The 8th International Conference on Chirality, Vorticity and Magnetic Field in Quantum Matter

Report of Contributions

https://indico.math.cnrs.fr/e/vorticity

Contribution ID: **10** Type: **Talk**

Spin 1 mesons as a probe for vorticity-polarization non-equilibrium

Friday, July 26, 2024 11:30 AM (30 minutes)

It is now clear, on a theoretical level, that spin polarization can not be in perfect local equilibrium with vorticity during the quark-gluon plasma evolution. Phenomenological consequences of this are however so far not clear. In this talk we argue that spin one mesons (and higher spin particles) are ideal probes of non-equilibrium between vorticity and polarization, because their density matrix carries, potentially, information unanbiguously related to local equilibrium.
We illustrate how light mesons (modeled via coalescence), quarkonia (modeled via potential models) and virtual photons (detectable via dilepton pairs) could be used to probe the interplay between vorticity and polarization in the system.
Based on 2305.02985 2104.12941 and ongoing work

Primary authors: TORRIERI, Giorgio (University of Campinas); Mr GONCALVES, Kayman Jhosef Carvalho (University of Campinas)

Presenter: TORRIERI, Giorgio (University of Campinas)

Session Classification: Polarization

Contribution ID: **11** Type: **Talk**

Relaxation terms for anomalous hydrodynamic transport in Weyl semimetals

Thursday, July 25, 2024 3:00 PM (30 minutes)

Weyl semimetals, a class of topological materials, exhibit a hydrodynamic regime and offer an ideal environment for investigating chiral anomalies through table-top experiments and transport measurements. In this presentation, I will consider a $(3+1)$-dimensional fluid with a $U(1)_V \times U(1)_A$ chiral anomaly as a model of Weyl semimetals. My focus will be on longitudinal thermoelectric magnetotransport, where I will search for relaxation models that meet fundamental and phenomenological constraints, including electric charge conservation, Onsager reciprocity, and finite DC conductivities. I will take into account all possible mixed energy, electric, and axial charge relaxations and show how models which respect these constraints unavoidably render the system open, thus violating the second law of thermodynamics. Furthermore, these relaxations lead to a novel prediction for the DC thermoelectric transport, opening the path to experimental verification. To conclude, I will discuss how mixed relaxations arise naturally from kinetic theory using a modified relaxation time approximation.

Primary author: MARTINOIA, Luca (University of Genova)

Co-authors: AMORETTI, Andrea (University of Genova); BRATTAN, Daniel K. (Ecole Polytechnique, CPHT); MATTHAIAKAKIS, Ioannis (University of Genova); RONGEN, Jonas (University of Genova)

Presenter: MARTINOIA, Luca (University of Genova)

Session Classification: Hydrodynamics

Contribution ID: **12** Type: **Talk**

Spacetime dynamics of chiral magnetic currents in a hot non-Abelian plasma

Tuesday, July 23, 2024 11:00 AM (30 minutes)

The correlations of electric currents in hot non-Abelian plasma are responsible for the experimental manifestations of the chiral magnetic effect in heavy-ion collisions. We evaluate these correlations using holography, and show that they are driven by large-scale topological fluctuations. In a non-Abelian plasma with chiral fermions, local axial charge can be generated either by topological fluctuations (creating domains with nonzero Chern-Simons number) or by thermal fluctuations. Within holography, we investigate the dynamical creation of the axial charge and isolate the imprint of the topological dynamics on the spatial correlations of electric current. In particular, we show that the spatial extent of the current correlation is quite large (~1 fm) and grows with time, which is consistent with sphaleronlike dynamics. We provide numerical estimates for this spatial size that can be used as an input in phenomenological analyses.

Primary authors: KHARZEEV, Dmitri E. (Stony Brook University); GRIENINGER, Sebastian (Stony Brook University)

Presenter: GRIENINGER, Sebastian (Stony Brook University)

Session Classification: Chiral Magnetic Effect

Contribution ID: **13** Type: **Talk**

Relativistic stochastic advection diffusion equation using Metropolis

Thursday, July 25, 2024 3:30 PM (30 minutes)

We present a method for simulating the stochastic relativistic advection-diffusion equation using the Metropolis algorithm. This approach simulates dissipative dynamics by randomly transferring charge between fluid cells, combined with ideal hydrodynamic time steps. Charge transfers are accepted or rejected based on entropy as a statistical weight in a Metropolis step. This reproduces expected dissipative strains in relativistic hydrodynamics within a specific hydrodynamic frame known as the density-frame. Numerical results, with and without noise, are compared to relativistic kinetics and analytical expectations. Notably, unlike other numerical approaches, this method is strictly first order in gradients and lacks non-hydrodynamic modes. The simplicity and convergence properties of the Metropolis algorithm make it promising for simulating stochastic relativistic fluids in heavy ion collisions and critical phenomena.

Primary authors: Prof. BASAR, Gokce (University of North Carolina); Mr BHAMBURE, Jay (Stony Brook University); Dr SINGH, Rajeev (West University of Timisoara); TEANEY, Derek (Stony Brook University)

Presenter: Dr SINGH, Rajeev (West University of Timisoara)

Session Classification: Hydrodynamics

Contribution ID: **15** Type: **Invited Talk**

Lattice study of rotating QCD properties (online)

Thursday, July 25, 2024 9:45 AM (45 minutes)

In this report the influence of relativistic rotation on QCD properties will be considered. I am going to review the results which were obtained within lattice simulation of QCD. It has become commonplace to perform such studies in the reference frame rotating with the system under investigation. In this case there appears the gravitational field and the problem is reduced to study of QCD in this external gravitational field. Within the report the following topics will be reviewed. The influence of relativistic rotation to the QCD critical temperatures. Equation of state of rotating QCD and the moment of inertia of quark-gluon plasma. Inhomogeneous phase transitions in rotating quark-gluon plasma.

Primary author: BRAGUTA, Victor (JINR)

Co-authors: ROENKO, Artem (JINR); SYCHEV, Dmitry (JINR); Dr KUDROV, Ilya (IHEP); Dr CHERNODUB, Maxim (CNRS, Université de Tours, France)

Presenter: BRAGUTA, Victor (JINR)

Session Classification: Plenary

Contribution ID: **16** Type: **Talk**

Charge transport in strongly magnetized relativistic matter

Thursday, July 25, 2024 4:30 PM (30 minutes)

Using the imaginary part of the self-energy function in the Landau-level representation, we derive the fermion damping rate in a hot magnetized plasma at the leading order of coupling. The results are used to investigate the longitudinal and transverse electrical conductivities. In the relativistic regime, these conductivities exhibit a scaling behavior expressed in terms of dimensionless functions of eB/T², where T represents the temperature and B the magnetic field. We demonstrate that the underlying mechanisms governing the transverse and longitudinal conductivities differ significantly, resulting in a substantial suppression of the former compared to the latter. We also extend our analysis to a magnetized quark-gluon plasma, although the approximation has limited validity at strong coupling.

Primary author: Prof. SHOVKOVY, Igor (Arizona State University)

Presenter: Prof. SHOVKOVY, Igor (Arizona State University)

Session Classification: Magnetic field and Rotation

Contribution ID: **17** Type: **On-line talk**

Mixed inhomogeneous phase in vortical gluon plasma from lattice simulation (online)

Wednesday, July 24, 2024 9:00 AM (30 minutes)

Using first-principle numerical simulations, we find a new spatially inhomogeneous phase in rigidly rotating gluon plasma. This mixed phase simultaneously possesses both confining and deconfining phases in thermal equilibrium. Unexpectedly, the local critical temperature of the phase transition at the rotation axis does not depend on the angular frequency within a few percent accuracy. An analytic continuation of our results to the domain of real angular frequencies indicates a profound breaking of the Tolman-Ehrenfest law in the vicinity of the phase transition, with the confining (deconfining) phase appearing far (near) the rotation axis.

Primary authors: BRAGUTA, Victor (JINR); Dr CHERNODUB, Maxim (CNRS, Université de Tours, France); ROENKO, Artem (JINR)

Presenter: ROENKO, Artem (JINR)

Session Classification: Phase diagram

Contribution ID: **18** Type: **On-line talk**

The effect of electric and chiral magnetic conductivities on azimuthally fluctuating electromagnetic fields and observables in isobar collisions (online)

Tuesday, July 23, 2024 11:30 AM (30 minutes)

We study the space-time evolution of electromagnetic fields along with the azimuthal fluctuations of these fields and their correlation with the initial matter geometry specified by the participant plane in the presence of finite electric (σ) and chiral magnetic (σ_χ) conductivities in Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV. We observe the partially asymmetric behavior of the spatial distributions of the electric and magnetic fields in a conducting medium when compared to the Lienard-Wiechert (L-W) solutions, and deceleration of the decay of the fields is observed in both isobar collisions. While studying the correlation between the magnetic field direction and the participant plane, we see the sizeable suppression of the correlation in the presence of finite conductivities when compared to the L-W case, reflecting the importance of taking into account the medium properties such as conductivities while calculating the magnetic field induced observable quantities.

Primary author: SIDDIQUE, Irfan (University of Chinese Academy of Sciences)

Presenter: SIDDIQUE, Irfan (University of Chinese Academy of Sciences)

Session Classification: Chiral Magnetic Effect

Contribution ID: **19** Type: **On-line talk**

Magnetic catalysis and diamagnetism from pion fluctuations (online)

Thursday, July 25, 2024 12:30 PM (30 minutes)

In the framework of Nambu–Jona-Lasinio model beyond mean field approximation, the effects of pion fluctuations on (inverse) magnetic catalysis and magnetic susceptibility are studied. The negative magnetic susceptibility at low temperature is observed when contributions from both neutral and charged pions are taken into account. In weak field approximation, it is observed that at finite temperature, the magnetic inhibition effect in the chiral limit, resulting from the difference between the transverse and longitudinal velocities of neutral pions, converts to weak magnetic catalysis when considering a non-zero current quark mass. Moreover, the magnetic catalysis is amplified by the charged pions.

