investigation of neutron
source in AGB stars [2, 3]. Considerable efforts were also put in designing a gas jet target coupled with RMS
for nuclear astrophysics, ion optics of accelerator and kinematically focused neutron source at IUAC.
References:
[1]."Developing a Discovery Class Particle Accelerator Facility at Cotton University by CUPAC - North East
Collaboration" by G. C. Wary , M Patgiri , A. Barthakur , K. Boruah , J.J. Das, V. M. Datar, B.M. Jyrwa , P. C.
Rout , S. Santra, D. Sarma, N. Nimai Singh in Proceedings of the DAE Symp. on Nucl. Phys. 65 (2021) 5-14
[2]. "The Importance of the 13C(α,n)16O Reaction in Asymptotic Giant Branch Stars"by S. Cristallo et. al. in
The Astrophysical Journal, 859:105 (14pp), 2018 June 1
[3]. n_ToF: Measurements of key reactions of interest to AGB stars by C. Massimi et. al. in Uni-

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**Presenter:** DAS, Jiban J. (Cotton University)

**Session Classification:** Section 3

Contribution ID: **95** Type: **not specified**

# Asymmetric and symmetric fission of $^{256}$No nuclei formed in the $^{24}$Mg+$^{232}$Th reaction

*Thursday 19 October 2023 10:00 (20 minutes)*

The fission fragment mass and kinetic-energy distribution measurements of the low-energy fission of actinides show significant structural deviations from those expected in the liquid drop model (LDM) of a nucleus [1]. The super asymmetric mode due to the influence of double magic Ca (Z= 20, N = 28) and double magic Pb (Z = 82, N = 126) has been observed in the fission of excited $^{260}$No compound nuclei, populated by the reactions $^{12}$C+$^{248}$Cm [2] and $^{22}$Ne+$^{238}$U [3]. To study the asymmetric and symmetric nuclear fission modes in the $^{256}$No nuclei in dependence on the excitation energy, we have measured the mass-energy distributions of fission fragments of $^{256}$No compound nucleus.

The experiments were carried out at the Flerov Laboratory of Nuclear Reactions using the beam of $^{24}$Mg ions from the U-400 cyclotron at energies of 125, 146, 155 and 181 MeV. The $^{232}$Th targets of thickness 100 μg/cm$^2$ on 30 μg/cm$^2$ carbon backing were used. The mass-energy distributions of binary reaction events measured using the two-arm time-of-flight (TOF-TOF) spectrometer CORSET [4]. Each arm of the spectrometer consists of a compact start detector and a position-sensitive stop detector based on microchannel plates (MCP). The size of each MCP-detector in the Stop assembly is 18 cm × 7 cm in size. The arms of the spectrometer were positioned in an optimal way according to the kinematics of the reaction. The data were analysed event by event, the mass (M) and total kinetic energy (TKE) of the fragments were calculated from measured velocities and angles in the lab-system using the mass and momentum conservation laws.

The fission-like fragments are well separated from the products of elastic and quasi-elastic scattering events. To obtain the fission fragment mass and kinetic-energy distribution characteristics of the $^{256}$No fission, we have fitted the mass distribution of fission fragments into multi-Gaussian. For the lowest energy the mass distribution of the fragments is of a clear-cut asymmetric form. The contributions of the symmetric fission mode are the smallest for fission at lowest excitation energy and the yield of symmetric fission increases with increasing the excitation energies. With increasing excitation energy, the asymmetric fission modes fade out due to the disappearance of shell effects.

References

[1] U. Brosa, S. Grossmann and A. Muller, Phys. Rep. 197, 167 (1990).
[2] G. Knyazheva et al., EXON-2012-Proc. Int. Symp., 167 (2013).
[3] K. B. Gikal et al., Bull. Russ. Acad. Sci.: Phys., 82, 716 (2018).
[4] E. M. Kozulin et al., Instrum. Exp. Tech. 51, 44 (2008).