Primary authors: Prof. MEI, Huang (中国科学院大学核科学与技术学院); MEI, Jie (中国科学院大学物理科学学院); Dr WEN, Rui (中国科学院大学核科学与技术学院); Prof. MAO, Shijun (西安交通大学)

Presenter: MEI, Jie (中国科学院大学物理科学学院)

Session Classification: Magnetic field and Rotation

Contribution ID: **23** Type: **Talk**

Chiral transport phenomena in core-collapse supernovae

Tuesday, July 23, 2024 2:30 PM (30 minutes)

The dynamics of relativistic leptons such as electrons and neutrinos play an important role in the evolution of core-collapse supernovae (CCSN). Nevertheless, chirality as one of the fundamental microscopic properties that could affect lepton transport through the weak interaction has been widely overlooked. In this talk, I will discuss how chiral effects such as the (effective) chiral magnetic effect (CME) for an electric charge current induced by magnetic fields could result in unstable modes of magnetic fields and inverse cascade, which may further influence the matter evolution in CCSN, pulsar kicks, and dynamical generation of strong magnetic fields in magnetars. I will also show how such an effective CME could be realized via the backreaction from non-equilibrium neutrino radiation even in the absence of chiral imbalance.

Primary author: YANG, Di-Lun (Institute of Physics, Academia Sinica)

Presenter: YANG, Di-Lun (Institute of Physics, Academia Sinica)

Session Classification: Chiral Magnetic Effect

Contribution ID: **24** Type: **On-line talk**

Pinched singularity and long time tail (online)

Friday, July 26, 2024 3:30 PM (30 minutes)

Hydrodynamic nonlinearity manifests itself as long time tail in the hydrodynamic correlation functions. This corresponds to the singularity of the correlation function in momentum space. We argue that the latter is actually a "pinched singularity" of the integrand in the integral associated with a bubble diagram. We then address how to find the pinched singularity by solving the "Landau Loop Equations" and thus find the long time tail. Finally, by using this approach we read the long time tails of the shear stress tensor correlation functions in two theories: relativistic hydrodynamics and (chiral) magnetohydrodynamics.

Primary author: ABBASI, Navid

Presenter: ABBASI, Navid

Session Classification: Hydrodynamics

Contribution ID: **25** Type: **Talk**

Effective Lagrangian for the macroscopic motion of fermionic matter

Thursday, July 25, 2024 11:30 AM (30 minutes)

We consider macroscopic motion of quantum field systems. The Zubarev statistical operator allows us to describe several types of motion of such systems in thermal equilibrium. We formulate the corresponding effective theory on the language of a functional integral. The effective Lagrangian is calculated explicitly for the fermionic systems interacting with dynamical gauge fields. Possible applications to physics of quark-gluon plasma are discussed.

Primary authors: SELCH, Maik (Ariel University, Israel); Prof. ZUBKOV, Mikhail (Ariel University, Israel); Dr ABRAMCHUK, Ruslan (Ariel University, Israel)

Presenter: SELCH, Maik (Ariel University, Israel)

Session Classification: Magnetic field and Rotation

Contribution ID: **26** Type: **On-line talk**

Chiral Kinetic Theory in Curved Space Revisited and Radiative Corrections (online)

Monday, July 22, 2024 4:30 PM (30 minutes)

It is usually believed that physics in off-equilibrium state can be equivalently studied using equilibrium state with suitable metric perturbation. We point out it is not the case for spin polarization phenomena: the exisiting chiral kinetic theory in curved space fails to recover all the couplings between spin and hydrodynamic gradients [1]. We present a new form of chiral kinetic theory in curved space, in which the equivalence is established [2]. The equivalence allows us to formulate spin polarization in hydrodynamic medium as a scattering problem, which is then studied using in-medium form factors [3,4]. We find radiative corrections to all couplings between spin and hydrodynamic gradients. Implications for local spin polarization of Lambda hyperon will be discussed.

[1] Y.-C. Liu, L.-L. Gao, K. Mameda and X.-G. Huang, Phys.Rev.D 99 (2019) 8, 085014
[2] J. Tian and S. Lin, to appear
[3] S. Lin and J. Tian, Acta Phys.Sin. 72 (2023) 7, 071201
[4] S. Lin and J. Tian, Eur.Phys.J.Plus 139 (2024) 2, 109

Primary author: LIN, Shu (Sun Yat-sen University)

Co-author: Mr TIAN, Jiayuan (Sun Yat-sen University)

Presenter: LIN, Shu (Sun Yat-sen University)

Session Classification: Magnetic field and Rotation

Contribution ID: **27** Type: **Talk**

Conductivities of CME, CSE and QHE as topological invariants

Tuesday, July 23, 2024 3:30 PM (30 minutes)

We recent results of our group on quantum Hall effect, Chiral Magnetic effect, and Chiral separation effect. Using Wigner - Weyl calculus the corresponding conductivities are calculated and represented in the form of topological invariants. Effects of interactions, inhomogeneity, and deviations from equilibrium are considered.

Primary author: Prof. ZUBKOV, Mikhail (Ariel University, Israel)

Presenter: Prof. ZUBKOV, Mikhail (Ariel University, Israel)

Session Classification: Chiral Magnetic Effect

Contribution ID: **28** Type: **On-line talk**

Chirality and a strong magnetic field give rise to novel hydrodynamic transport near and far from equilibrium (online)

Thursday, July 25, 2024 2:30 PM (30 minutes)

When chiral charged matter is exposed to extremely strong magnetic fields, novel hydrodynamic transport effects emerge 1. These novel effects need to be estimated and possibly taken into account, for example in the hydrodynamic codes used to analyze heavy-ion collision data or magnetars. Kubo formulae link the macroscopic transport coefficients to the microscopic retarded two-point correlation functions of conserved currents. Some among the transport effects cause no dissipation, i.e. they produce no entropy; one well known example is the chiral magnetic effect (CME). As a case study far away from equilibrium, the CME within holographic plasma suggests lessons for the quark-gluon-plasma at colliders 2.
References: Phys.Rev.C 105 (2022) 3, 034903; JHEP 04 (2021) 078

Primary author: KAMINSKI, Matthias (University of Alabama, U.S.A.)

Presenter: KAMINSKI, Matthias (University of Alabama, U.S.A.)

Session Classification: Hydrodynamics

Contribution ID: **29** Type: **Talk**

Chiral restoration driven spin polarization

Friday, July 26, 2024 11:00 AM (30 minutes)

Semiclassical expansion of the Wigner function for spin-1/2 fermions having an effective spacetime-dependent mass is used to analyze spin-polarization effects. The existing framework is reformulated to obtain a differential equation directly connecting the particle spin tensor with the effective mass. It reflects the conservation of the total angular momentum in a system. In general, we find that the gradients of mass act as a source of the spin polarization. Although this effect is absent for simple boost-invariant dynamics, an extension to non-boost-invariant systems displays a non-trivial dependence of the spin density on the mass indicating that the spin polarization effects may be intertwined with the phenomenon of chiral restoration.

Reference: *Physics Letters* **B 849** (2024) 138464 • e-Print: 2307.12436 [hep-ph]

Primary authors: Dr DAS, Arpan (Birla Institute of Technology and Science); Dr K.K., Gowthama (Indian Institute of Technology Gandhinagar); RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN, Kraków, Poland); Dr BHADURY, Samapan (Jagiellonian University); Prof. FLORKOWSKI, Wojciech (Jagiellonian University)

Presenter: RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN, Kraków, Poland)

Session Classification: Polarization

Contribution ID: **30** Type: **Talk**

Longitudinal spin polarization in a thermal model with dissipative effects

Friday, July 26, 2024 12:30 PM (30 minutes)

In this work, we address the problem of longitudinal spin polarization of the Λ hyperons produced in relativistic heavy-ion collisions. We combine a relativistic kinetic-theory framework that includes spin degrees of freedom treated in a classical way with the freeze-out parametrization used in previous investigations. The use of the kinetic theory allows us to incorporate dissipative corrections (due to the thermal shear and gradients of thermal vorticity) into the Pauli-Lubanski vector that determines spin polarization and can be directly compared with the experimental data. As in earlier similar studies, it turns out that a successful description of data can only be achieved with additional assumptions –in our case, they involve the use of projected thermal vorticity and a suitably adjusted time for spin relaxation (τ_s). From our analysis, we find that τ_s ~ 5 fm/c, which is comparable with other estimates.

Based on: arXiv 2405.05089 [hep-ph]

Primary authors: Dr JAISWAL, Amaresh (National Institute of Science Education and Research); RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN, Kraków, Poland); Mr BHADURY, Samapan (Jagiellonian University); Mr BANERJEE, Soham (National Institute of Science Education and Research); FLORKOWSKI, Wojciech (Jagiellonian University)

Presenter: Mr BHADURY, Samapan (Jagiellonian University)

Session Classification: Polarization

Contribution ID: **32** Type: **Talk**

3D Pion crystal from the chiral anomaly

Monday, July 22, 2024 2:30 PM (30 minutes)

Including the effects of the chiral anomaly within Chiral Perturbation Theory at finite baryon chemical potential, it has been shown that neutral pions form an inhomogeneous phase dubbed the "Chiral Soliton Lattice" (CSL) above a certain critical magnetic field. Above a second (higher) critical field, the CSL becomes unstable to fluctuations of charged pions, implying they condense. I will point out the similarity of this second critical field to the upper critical magnetic field in conventional type-II superconductors, suggesting that an inhomogeneous superconducting charged pion phase exists beyond this point. Applying similar methods originally used by Abrikosov, I will present results where we've constructed such a phase, and show the region where it is preferred in the baryon chemical potential-magnetic field phase diagram at zero temperature. This new phase has a non-zero baryon number density which is periodic in all three spatial dimensions.

Primary authors: EVANS, Geraint (Institute of Physics, Academia Sinica); SCHMITT, Andreas (University of Southampton)

Presenter: EVANS, Geraint (Institute of Physics, Academia Sinica)

Session Classification: Phase diagram

Contribution ID: **33** Type: **Talk**

QCD phase diagram in the $T - eB$ plane for pion masses beyond its physical value

Wednesday, July 24, 2024 10:00 AM (30 minutes)

It is interesting to observe the effect of the pion mass beyond its physical value on the QCD phase diagram in the $T - eB$ plane. The fate of the inverse magnetic catalysis (IMC) and the behaviour of $T_{\rm CO}$ beyond the physical point are of particular interest. Lattice QCD studies hint at a possible elimination of IMC effects with increasing pion mass. We aim to understand the entire problem from an analytical perspective using effective models. We find that effective models can align with lattice results and are capable of capturing the underlying mathematical structure of the theory.

Primary author: CHOWDHURY, Aminul Islam

Presenter: CHOWDHURY, Aminul Islam

Session Classification: Phase diagram

Contribution ID: **34** Type: **Talk**

Non-relativistic transport from frame-indifferent kinetic theory

Friday, July 26, 2024 2:30 PM (30 minutes)

I will present the application of Newton-Cartan geometry to the kinetic theory of gases in gravitational fields. Starting with an introduction to the basics of Newton-Cartan geometry, I will examine the motion of point particles within this framework, leading to a detailed analysis of kinetic theory and the derivation of conservation equations. The equilibrium distribution function will explored, culminating in a practical example involving a rotating gas in a gravitational field. Further, we will develop covariant hydrodynamics equations and extend our analysis through a gradient expansion approach to assess first-order constitutive relations. This allows us to derive the viscous transport for rotating gases in a consistent way. Finally, we will address the frame-dependence paradox, presenting a novel resolution that explains apparent discrepancies in the literature. Our construction resolves a fifty-year-old debate about the frame-indifferent formulation of kinetic theory.

Primary author: SURÓWKA, Piotr

Co-authors: Dr PEÑA-BENITEZ, Francisco; Mr MATUS, Paweł; Mr BISWAS, Rajesh

Presenter: SURÓWKA, Piotr

Session Classification: Hydrodynamics

Contribution ID: **36** Type: **On-line talk**

Effect of the QCD critical point on spin polarization of Λ hyperons (online)

Friday, July 26, 2024 12:00 PM (30 minutes)

We investigate the effects of the QCD critical point on spin polarization of Λ hyperons. For this we evaluate thermal vorticity and thermal shear by solving the equations of relativistic causal hydrodynamics in (3+1) dimensions. The effects of the critical point are incorporated through the equation of state and the scaling behaviour of the transport coefficients. For the same global polarization, we find a significant suppression in the rapidity profile of the component of polarization along the angular momentum direction due to the critical point. The study suggests that the change induced by the critical point in the rapidity dependence of the spin polarization of Λ hyperons can be used as an indicator of the critical point.

Reference:
1 Sushant K Singh & J Alam, Eur. Phys. J. C 83, 585 (2023).

Primary author: SINGH, Sushant Kumar

Presenter: SINGH, Sushant Kumar

Session Classification: Polarization

Contribution ID: **37** Type: **On-line talk**

Chiral symmetry breaking and restoration for an accelerated and rotated observer (online)

Wednesday, July 24, 2024 9:30 AM (30 minutes)

In the relativistic heavy ion collision experiment, there exist a large acceleration and rapid rotation in the non-central collision which can be considered as a system with acceleration and rotation. According to the Hawking-Unruh effect, the accelerated observer sees himself in a system with Unruh temperature $T/2\pi$. And the color glass condensate picture predicts that in heavy ion collision the particle under a strong color-electric field with strength $E \sim Q_s^2/g$ (Q_S is the saturation scale, and g is the strong coupling) which will provide a typical acceleration $a \sim Q_s \sim 1GeV$ such that the Unruh temperature $T \sim 200MeV$ which is large than the pseudo-critical temperature for QCD phase transition. It means that the Unruh effect may play an important role in QCD phase transition. The chiral symmetry breaking and restore for an accelerating observer have been discuss in the past study. As the QGP is the most vortical fluid, QCD matter under rotation has attracted many attentions. In this work we study the chiral symmetry for an observer under both acceleration and rotation.

We study the chiral condensate as observed by an accelerating and rotating observer using field theory in general spacetime. We develop the formalism to calculate the chiral condensate using the Nambu-Jona-Lasinio model in accelerating and rotating frame. We solve the gap equation and obtain the chiral condensate as a function of proper acceleration and angular velocity. We also defined a critical acceleration a_c where the chiral symmetry restore. As one of our main results, a_c as a function of rotation angular velocity ω was obtained. And we also study the constituent quark mass and neutral pion condensate in the case with the presence of $a \cdot \omega$. Like the case in parallel electromagnetic field, we observe a chiral rotation form the σ-direction toward the π-direction.

Primary author: ZHU, Zhibin (Fudan university)

Co-author: Prof. HUANG, Xu-Guang (Fudan university)

Presenter: ZHU, Zhibin (Fudan university)

Session Classification: Phase diagram

Contribution ID: **38** Type: **On-line talk**

Spin Alignment Induced by Curvature of Freezeout Hypersurface (online)

Monday, July 22, 2024 12:30 PM (30 minutes)

We derive a Cooper-Frye-type formula for the spin alignment of neutral vector mesons, such as ϕ mesons, at local thermal equilibrium. We describe the local equilibrium state with a grand canonical ensemble specified by temperature, fluid velocity, and spin potential. We develop a set of Feynman rules to evaluate the Wigner function order by order in space-time gradient.
We assume that the vector mesons freeze out on a space-like hypersurface in the Minkowski space-time that is close to a hyperplane. We find that the leading order of the spin alignment is proportional to the curvature of the hypersurface and the hydrodynamic fields at first-order space-time gradient, such as the thermal shear. It is a non-dissipative mechanism that induces the spin alignment proportional to the hydrodynamic fields with the first-order space-time gradient.

Primary author: ZHANG, Zhong-Hua (Fudan University)

Co-author: Prof. HUANG, Xu-Guang (Fudan University)

Presenter: ZHANG, Zhong-Hua (Fudan University)

Session Classification: Polarization

Contribution ID: **40** Type: **Talk**

Relativistic Quantum-statistical formulation of spin hydrodynamics

Tuesday, July 23, 2024 5:00 PM (30 minutes)

Motivated by the evidence of spin polarization of particles produced in relativistic heavy ion collisions, there is a growing interest in the so-called relativistic spin hydrodynamics. In this talk, we will present the outcomes of using a first-principle quantum-statistical method to derive the expression of the entropy current and entropy production rate in relativistic spin hydrodynamics. We'll discuss key findings in comparison to phenomenological spin hydrodynamics, along with its future potential.

Ref: [Phys.Lett.B 850 (2024) 138533]

Primary authors: DAHER, Asaad (IFJ PAN Krakow Poland); BECATTINI, Francesco (Università di Firenze); SHENG, Xin-Li (INFN Firenze)

Presenter: DAHER, Asaad (IFJ PAN Krakow Poland)

Session Classification: Hydrodynamics

Contribution ID: **41** Type: **On-line talk**

Negative magnetoresistence in Dirac Semimetals from Keldysh technique (online)

Tuesday, July 23, 2024 12:00 PM (30 minutes)

Negative magnetoresistance in topological semimetals is typically considered as a manifestation of chiral magnetic effect (CME). The relation between these two phenomena has the status of hypothesis and is based on the sequence of assumptions. In the present paper we rely on rigorous Keldysh technique of non-equilibrium theory. It allows us to investigate the accumulation of axial charge —the process that involves both chiral anomaly and relaxation followed by the energy dissipation.
We also calculate directly the contribution to electric conductivity due to the same two processes. We obtain the same dependence of conductivity on the angle between electric and magnetic field as the standard heuristic CME calculation. The dependence of conductivity on magnetic field in the limit of weak magnetic field also matches the CME calculation. However, comparison of axial charge density and electric conductivity does not confirm the CME hypothesis, and demonstrates that the true mechanism of magnetoresistance in Dirac semimetals is (partially or completely) different from the one based on the CME.