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**Session Classification:** An extra day session

Contribution ID: **97** Type: **not specified**

# Multifunctional Information and Computing Complex to Support JINR Research

*Wednesday 18 October 2023 10:00 (30 minutes)*

**Presenter:** VOYTISHIN, Nikolay (JINR)

**Session Classification:** Plenary

Contribution ID: **98** Type: **not specified**

# Non-linear Hall effect

*Wednesday 18 October 2023 09:00 (30 minutes)*

It has recently been realized that the first-order moment of the Berry curvature, namely the Berry curvature dipole (BCD) can give rise to non-linear current in a wide variety of time-reversal invariant and non-centrosymmetric materials. While the BCD in two-dimensional Dirac systems is known to be finite only in the presence of either substantial spin-orbit coupling where low-energy Dirac quasiparticles form tilted cones or higher order warping of the Fermi surface, In this talk, I will show that the low-energy Dirac quasiparticles arising from the merging of a pair of Dirac points without any tilt or warping of the Fermi surface can lead to a non-zero BCD. Remarkably, in such systems, the BCD is found to be independent of Dirac velocity as opposed to the Dirac dispersion with a tilt or warping effects. I will further show that the proposed systems can naturally host helicity-dependent photocurrent due to their linear momentum-dependent Berry curvatures. Finally, I will discuss an important byproduct of this work, i.e., nonlinear anomalous Nernst effect as a second-order thermal response.

**Presenter:** SAHA, Kush (NISER)

**Session Classification:** Plenary

Contribution ID: **100** Type: **not specified**

# Condensed Matter and Nuclear Physics Research at Frank Laboratory of Neutron Physics

*Wednesday 18 October 2023 11:00 (30 minutes)*

**Presenter:** KOPATCH, Yuri (JINR)

**Session Classification:** Plenary

Contribution ID: **101** Type: **not specified**

# Controlling the mechanical and thermal properties of entropy stabilized oxides by intelligent control of cooling rates

*Wednesday 18 October 2023 12:00 (30 minutes)*

**Presenter:** VIJAYKUMAR, Ravi K. N. (IIT Madras)

**Session Classification:** Plenary

Contribution ID: **102** Type: **not specified**

# Utilizing Scattering Techniques for Investigating Polymers under Confinement

*Wednesday 18 October 2023 12:30 (30 minutes)*

**Presenter:** SATAPATHY, Dilip K. (IIT Madras)

**Session Classification:** Plenary

Contribution ID: **103** Type: **not specified**

# Status of the Baikal-GVD neutrino telescope and selected results

*Wednesday 18 October 2023 14:30 (30 minutes)*

**Presenter:** SHAYBONOV, Bair (JINR)

**Session Classification:** Section 2

Contribution ID: **104** Type: **not specified**

# The trilinear Higgs coupling and new physics

*Wednesday 18 October 2023 15:20 (20 minutes)*

**Presenter:** DAS, Chitta Ranjan (BLTP, JINR)

**Session Classification:** Section 2

Contribution ID: **105** Type: **not specified**

# Investigation of Multi-nucleon Transfer using a Recoil Separator

*Monday 16 October 2023 15:40 (30 minutes)*

Recoil separators are used for identification of rare channels in a nuclear reaction amidst overwhelmingly intense background events. The Inter-University Accelerator Centre (IUAC), New Delhi, houses two recoil separators, namely, the Heavy Ion Reaction Analyzer (HIRA) and the HYbrid Recoil mass Analyzer (HYRA). These two devices are primarily used for the study of fusion dynamics, utilising heavy ion beams from the Pelletron and the superconducting linac. A conventional recoil separator can also be used for identification of multi-nucleon transfer (MNT) channels in heavy ion-induced reactions. In this case, the forward-recoiling target-like ions are transported to the focal plane of the separator and measured by a position-sensitive detector. In my talk, I shall present our recent measurements on MNT reactions with the HIRA and efforts to understand the mechanism of nucleon transfer in terms of coupled reaction channels (CRC) calculations. Plans with the HYRA, using beams from the High Current Injector (HCI) which will be available in the near future, will also be outlined.