Primary author: ABRAMCHUK, Ruslan (Ariel University, Israel)

Co-author: ZUBKOV, Mikhail (Ariel University, Israel)

Presenter: ABRAMCHUK, Ruslan (Ariel University, Israel)

Session Classification: Chiral Magnetic Effect

Contribution ID: **42** Type: **Talk**

Spin alignment of vector mesons in holographic model

Wednesday, July 24, 2024 5:00 PM (30 minutes)

The global spin alignment for the ϕ meson has been recently observed by the STAR collaboration at RHIC, implying that the spin of its consituent quark has a significant correlation with the spin of the consituent antiquark, which may arise from their strong interaction with the quark-gluon plasma. We develop a general framework for studying the spin alignment ρ_{00} for flavorless vector mesons by using the gauge/gravity duality. Focusing on the dilepton production through vector meson decay, we derive the relation between production rates at each spin channel and meson's spectral function, which can be evaluated by holographic models for a strongly coupled system. As examples, we study ρ_{00} for J/ψ and ϕ mesons, induced by the relative motion to a thermal background, within the soft-wall model. We show that ρ_{00} in the helicity frame for J/ψ and ϕ mesons have positive and negative deviations from 1/3 at $T = 150$ MeV, respectively, which consequently leads to different properties for their global spin alignments.

Primary authors: SHENG, Xin-Li (INFN Firenze); BECATTINI, Francesco (Università di Firenze); Dr ZHAO, Yan-Qing (Central China Normal University); Prof. LI, Si-Wen (Dalian Maritime university); Prof. HOU, Defu (Central China Normal University)

Presenter: SHENG, Xin-Li (INFN Firenze)

Session Classification: Polarization

Contribution ID: **43** Type: **Talk**

Initial conditions and bulk viscosity effects on Λ polarization in high-energy heavy ion collisions

The Λ polarization is a crucial probe of the gradients of velocity and temperature in the quark-gluon plasma generated in heavy-ion collisions. However, it is still not systematically used to tune hydrodynamic models. In this talk, we investigate the influence of different initial conditions and parametrization of the bulk viscosity on Λ polarization, showing that they affect the local polarization significantly. These results highlight the impact that the use of local Lambda polarization can have on refining theoretical models. Finally, we compare our results, including feed-down corrections, with experimental data from high-energy heavy-ion collisions at STAR and ALICE, and demonstrate the crucial role of bulk viscosity in generating the correct sign of longitudinal polarization at LHC energies.

Primary authors: PALERMO, Andrea (Stony Brook University); Dr GROSSI, Eduardo (Università di Firenze); BECATTINI, Francesco (Università di Firenze); Dr KARPENKO, Iurii (Czech Technical University in Prague)

Presenter: PALERMO, Andrea (Stony Brook University)

Contribution ID: **44** Type: **On-line talk**

Hyperon polarization along the beam direction in pPb collision at CMS (online)

Wednesday, July 24, 2024 11:30 AM (30 minutes)

The observation of hyperon polarization along beam direction (P_z) in nucleus-nucleus collisions has opened a new way to study the complex vortical structures of the QGP. With the high-statistics data collected by the CMS experiment, we present the first P_z results for Λ and $\bar{\Lambda}$ particles in pPb collision at $\sqrt{s_{NN}} = 8.16$ TeV over a wide transverse momentum and multiplicity range. The measured P_z signal can shed light on the origin of collectivity in small collision systems as well as the mechanism of spin polarization in heavy ion collisions.

Primary authors: LI, Chenyan (Shandong University); CHEN, Zhenyu (Shandong University)

Presenter: LI, Chenyan (Shandong University)

Session Classification: Hyperons

Contribution ID: **45** Type: **On-line talk**

Electromagnetic field induction in quark-gluon plasma due to thermoelectric effects (online)

Thursday, July 25, 2024 12:00 PM (30 minutes)

Quark-gluon plasma (QGP) produced in relativistic heavy-ion collisions cools rapidly as the medium evolves. QGP with non-zero conserved charged current, higher thermal conductivity of medium advances in global thermalization. Being made of electrically charged partons, heat current leads to electromagnetic (EM) field induction in the medium, commonly known as the *thermoelectric effect*. Quantum modification of the classical non-relativistic phenomenon in relativistic matter –QGP, is fascinating to explore. In this work, for the first time, we have estimated the induced electric field due to the thermoelectric effects in a QGP. This phenomenon can induce an EM field even in QGP created in head-on collisions with non-vanishing chemical potential. We found that the induced electric field is zero at the center and increases moving away from the center. For baryon chemical potential of 0.3 GeV, the maximum induced field could be as high as $1\ m^2$.

Primary authors: DEY, Jayanta (IIT Indore); Mr SINGH, Kamaljeet (IIT Indore); Prof. SAHOO, Raghunath (IIT Indore)

Presenter: DEY, Jayanta (IIT Indore)

Session Classification: Magnetic field and Rotation

Contribution ID: **47** Type: **Talk**

Pryce's spin and polarization of massive Dirac fermions

Monday, July 22, 2024 12:00 PM (30 minutes)

A major difficulty in QFT comes from the fact that the traditional Pauli-Dirac spin operator of Dirac's theory is not a conserved observable. This inconvenience can be overdrawn taking the Pauli-Lubanski operator as covariant spin operator, even though this is not related directly to an $SU(2)$ symmetry. Another possibility is to focus on the new spin and position operators proposed initially by Pryce long time ago and re-defined recently with the help of a new spin symmetry and suitable spectral representations. [I. I. Cot\u aescu, Eur. Phys. J. C (2022) 82:1073]. In this framework the quantization gives rise to a large set of one-particle operators with physical meaning, including the spin and orbital parts of isometry generators. A special attention is paid to the new spin and polarization one-particle operators which are compared with other operators describing polarization used so far.

Primary author: COTAESCU, Ion (West University of Timisoara, Romania)

Presenter: COTAESCU, Ion (West University of Timisoara, Romania)

Session Classification: Polarization

Contribution ID: **48** Type: **Talk**

In- and out-of-equilibrium aspects of the Chiral Magnetic Effect from lattice QCD

Monday, July 22, 2024 6:10 PM (5 minutes)

In this work, we study the Chiral Magnetic Effect (CME) from lattice QCD simulations in two different scenarios, particularly focusing on the leading-order coefficient of the vector current in a chiral chemical potential expansion. In the first case, we consider a system in thermal equilibrium with a non-uniform magnetic background. We show that local chiral magnetic currents appear in this setup, following non-trivially the magnetic field profile. We check that these currents average zero in the full volume, confirming that the total CME conductivity vanishes in equilibrium. In the second case, we present the first steps towards studying the out-of-equilibrium aspects of CME on the lattice. We use Euclidean correlators, calculated in a uniform magnetic background, to investigate the out-of-equilibrium conductivity via spectral reconstruction methods.

Primary authors: Dr BRANDT, Bastian (Bielefeld University); Prof. ENDRODI, Gergely (Bielefeld University); GARNACHO-VELASCO, Eduardo (Bielefeld University); Dr MARKO, Gergely (Bielefeld University); VALOIS, Dean (Bielefeld University)

Presenter: GARNACHO-VELASCO, Eduardo (Bielefeld University)

Session Classification: Flash talk and posters

Contribution ID: **49** Type: **On-line talk**

Chiral Magnetic and Vortical Effect in the Chiral Kinetic Approach using AMPT model (online)

Tuesday, July 23, 2024 3:00 PM (30 minutes)

Built upon the state-of-the-art model a multiphase transport (AMPT), we develop a new module of chiral anomaly transport (CAT) to trace the evolution of the initial topological charge of gauge field created through sphaleron transition at finite temperature and external magnetic field in heavy ion collisions. The eventual experimental signals of chiral magnetic effect(CME) has been measured. The CAT explicitly shows the generation and evolution of the charge separation, and the signals of CME through the CAT are quantitatively in agreement with the experimental measurements in Au+Au collision and isobar collision at $\sqrt{s} = 200\mathrm{GeV}$, and the centrality dependence of the CME fraction .

Primary author: YUAN, Zilin (中国科学院大学核科学与技术学院)

Presenter: YUAN, Zilin (中国科学院大学核科学与技术学院)

Session Classification: Chiral Magnetic Effect

Contribution ID: **50** Type: **On-line talk**

Higher order terms in fermion spin polarization (online)

Wednesday, July 24, 2024 4:30 PM (30 minutes)

In this talk I will present a derivation of second order terms of the spin polarization of fermions at local thermodynamic equilibrium including second order derivatives and quadratic terms in thermal vorticity and shear. While quadratic terms are expected to provide a small correction to the predicted polarization, the importance of second order derivatives can be verified only through numerical simulations.

Primary authors: BECATTINI, Francesco (Università di Firenze); SHENG, Xin-Li (INFN Firenze); HUANG, Xu-Guang (Fudan university); ZHANG, Zhong-Hua (Fudan University)

Presenter: BECATTINI, Francesco (Università di Firenze)

Session Classification: Polarization

Contribution ID: **52** Type: **On-line talk**

Global Hypertriton Polarization in Au+Au collisions at $\sqrt{s_{NN}} = 7.7 - 200$ GeV (online)

Wednesday, July 24, 2024 12:00 PM (30 minutes)

Particles of non-zero spin produced in non-central heavy-ion collisions are expected to be polarized along the direction perpendicular to the reaction plane due to spin-orbit coupling in the produced matter, and this has indeed been observed for many hyperons and vector mesons. Here, we show that the hypertriton ($^3_\Lambda$H), which is the lightest hypernucleus, is also polarized in these collisions. Using the coalescence model based on the kinetic freezeout baryons for light (hyper-)nuclei production, we find that the angular distribution of the decay product of polarized $^3_\Lambda$H is highly sensitive to the spin configuration of its wavefunction, providing a novel way to determine its spin structure. We also predict the beam energy dependence of $^3_\Lambda$H polarizations in heavy-ion collisions from a few to hundreds GeV based on a multi-phase transport model (AMPT) and coalescence model. We further discuss the comparation of the global polarization between hypertriton and hyperon with the energy dependence. These patterns of the global $^3_\Lambda$H polarization are expected to be tested in future experiments.