**Presenter:** NATH, Subir (IUAC)

**Session Classification:** Section 3

Contribution ID: **106** Type: **not specified**

# Neutron TOF Spectrometers for fusion-fission reaction studies

*Wednesday 18 October 2023 15:10 (20 minutes)*

**Presenter:** GOLDA, K. S. (IUAC)

**Session Classification:** Section 3

Contribution ID: **107** Type: **not specified**

# Performing Molecular Dynamics Studies of Nanosized Systems Combined with Neutron Scattering Experiments

*Monday 16 October 2023 14:50 (20 minutes)*

**Presenter:** KHOLMURODOV, Kholmirzo (JINR)

**Session Classification:** Section 4

Contribution ID: **108** Type: **not specified**

# Morphological reorganization of lipid membranes induced by amyloid-beta peptides

*Wednesday 18 October 2023 15:10 (20 minutes)*

Alzheimer's disease (AD) is one of the most dangerous illnesses leading to the neuronal cell death. It is known that the amyloid-beta (Aβ) peptide plays a key role in this disease, one of the transmembrane fragments of which (Aβ25-35) demonstrates destructive toxic properties. Importantly, the toxic properties of this fragment are manifested upon its interaction with the lipid membrane of cells.

In this work, joint studies of SANS, SAXS, NMR, EM, and MD techniques reveal the membrane breakage when investigating the interactions between Aβ25-35 and model biological membranes mimicking the pre-AD conditions. Namely, it was found that the Aβ25-35 peptide being in the monomeric form incorporated in the lipid bilayer is able to cause a dramatic reorganization between small unilamellar vesicles (SUVs) and bicelle-like structures (BLSs) when transitioning through lipid thermodynamic phases. This effect is explained by the temporal destruction of lipid membranes by Aβ25-35 at the molecular level of a lipid bilayer, whereas it occurs at the superstructure level. In addition, we closely characterize the lipid structure of BLSs and SULVs, as well as localization of peptide molecules.

**Presenter:** KURAKIN, Sergei

**Session Classification:** Section 4

Contribution ID: **112** Type: **not specified**

# Applied research at NICA facility: new gates for cooperation in life sciences, materials sciences and nuclear technology

*Tuesday 17 October 2023 12:30 (30 minutes)*

**Presenter:** BELOV, Oleg (VBLHEP JINR)

**Session Classification:** Plenary

Contribution ID: **113** Type: **not specified**

# JOINT INSTITUTE FOR NUCLEAR RESEARCH: The Status and Prospects of Multidisciplinary Complex of Large Research Infrastructures

**Presenter:** NEDELKO, Sergei (Bogoliubov Laboratory of Theoretical Physics, JINR)

**Session Classification:** An extra day session

Contribution ID: **114** Type: **not specified**

# JINR-India collaborative investigations of Josephson nanostructures

*Tuesday 17 October 2023 16:00 (20 minutes)*

We present unique results of collaborative investigations of Josephson nanostructures obtained in recent years.We have studied a Josephson junction involving a Weyl and a multi-Weyl semimetals separated by a barrier created by putting a gate voltage over the Weyl semimetal.It was shown that the product of the critical current on the normal-state resistance for such junctions, has a universal value independent of the barrier potential, which is a consequence of change in topological winding number across the junction. We have investigated the perspectives of magnetization control in superconductor / ferromagnet / superconductor (S/F/S) Josephson junctions on the surface of a 3D topological insulator hosting Dirac quasiparticles. It was demonstrated that this can lead to splitting of the ferromagnet's easy-axis which can lead to stabilization of an unconventional four-fold degenerate ferromagnetic state. We have studied a magnetization reversal by an electric current pulse in a superconductor / insulating ferromagnet / superconductor Josephson junction placed on top of a 3D topological insulator (TI). It was demonstrated that strong spin-momentum locking in the TI surface states provides a possibility of efficient reversal of the magnetic moment by current pulse with amplitude lower than the critical current, that results in strongly reduced energy dissipation. We have demonstrated that a current sweep along IV-characteristic of the S/F/S $\phi_0$ junction may lead to regular magnetization dynamics with a series of specific phase trajectories. It was shown that an external electromagnetic field allows to control the magnetic moment dynamics and can lead to a topological transformation of precession trajectories.

**Presenter:** KULIKOV, Kirill (RF)

**Session Classification:** Section 4