Primary author: LIU, Dai-Neng

Presenter: LIU, Dai-Neng

Session Classification: Hyperons

Contribution ID: **53** Type: **On-line talk**

Anomalous Hall instability in chiral magnetohydrodynamics (online)

Friday, July 26, 2024 3:00 PM (30 minutes)

The quark gluon plasma(QGP) is expected to exhibit a chiral imbalance known as the chiral anomaly which induces various anomalous currents, such as: the chiral magnetic effect(CME), the chiral vortical effect(CVE), the anomalous Hall effect(AHE) and so on. To describe these anomalous effects, one can use the chiral magnetohydrodynamics (CMHD).

We study the collective excitations and instabilities in a CMHD and focus on the anomalous Hall instability(AHI) which is due to the AHE in this talk.

Like the CME's instability, the AHI is dependent on the value of **k** and appears in a limited scope which is decided by the AHE coefficient ξ_H. Notably, the AHE does not trigger an instability by itself in a pure electrodynamic context without fluid, but it does in the CMHD. For small |**k**| expansion, we show that the Alfven wave modified by the AHE leads to an unstable solution. In particular, one can introduce an axion
field $\theta(x)$ which interacts with the electromagnetic field in the form of $\theta E \cdot B$, to reproduce the AHE $\nabla\theta \times E$, the chiral chemical potential $\mu_5(x) \equiv \partial_t\theta$, where E, B are electric and magnetic fields, the AHE coefficient is $\xi_H \equiv \nabla\theta$. Because the AHI happens in a small scope and the total helicity is conserved, these give rise to a novel type of inverse cascade: the fermionic helicity will be transferred to various helicities of the small |**k**| modes. Then the AHI ceases eventually by depleting the value of μ_5, ξ_H.

Finally, we briefly discuss three different instabilities such as: the chiral plasma instability(CPI), the chiral magnetovortical instability(CMVI), the AHI and the possible relevance in QGP and other physical systems.

Primary author: WANG, Shuai

Co-author: HUANG, Xu-Guang (Fudan university)

Presenter: WANG, Shuai

Session Classification: Hydrodynamics

Contribution ID: **54** Type: **Talk**

Dynamical generation of canonical spin potential in hot QCD

Tuesday, July 23, 2024 5:30 PM (30 minutes)

Spin hydrodynamics relies on the non-unique definition of the spin tensor, representing the distribution of spin degrees of freedom, but different spin tensors lead to different physical results. In general, this pseudogauge symmetry represents a significant theoretical ambiguity in relativistic out-of-equilibrium statistical mechanics. This ambiguity may be resolved by fundamental quantum field theory. In this talk, we prove the equivalence between the finite-temperature NJL model and the covariant statistical operator of a free Dirac field with a spin potential coupled to the canonical spin tensor. The spin potential is induced by a mean axial vector field, expected to be generated in heavy-ion collisions through the chiral separation and axial vortical effects. Our description favors the canonical pseudogauge.

Primary authors: PALERMO, Andrea (Stony Brook University); BUZZEGOLI, Matteo (West University of Timisoara)

Presenter: BUZZEGOLI, Matteo (West University of Timisoara)

Session Classification: Hydrodynamics

Contribution ID: **55** Type: **Flash Talk (Plenary) + Poster**

Dirac Eigenvalue Distributions and the Chiral Magnetic Effect

Monday, July 22, 2024 6:20 PM (5 minutes)

We investigated the Dirac eigenvalue distributions at finite chiral chemical potential and strong magnetic field. We found that the eigenvalue distributions exhibit what is called the skin effect in condensed matter physics which is typical behavior when a topological transport is expected.

We also analyzed different distribution patterns by multiplying some matrices to the Dirac operator. The eigenvalues are placed not randomly but along lines only when the operator product corresponds to the physical observable relevant to the topological transport.

We also discuss possible applications of topological data analysis (TDA) to judge whether the topological current emerges.

Primary authors: SHIOZAKI, Ken; Prof. FUKUSHIMA, Kenji (The University of Tokyo); FUNAI, Shotaro; KAMATA, Syo; MISUMI, Tatsuhiro; HIRONO, Yuji

Presenter: Prof. FUKUSHIMA, Kenji (The University of Tokyo)

Session Classification: Flash talk and posters

Contribution ID: **56** Type: **On-line talk**

Measuring the Global Spin Alignment of ⊠ meson in Heavy Ion Collisions by STAR (online)

In non-central heavy-ion collisions, a large orbital angular momentum is produced. A part of the orbital angular momentum can polarize the quarks and anti-quarks, hence the vector mesons, inside the medium. Recently, STAR measured the global spin alignment of $\phi(1020)$ and K^* (892) mesons in Au+Au collisions from the RHIC Beam Energy Scan I (BES I) program 1. The global spin alignment, quantified by the 00th coefficient of the spin density matrix, $\rho 00$, is measured by a fit to the acceptance and efficiency corrected ϕ meson yield versus polar angle (θ^*) between the daughter kaon in the parent's rest frame and the orbital angular momentum direction. In this talk, we present an alternative approach to extract $\rho 00$ by utilizing the $\langle \cos 2\theta^* \rangle$ as a function of pair-invariant mass instead of analyzing the ϕ meson yields in $\cos \theta^*$ bins. We use a data-driven method to correct for acceptance and efficiency. We report new analysis from this method.

1 M. Abdallah et al. (STAR Collaboration), Nature 614, 244–248 (2022).

Primary author: ROBERTSON, CW (Purdue University)

Presenter: ROBERTSON, CW (Purdue University)

Session Classification: Polarization

Contribution ID: **57** Type: **Talk**

Latest updates on ideal-spin hydrodynamics

Tuesday, July 23, 2024 4:30 PM (30 minutes)

Spin hydrodynamics can be developed from a systematic expansion in the reduced plank constant. Up to the first order in this expansion, there is no back-reaction from the spin to fluid dynamics, and, therefore, solutions to the standard hydrodynamics act as an input for the equations of motion for the spin tensor. Furthermore, one can assume a so-called ideal-spin approximation where the entropy production from the spin degrees of freedom is second-order in the reduced plank constant and the conservation of angular momentum is a closed system of equations. In this talk, I present developments in ideal-spin hydrodynamics including the linear regime, the covariance of spin dynamics, and the spin dynamics on top of Bjorken attractors.

Primary author: SHOKRI, Masoud (Goethe University)

Co-authors: WAGNER, David; RISCHKE, Dirk (Goethe-University Frankfurt)

Presenter: SHOKRI, Masoud (Goethe University)

Session Classification: Hydrodynamics

Contribution ID: **58** Type: **Talk**

Gauge invariance and thermodynamic stability of rotating magnetized systems

Thursday, July 25, 2024 11:00 AM (30 minutes)

In this presentation, I revisit the Dirac theory under an external magnetic field and rotation. Motivated by experimental observations of significant vorticities in heavy ion collisions, there has been active exploration into the thermodynamics of rotating QCD matter. While the pure rotational effect has received attention, the interplay between rotation and magnetic fields remains insufficiently elucidated. In this talk, I address two significant issues present in previous formulations of rotating magnetized systems: gauge invariance and thermodynamic stability. I demonstrate that resolving both issues necessitates considering the kinetic angular momentum coupled with angular momentum. The reformulated Dirac theory presented here reproduces a well-known charged density first discovered by Hattori and Yin. Moreover, it indicates that higher-order contributions of angular velocity do not affect the charge density, providing evidence of its anomalous nature. Lastly, I offer insights into the rotational response of QCD vacuum from the perspective of the Savvidy vacuum.

Primary author: MAMEDA, Kazuya (Tokyo University of Science)

Presenter: MAMEDA, Kazuya (Tokyo University of Science)

Session Classification: Magnetic field and Rotation

Contribution ID: **59** Type: **On-line talk**

Measurement of global and local spin polarization of Λ and $\bar{\Lambda}$ in Au+Au collisions from the RHIC Beam Energy Scan-II (online)

Wednesday, July 24, 2024 11:00 AM (30 minutes)

Significant global hyperon polarization has been observed in non-central heavy ion collisions, providing evidence of the vorticity of the quark-gluon plasma (QGP). This effect can serve as a new probe for exploring the fluid properties of strongly interacting matter. A difference between the global polarization of $\bar{\Lambda}$ and Λ could originate from the strong late-stage magnetic field in heavy ion collisions. In addition, local vorticity in the transverse plane, related to collective flow and density fluctuations, can lead to polarization along the beam direction, known as local polarization. A baryonic spin Hall effect is also predicted, with local polarization difference of Λ and $\bar{\Lambda}$ induced by the gradient of the baryonic chemical potential.

In this talk, we will present new results of Λ and $\bar{\Lambda}$ global polarization in Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7, 9.2, 11.5, 14.6 and 17.3 GeV from RHIC BES-II with upgraded STAR detector systems. We also present results of local polarization for Λ and $\bar{\Lambda}$ in Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7 - 27 GeV from BES-II. Our measurements can provide important insights into the late-stage magnetic field sustained by the QGP and the spin Hall currents possibly created in a highly dense baryonic environment.

Primary author: FU, Tong

Presenter: FU, Tong

Session Classification: Hyperons

Contribution ID: **60** Type: **Talk**

Search for the Chiral Magnetic Effect by Event Shape Engineering Differentially in Invariant Mass in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV from STAR

Thursday, July 25, 2024 5:30 PM (30 minutes)

Chiral Magnetic Effect (CME) is a phenomenon in which electric charge is separated by a strong magnetic field from local domains of chirality imbalance and parity violation in quantum chromodynamics (QCD). The CME-sensitive observable, charge-dependent three-particle azimuthal correlator $\Delta\gamma$, is contaminated by a major physics background proportional to the particle elliptic anisotropy (v_2). In this talk, we report a new analysis from STAR on charge separation using the Event Shape Engineering (ESE) approach 1, projecting $\Delta\gamma$ to zero v_2 to obtain the intercept $\Delta\gamma_{ESE}$ in which flow-driven background is largely suppressed. Our approach has several novel aspects: (1) we use three subevents to select dynamical fluctuations of v_2 by separating particles of interest from ESE selection; (2) we apply the ESE method differentially as a function of the pair invariant mass of particles of interest since CME is a low-p_T phenomenon and hence more sensitive to lower mass; (3) we investigate remaining nonflow contamination in the extracted intercept 2. We report preliminary results in Au+Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV from STAR using the event plane reconstructed with the time projection chamber (TPC) and the spectator plane reconstructed with the zero-degree calorimeter (ZDC). We compare our results to Anomalous-Viscous Fluid Dynamics (AVFD) model simulations [3].

Primary author: Mr LI, Han-Sheng (Purdue University)

Presenter: Mr LI, Han-Sheng (Purdue University)

Session Classification: Magnetic field and Rotation

Contribution ID: **61** Type: **Talk**

Chiral Symmetry Breaking and Spin-One Condensates in Rotating Quark-Meson Systems (online)

Wednesday, July 24, 2024 5:30 PM (30 minutes)

We explore chiral symmetry breaking in a rotating system within a quark-meson model of interacting massless quarks, incorporating tensor channels. Our findings reveal that new interaction channels emerge due to the explicit breaking of rotational symmetry due to non-zero rotation. We demonstrate that chiral symmetry breaking leads to the generation of two independent condensates: the conventional chiral condensate and a spin-one condensate. The chiral condensate results in a dynamical fermion mass, while the spin-one condensate is associated with the spin chemical potential. The quark-antiquark pairs with opposite spins possess a resultant spin moment, which can align with the net angular momentum, giving rise to a net spin moment for the ground state.

Primary authors: DASH, Ashutosh (Goethe Univeristy, Frankfurt); Mr KIEFER, Lutz (Goethe University, Frankfurt)

Presenter: DASH, Ashutosh (Goethe Univeristy, Frankfurt)

Session Classification: Polarization

Contribution ID: **62** Type: **Talk**

The weak magnetic effect on the direct photon production and hyperon local spin polarization

Tuesday, July 23, 2024 12:30 PM (30 minutes)

It is expected that there exists an ultra-central strong magnetic field during the early stages of heavy-ion collisions. However, due to the rapid decay, it is a weak magnetic field that along with the evolution of quark-gluon plasma (QGP)

In this work, we study the dissipative correction induced by a weak magnetic field during the QGP stage. Employing the viscous hydrodynamics simulation, we calculate two associated probes with weak magnetic dissipation, i.e., the direct photon elliptic flow and the hyperon local spin polarization.

We find that the magnetic field can lead to a large enhancement of the photon momentum anisotropy when coupled with the longitudinal dynamics of the background medium. With a finite magnetic field, the experimental measured direct photon v_2 can be well reproduced but with less than a 10% increment on the photon yield. On the other hand, we find that the weak magnetic correction on the quark phase distribution has a significant contribution to the local spin polarization and even flips the sign. The spin cooper frye formula with the weak magnetic correction is obtained. After incorporating this novel effect, one can reproduce the second and third modulation of local spin polarization along the beam direction, not only the sign but also the centrality dependence. Finally, the required magnetic field for these two observables is about 0.1 m_π^2.

arxiv:2302.07696
Phys.Rev.C 109 (2024) 3, 034917
arxiv:2401.07458

Primary authors: SUN, Jing-An (Mcgill and Fudan University); Prof. YAN, Li (Fudan University)

Presenter: SUN, Jing-An (Mcgill and Fudan University)

Session Classification: Chiral Magnetic Effect

Contribution ID: **63** Type: **Flash Talk (Plenary) + Poster**

Ideal-spin hydrodynamics on top of a rotating background

Monday, July 22, 2024 5:40 PM (5 minutes)

After formulating the angular momentum conservation in a covariant form, we consider the equations of spin hydrodynamics in the background of an uncharged fluid in global equilibrium with a non-vanishing thermal vorticity.
Assuming that the spin degrees of freedom are not in equilibrium, we derive relaxation-type equations for the components of the spin potential.
These equations generalize the existing literature on the spin waves which were derived on top of a fluid in a hydrostatic state, where the thermal vorticity is zero.
Our purpose is to understand the dynamics of relaxation of the spin potential to the thermal vorticity in a simple setup and also pave the way for realistic numerical simulations.

Primary authors: SHOKRI, Masoud (Goethe University); CHIARINI, Annamaria (Goethe University)

Presenter: CHIARINI, Annamaria (Goethe University)

Session Classification: Flash talk and posters

Contribution ID: **65** Type: **Talk**

Vortical waves in a fluid with massless fermions

Monday, July 22, 2024 11:30 AM (30 minutes)

The anomalous axial symmetry of the Lagrangian for massless fermions is known to be ultimately responsible for a variety of macroscopic transport phenomena in rotating states, e.g. the chiral vortical effect (CVE) and chiral vortical separation effect (CVSE). Their coherent interplay gives rise to the chiral vortical wave. Traditionally, only the axial and vector degrees of freedom are included in the hydrodynamic analysis. In this talk, we generalise the previous approaches to include another conserved charge for massless free fermions, helicity, and obtain the spectrum of collective excitations. We explicitly introduce the dissipative effects and non-conservation of charges that arise due to interactions. Finally, we discuss the possible phenomenological impact for the quark-gluon plasma nucleated in heavy-ion collisions.

Primary author: MORALES TEJERA, Sergio (West university of Timisoara)

Co-authors: Dr CHERNODUB, Maxim (CNRS, Université de Tours, France); AMBRUȘ, Victor E. (West University of Timișoara)

Presenter: MORALES TEJERA, Sergio (West university of Timisoara)

Session Classification: Polarization

Contribution ID: **66** Type: **Talk**

Inhibition of splitting of confining and chiral transition by rotation.

Monday, July 22, 2024 3:00 PM (30 minutes)

We will discuss the effect of rotation on the confining and chiral properties of QCD using the linear sigma model coupled to the Polyakov loop. Enforcing the causality constraint by the spectral boundary conditions we obtain the phase diagram at finite temperature, baryon density, and angular frequency. At nonrotating limit we observe a splitting between the chiral and confining transitions that decreases with increasing radius. In the presence of finite rotation this splitting decreases with increasing angular velocity for experimentally relevant, slow angular velocities. However, we observe a increment in the splitting when the boundary of the system rotates at near-to-light velocities.

Primary author: SINGHA, pracheta (West University of Timisoara)

Co-authors: Dr CHERNODUB, Maxim (CNRS, Université de Tours, France); AMBRUȘ, Victor E. (West University of Timișoara)

Presenter: SINGHA, pracheta (West University of Timisoara)

Session Classification: Phase diagram

Contribution ID: **67** Type: **On-line talk**

Influence of magnetic field-induced anisotropic gluon pressure during pre-equilibrium (online)

Thursday, July 25, 2024 5:00 PM (30 minutes)

Magnetic fields of a large intensity can be generated in peripheral high-energy heavy-ion collisions. Although the intensity drops down fast and, moreover, it is not clear whether the fields last long enough to induce a magnetization during the quark-gluon plasma phase, most of the models and simulations predict a significant intensity that lasts up to proper times of order 1 fm after the beginning of the reaction, which is a typical time for the hydrodynamical phase to start. This interval of time is referred to as the pre-equilibrium stage. One can expect that the evolution of the reaction during pre-equilibrium is likely to be influenced by these fields. In this work we adopt a strong field approximation to study the effects of the magnetic field-induced anisotropy in the gluon pressure. We include this anisotropy within the description obtained by means of effective kinetic theory and explore the consequences to reach isotropization at proper times of order 1 fm.

Primary author: MIZHER, Ana (IFT-UNESP)

Co-author: AYALA, Alejandro (UNAM)

Presenter: MIZHER, Ana (IFT-UNESP)

Session Classification: Magnetic field and Rotation

Contribution ID: **68** Type: **Invited Talk**

CME-2024 (online)

Wednesday, July 24, 2024 3:15 PM (45 minutes)

A review talk on some of the new developments on the Chiral Magnetic Effect.

Primary author: KHARZEEV, Dmitri (Stony Brook University and BNL)

Presenter: KHARZEEV, Dmitri (Stony Brook University and BNL)

Session Classification: Plenary

Contribution ID: **69** Type: **Invited Talk**

Polarization in relativistic nuclear collisions: Experiment

Monday, July 22, 2024 9:00 AM (45 minutes)

Review of the experimental status of the polarization measurements in heavy ion collisions is presented.

Primary author: Prof. VOLOSHIN, Sergei (Wayne State University)

Presenter: Prof. VOLOSHIN, Sergei (Wayne State University)

Session Classification: Plenary

Contribution ID: **70** Type: **Invited Talk**

Theoretical review on spin polarization

Monday, July 22, 2024 9:45 AM (45 minutes)

In this review talk, I discuss recent advancements in the theoretical understanding of polarization phenomena in heavy ion collisions. I will focus on recent theoretical developments concerning vector polarization and spin alignment, including their numerical study and comparison with experiments. I will highlight the successes and the open questions in the current models, offering insights into future research directions.

Primary author: PALERMO, Andrea (Stony Brook University)

Presenter: PALERMO, Andrea (Stony Brook University)

Session Classification: Plenary

Contribution ID: **71** Type: **Invited Talk**

Searches for Chiral Magnetic and Chiral Vortical Effects with ALICE

Tuesday, July 23, 2024 9:00 AM (45 minutes)

The interplay between the chiral anomaly and the magnetic/vortical field created in heavy-ion collisions can give rise to anomalous chiral effects. In this talk, the latest results of the Chiral Magnetic Effect, Chiral Magnetic Wave, and Chiral Vortical Effect are reported in Pb–Pb and Xe–Xe collisions recorded by the ALICE detector.

Primary author: DOBRIN, Alexandru Florin (Institute of Space Science - INFLPR Subsidiary)

Presenter: DOBRIN, Alexandru Florin (Institute of Space Science - INFLPR Subsidiary)

Session Classification: Plenary

Contribution ID: **72** Type: **Invited Talk**

A Novel Approach to Search for CME from STAR and the Future Prospect

Tuesday, July 23, 2024 9:45 AM (45 minutes)

In this talk I will present the recent results of CME searches from the STAR collaboration using a novel event shape selection method and give a personal prospect on the future of the CME experimental searches. In high-energy heavy-ion collisions, the chiral magnetic effect (CME) may arise from the interplay between domains of chirality imbalanced quarks in the quark-gluon plasma and the strong magnetic field ($\vec{B}$) generated by spectator protons. The CME is predicted to induce an electric charge separation along the $\vec{B}$ direction, manifestly violating local
$calP$ and
$calCP$ symmetries. We use the $\Delta\gamma^{112}$ correlator based on pairs of same- and opposite-sign charged hadrons to detect such a charge separation along the $\vec{B}$ direction. To remove the background induced by elliptic flow (v_2), we use a novel event shape selection (ESS) approach that classifies events based on their shapes which allows us to determine $\Delta\gamma^{112}_{\rm ESS}$ at the zero-v_2 limit. Furthermore, we use the spectator information to reconstruct the $\vec{B}$ direction, thereby minimizing nonflow backgrounds. We report the measurements of $\Delta\gamma^{112}$ and a background indicator $\Delta\gamma^{132}$ in Au+Au collisions from the RHIC Beam Energy Scan phase II and at the top RHIC energy. After background suppression, $\Delta\gamma^{132}_{\rm ESS}$ is consistent with zero, and $\Delta\gamma^{112}_{\rm ESS}$ is reduced from inclusive $\Delta\gamma^{112}$ by more than five-fold. The measured $\Delta\gamma^{112}_{\rm ESS}$ value in the 20\%–50\% centrality range is finite with an over 3σ significance at each of center-of-mass energies 11.5, 14.6, and 19.6 GeV, whereas the corresponding values at other beam energies are consistent with zero within uncertainties. The STAR results present intriguing scenarios for the RHIC BES regime and more theoretical insights are needed. I will comment on future prospect related to experimental CME searches.

Primary author: HUANG, Huan (UCLA)

Presenter: HUANG, Huan (UCLA)

Session Classification: Plenary

Contribution ID: **74** Type: **Invited Talk**

The Chiral Magnetic Effect and Chiral Separation Effect from the lattice QCD perspective

Thursday, July 25, 2024 9:00 AM (45 minutes)

In this talk, I will review how the conductivities of anomalous transport phenomena can be extracted using lattice QCD, in particular focusing on the Chiral Separation Effect (CSE) and Chiral Magnetic Effect (CME). For the CSE, I will explain how the sign problem has been circumvented to study this effect in different setups, leading to the determination of its conductivity in QCD with physical quark masses. In the case of CME, I will emphasize the role of regularization for its equilibrium formulation, as well as the importance of using conserved vector currents on the lattice to study this effect. Finally, I will discuss what are the next steps being taken in the lattice community to shed light on how CME manifests in physical systems.

Primary author: GARNACHO-VELASCO, Eduardo (Bielefeld University)

Presenter: GARNACHO-VELASCO, Eduardo (Bielefeld University)

Session Classification: Plenary

Contribution ID: **75** Type: **Invited Talk**

Phase diagram under rotation and magnetic field

Wednesday, July 24, 2024 2:30 PM (45 minutes)

I will review the recent discussions on the phase diagram under rotation and magnetic field. The interpretation of rotation effects on the QCD phase transition is still controversial, and the coexisting of rotation and magnetic field makes the physical system even more confusing. The talk will go through results from lattice results, model calculations, perturbative QCD, as well as the latest surprise from general analysis.

Primary author: Prof. FUKUSHIMA, Kenji (The University of Tokyo)

Presenter: Prof. FUKUSHIMA, Kenji (The University of Tokyo)

Session Classification: Plenary

Contribution ID: **76** Type: **Invited Talk**

Transport properties from quantum kinetic theory

Friday, July 26, 2024 9:45 AM (45 minutes)

Quantum kinetic theory, arising as a semiclassical limit of quantum field theory, is an effective microscopic description applicable to a wide variety of systems.
I present an introduction to the topic and discuss important developments, such as the application of quantum kinetic theory to systems of particles with nonvanishing spin, leading to intriguing transport phenomena relevant to the study of the Quark-Gluon Plasma (QGP).
In particular, emphasis is put on the connection of a quantum-kinetic approach to polarization-related phenomena in heavy-ion collisions.

Primary author: WAGNER, David

Presenter: WAGNER, David

Session Classification: Plenary

Contribution ID: **78** Type: **On-line talk**

Quark spin correlations in relativistic heavy ion collisions (online)

Monday, July 22, 2024 3:30 PM (30 minutes)

The observation of the vector meson's global spin alignment by the STAR Collaboration reveals that strong spin correlations may exist for quarks and antiquarks in relativistic heavy-ion collisions in the normal direction of the reaction plane. We propose a systematic method to describe such correlations in the quark matter. The correlations can be classified as local and long range types. We show in particular that the effective quark spin correlations contain the genuine spin correlations originated directly from the dynamical process as well as those induced by averaging over other degrees of freedom. We also show that such correlations can be studied by measuring the vector meson's spin density matrix and hyperon-hyperon and hyperon-anti-hyperon spin correlations. We present the relationships between these measurable quantities and spin correlations of quarks and antiquarks.

Primary author: WANG, Qun (University of Science and Technology of China)

Co-author: Prof. WANG, Xin-Nian (Lawrence Berkeley Lab)

Presenter: WANG, Qun (University of Science and Technology of China)

Session Classification: Phase diagram

Contribution ID: **79** Type: **Talk**

Lambda-(anti)Lambda Spin Correlation in Heavy-Ion Collisions

Wednesday, July 24, 2024 12:30 PM (30 minutes)

Recent experimental data indicate a strong phi vector meson spin alignment which can be explained as a result of a short distance correlation of fluctuating strong-force field. If such strong-force for strange quark exists in the late stage of heavy-ion collisions, it will also lead to spin-spin correlation of final state hyperons such as Lambda-(anti)Lambda. We calculate such spin-spin correlation within the CLVisc hydrodynamics with the strength of the fluctuating strong-field given by the phi meson spin alignment. The correlation is found to be 100 times stronger than that due to spin polarization by local vorticity.

Primary author: WANG, Xin-Nian (Central China Normal University)

Co-authors: Dr WU, Xiangyu (McGill University); Dr SHENG, Xin-Li (INFN, Florence)

Presenter: WANG, Xin-Nian (Central China Normal University)

Session Classification: Hyperons

Contribution ID: **80** Type: **On-line talk**

Baryon Stopping and Initial Angular Momentum in Heavy Ion Collisions (online)

Monday, July 22, 2024 5:00 PM (30 minutes)

Non-central heavy-ion collisions contain large orbital angular momentum ($\sim 10^{3\sim6}\hbar$) that, at high energies, is expected to induce strong vorticity in the hot bulk fluid and generate global spin polarization of produced particles. As the collision energy $\sqrt{s}$ approaches threshold, the observed global spin polarization should reach a maximum, then drop to zero as increased stopping competes with decreased initial momentum. Recent experimental measurements, however, appear to show a continual rise of hyperon polarization even down to $\sqrt{s} = 2.42$ GeV, suggesting a peak very near threshold and hard to interpret theoretically. Here, we develop a simple Glauber-based initial state model to investigate the initial distribution of angular momentum with respect to rapidity, and the dependence of this distribution on initial baryon stopping across a wide range of collisional beam energy. We estimate that the angular momentum per produced final particle at mid-rapidity peaks around 5 GeV, which presents a potential challenge to an interpretation of the spin polarization measurements near threshold as a consequence due to the initial angular momentum of the colliding system.

Primary author: Prof. LIAO, Jinfeng (Indiana University)

Presenter: Prof. LIAO, Jinfeng (Indiana University)

Session Classification: Magnetic field and Rotation

Contribution ID: **81** Type: **Flash Talk (Plenary) + Poster**

Helicity conservation for process of fermion production in Coulomb field on de Sitter universe

Monday, July 22, 2024 6:15 PM (5 minutes)

Fermion production in an external Coulomb field on de Sitter expanding universe is studied. The amplitude and probability of pair production in an external Coulomb field are computed and the cases of large/small values of the expansion factor comparatively with the particle mass are studied. We obtain from our calculations that the modulus of the momentum is no longer a conserved quantity. We find that in the de Sitter space there are probabilities for production processes where the helicity is no longer conserved.

Primary author: CRUCEAN, Cosmin (West University of Timisoara)

Presenter: CRUCEAN, Cosmin (West University of Timisoara)

Session Classification: Flash talk and posters

Contribution ID: **82** Type: **Flash Talk (Plenary) + Poster**

Shear viscosity of rotating, hot, and dense spin-half fermionic systems using Kubo formalism

Monday, July 22, 2024 5:30 PM (5 minutes)

In this study, we calculate the shear viscosity for rotating fermions with spin-half under conditions of high temperature and density. We employ the Kubo formalism, rooted in finite-temperature quantum field theory, to compute the field correlation functions essential for this evaluation. The one-loop diagram pertinent to shear viscosity is analyzed within the context of curved space, utilizing tetrad formalism as an effective approach in cylindrical coordinates. Our findings focus on extremely high angular velocities, ranging from 0.1 to 1 GeV, which align with experimental expectations. Furthermore, we explore the inter-relationship between the chemical potential and angular velocity within the scope of this study.

Presenter: Dr SINGH, Rajeev (Stony Brook University)

Session Classification: Flash talk and posters

Contribution ID: **83** Type: **Flash Talk (Plenary) + Poster**

Dirac fermions under imaginary rotation

Monday, July 22, 2024 5:45 PM (5 minutes)

Recent years have seen an increase in the interest to investigate the thermodynamic properties of strongly-interacting systems under rotation. Such studies are usually performed using lattice gauge techniques on the Euclidean manifold and with an imaginary angular velocity, Ω = iΩ_I . When ν = βΩ_I /2π is a rational number, the thermodynamics of free scalar fields ”fractalizes”in the large volume limit, that is, it depends only on the denominator q of the irreducible fraction ν = p/q 1.

The present study considers the same problem for free, massless, fermions at finite temperature T = \beta^{-1} and chemical potential μ and confirms that the thermodynamics fractalizes when μ = 0. Curiously, fractalization has no effect on the chemical potential μ, which dominates the thermodynamics when q is large. The fractal behavior is shown analytically for the fermionic condensate, the charge currents and the energy-momentum tensor. For these observables, the limits on the rotation axis are validated by comparison to the results obtained in 2 for the case of real rotation. Enclosing the system in a fictitious cylinder of radius R and length Lz allows constructing averaged thermodynamic quantities that satisfy the Euler relation and fractalize.

1 V. E. Ambruș, M. Chernodub, Phys. Rev. D 108 (2023) 085016.
2 V. E. Ambruș, J. High Energ. Phys. 2020 (2020) 16.

Primary authors: Mr PĂTULEANU, Tudor (West University of Timisoara); Ms FODOR, Dariana (West University of Timisoara); AMBRUȘ, Victor E. (West University of Timișoara); CRUCEAN, cosmin (West University of Timisoara)

Presenter: Mr PĂTULEANU, Tudor (West University of Timisoara)

Session Classification: Flash talk and posters

Contribution ID: **84** Type: **Flash Talk (Plenary) + Poster**

Acceleration as a circular motion along an imaginary circle

Monday, July 22, 2024 5:50 PM (5 minutes)

We describe a quantum fluid undergoing constant acceleration in the grand canonical ensemble, in thermal equilibrium at finite inverse temperature β. Writing the action of the density operator ρ as a Poincare transformation with imaginary parameters, we derive the Kubo-Martin-Schwinger (KMS) relation characterizing the two-point functions. The KMS relation sets boundary conditions for the Euclidean propagator, identifying points in the τ-z plane on a circle separated by an angle equal to the thermal acceleration α. When $\alpha/2\pi = p/q$ is a rational number, we find a fractalization of thermodynamics, similar to the case of states under imaginary rotation.

Primary authors: AMBRUȘ, Victor E. (West University of Timișoara); Dr CHERNODUB, Maxim (CNRS, Université de Tours, France)

Presenter: AMBRUȘ, Victor E. (West University of Timișoara)

Session Classification: Flash talk and posters

Contribution ID: **85** Type: **Flash Talk (Plenary) + Poster**

Helicity relaxation time in an interacting fermionic plasma

Monday, July 22, 2024 6:00 PM (5 minutes)

The polarization of free Dirac fermions can be described by helicity, which represents the projection of the spin along the direction of motion. The helicity operator commutes with the Hamiltonian and therefore helicity is a good" quantum number, even in the case of massive fermions. This opens the possibility of defining ahelicity current", J^\mu_H, which is conserved for free fermions. In the case of massless fermions, J^mu_H transforms covariantly under Lorentz transformations. Integrating its zeroth component over the spatial volume gives the helicity charge, Q_H.

Consider now an ensemble of interacting fermions with a slight helicity imbalance. Due to the helicity-violating pair annihilation (HVPA) processes, the helical imbalance will dissipate in time. This poster addresses the calculation of the typical timescale of the helicity relaxation time in the high-temperature, deconfined phase of the quark-gluon plasma, by employing the Boltzmann collision integral for the HVPA processes.

Primary authors: AMBRUȘ, Victor E. (West University of Timișoara); Dr CHERNODUB, Maxim (CNRS, Université de Tours, France)

Presenter: AMBRUȘ, Victor E. (West University of Timișoara)

Session Classification: Flash talk and posters

Contribution ID: **86** Type: **Flash Talk (Plenary) + Poster**

Helical effects in fermionic plasma

Monday, July 22, 2024 5:55 PM (5 minutes)

A quantum fluid in thermal equilibrium can be described in the grand canonical ensemble using the density operator ρ. At finite temperature and chemical potential, the expectation values of the energy-momentum tensor and the charge current reveal the well-known thermodynamics of the Fermi-Dirac fluid. When the system is rotating or immersed in a magnetic field, deviations from the Fermi-Dirac thermodynamics can be seen, a particular form of which gives rise to anomalous transport.

Anomalous transport was originally uncovered at the level of the axial current: a rotating fluid exhibits a flow of chirality along the rotation vector (the chiral vortical effect). Similarly, Dirac fermions in a magnetic field exhibit the chiral separation effect, by which vector charge imbalance drives a flow of chirality. Conversely, chiral imbalance drives a flow of vector charge (the chiral magnetic effect).

In this poster, we address similar effects at the level of the helicity current, describing the flow of helicity (as opposed to chirality) at finite rotation and in the presence of a magnetic field. Because the helicity has opposite charge conjugation parity compared to chirality, these transport laws complement each other. At high temperature and under rotation, the axial conductivity is dominant; while under a magnetic field, the helical conductivity becomes dominant.

Primary authors: AMBRUȘ, Victor E. (West University of Timișoara); Dr CHERNODUB, Maxim (CNRS, Université de Tours, France)

Presenter: AMBRUȘ, Victor E. (West University of Timișoara)

Session Classification: Flash talk and posters

Contribution ID: **87** Type: **Flash Talk (Plenary) + Poster**

Gluon matter under weak acceleration: lattice results

Monday, July 22, 2024 6:05 PM (5 minutes)

When two relativistic heavy nuclei collide, they produce strong chromoelectric fields that lead to a rapid deceleration of the colliding nuclei. It was suggested twenty years ago that the deceleration leads to a rapid thermalization of the gluon matter through the Hawking-Unruh effect that produces a final thermal gluon state via quantum tunneling through the emerging event horizon. In the Color Glass Condensate picture, the deceleration in the relativistic heavy-ion collisions has been estimated to reach an enormous value of $a \simeq 1$ GeV. Around the same time, it was also demonstrated in a Nambu-Jona-Lasinio approach that the acceleration produces a phase transition to a chirally restored phase. In our work, we study the non-perturbative properties of gluon plasma subjected to weak acceleration using first-principle numerical Monte Carlo simulations. Under acceleration, the gluon plasma resides in local thermal equilibrium. We use the Luttinger (Tolman-Ehrenfest) correspondence between temperature gradient and gravitational field to impose acceleration in imaginary time formalism, which can be performed with the real-valued acceleration. We show that even the weakest acceleration of the order of $a \sim 25$ MeV drastically softens the deconfinement phase transition, converting the first-order phase transition of a static system to a very soft crossover. On the other hand, we found that the weak acceleration of gluon plasma does not affect the critical temperature of the deconfinement transition.

Primary author: Dr CHERNODUB, Maxim (CNRS, Université de Tours, France)

Co-authors: POCHINOK, A. S.; Prof. MOLOCHKOV, Alexander (Beijing Institute of Mathematical Sciences and Applications); STEPANOV, D. V.; GOY, V.A.

Presenter: Dr CHERNODUB, Maxim (CNRS, Université de Tours, France)

Session Classification: Flash talk and posters

Contribution ID: **88** Type: **Flash Talk (Plenary) + Poster**

The advection-diffusion equation in the density frame

Monday, July 22, 2024 5:35 PM (5 minutes)

We investigate an alternative approach, to the MIS relativistic approach, developed to describe fluids without an underlying boost symmetry. This "density frame" approach has no non-hydrodynamic modes and no additional parameters compared to the Landau theory of first order hydrodynamics, at the price of not being fully boost invariant. We show that the density frame equations of motion follow Landau ones if the ideal equations are used to rewrite lab-frame time derivatives appearing in the dissipative strains as spatial derivatives. With this rewrite the equations are first order in time and are stable. In addition, we also show that the density frame equations can be derived from the relativistic kinetic theory.

Primary author: Dr SINGH, Rajeev (Stony Brook University)

Presenter: Dr SINGH, Rajeev (Stony Brook University)

Session Classification: Flash talk and posters