Quantum Anomalies and Hydrodynamics: Applications to Nuclear and Condensed Matter Physics Workshop Talk Schedule

Events for:
Monday, February 17th - Friday, February 21st

Monday, February 17th

8:00am **Breakfast and registration - SCGP Lobby and Cafe**

9:00am **Remarks from the organizers - SCGP 102**

9:10am **Duncan Haldane - SCGP 102**

Title: Emergent geometry of fractional quantum Hall fluids

Abstract: The complex coordinate "z" in Laughlin's wavefunction, and in other model wavefunctions inspired by conformal field theory, is commonly taken to be defined by the shape of the lowest-Landau level cyclotron orbit. This is a fundamental misinterpretation: it is defined by the shape of the "flux attachment" that binds a correlation hole to the particles, which is an emergent local geometric property. The $? = p/q$ FQH fluids can be understood as condensates of "composite bosons" formed by "attachment" of q "flux quanta" to p particles. The mean shape of these elementary incompressible droplets of FQH fluid defines a spatial metric field $g_{ab}(x, t)$ that can fluctuate in space and time, and adjust to the local environment. More precisely, the expectation value of a quasi-local operator defines a quantity $?_{ab}(x) = h ?s?_{ac}?^{bdg} (x)$, H cd which is the "guiding center" contribution to the "Hall viscosity tensor", where s is a topologically-quantized (signed) "geometric spin" (related to the so-called "shift" of FQHE states), and $?_{ab}$ is the antisymmetric symbol. The composite particles behave like neutral bosons that carry a geometric spin s (distinct from the more-familiar topological spin $1pq$ of the attached 2 flux) and their density is incompressibly-pinned to $B(x)/q?0 + sK_G(x)/2?$, where $?0 = h/e$ is the magnetic flux quantum for charge-e particles, $B(x)$ is the magnetic flux density, and $K_G(x)$ is the Gaussian curvature of the emergent spatial metric. The zeropoint fluctuations of the metric (with fixed det g) lead to the $O(q4)$ long-wavelength behavior of the FQH guiding center structure factor found by Girvin, MacDonald and Platzman.

9:45am **Sean Hartnoll - SCGP 102**

Title: Quasi-hydrodynamic metals: theory and practice

Abstract: TBA

10:20am **Coffee Break - SCGP Cafe**

10:50am **Dam Son - SCGP 102**

Title: Field theory and quantum Hall states

Abstract: TBA

11:25am **Tigran Kalaydzhyan - SCGP 102**

Title: Applications of the chiral superfluidity to QCD

Abstract: In this talk I will discuss appearance of the chiral superfluidity in two regimes of QCD. First, at low temperatures and finite density, where the cold pion condensate under rotation and in electromagnetic fields develops string-like defects and anomalous currents flowing along them. Second, at low density and high temperatures, slightly above the deconfinement transition, where the quark-gluon plasma (QGP) can be described as a two-component fluid with the fermionic zero-modes forming the "superfluid" component carrying all the chiral properties of the QGP. The anomalous phenomena under consideration include the chiral magnetic, chiral vortical, axial vortical, chiral electric, chiral separation and other effects. I will also comment on the nature of their temperature dependence in both regimes.

12:00pm **Lunch - SCGP Cafe**

1:30pm **Yi Yin - SCGP 102**

Title: Thermal correlators with chiral anomaly and soft photon production in heavy-ion collisions

Abstract: TBA

1:55pm **Onkar Parrikar - SCGP 102**

Title: Torsion, Parity-odd response & Anomalies in Topological Insulators

Abstract: TBA

2:20pm **Masaru Hongo - SCGP 102**

Title: Anomalous hydrodynamic simulation for heavy-ion collisions

Abstract: Anomaly induced transport effects, like the chiral magnetic effect or the chiral separation effect, have recently attracted much attention and are expected to be observed in ultra-relativistic heavy-ion collisions. So far, the evidence in the experiments has been elusive, mainly due to the lack of quantitative theoretical predictions. In order to asses the contributions from anomalous transport in heavy-ion collisions, we consider a hydrodynamic model in the presence of anomaly. We numerically solve the anomalous hydrodynamic equations under a background electromagnetic field and calculate the propagation of the chiral magnetic wave in an expanding quark-gluon plasma. The charge-dependent elliptic flow ($v_{\pm 2}$) is recently proposed as a signal of the chiral magnetic effect. We calculate the charge-dependent particle distributions and estimate the contribution from anomaly to $v_{\pm 2}$.

2:45pm **Ariel Zhitnitsky - SCGP 102**

Title: The long range order in QCD and the violation of local P invariance in heavy ion collisions

Abstract: We argue that the local violation of P invariance in heavy ion collisions is a consequence of the long range topological order which is inherent feature of strongly coupled QCD. The phenomenon is similar to many well-known topologically ordered condensed matter systems with a gap. Our arguments are based on an analysis of the so-called ``deformed QCD'' model which is a weakly coupled gauge theory, but nevertheless preserves all the crucial elements of strongly interacting QCD, including confinement, nontrivial theta dependence, degeneracy of the topological sectors, etc. Talk is based on two recent papers: 1.``QCD as a topologically ordered system,'' Annals Phys.\ {\bf 336}, 462 (2013) 2. ``Local P Violation Effects and Thermalization in QCD: Views from Quantum Field Theory and Holography,'' Nucl.\ Phys.\ A {\bf 886}, 17 (2012)

3:30pm **Tea Time - SCGP Cafe**

4:00pm **Informal Discussion**

Tuesday, February 18th

8:30am **Breakfast - SCGP Cafe**

9:30am **Talks moved up due to weather**

10:05am **Edward Shuryak - SCGP 102**

Title: QCD Topology, Chiral Symmetry Breaking and Deconfinement

Abstract: We start with the relation between the chiral symmetry breaking and gauge field topology. New lattice result further enhance the notion of Zero Mode Zone, a very narrow strip of states with quasizero Dirac eigenvalues, which is as fundamental for this field as Fermi sphere is for condense matter theory. Progress in understanding of topology require introduction of nonzero holonomy $\neq 0$, which splits instantons into N_c (anti)selfdual ``instanton-dyons''. Qualitative progress, as well as first numerical studies of the dyon ensemble are reported. New connections between chiral symmetry breaking and confinement are recently understood: instanton-dyons generate holonomy potential with a minimum at a confining value, if the ensemble is dense enough.

10:40am **Coffee Break - SCGP Cafe**

11:10am **Mikhail Stephanov - SCGP 102**

    Title: Chiral Kinetic Theory

    Abstract: TBA

11:45am **Gökçe Basar - SCGP 102**

    Title: On the existence of the Chiral Magnetic Effect in Weyl semimetals

    Abstract: TBA

12:10pm **Lunch - SCGP Cafe**

1:30pm **Shu Lin - SCGP 102**

    Title: Out-of-equilibrium chiral magnetic effect from holography

    Abstract: I will talk about chiral magnetic effect and chiral magnetic wave in out-of-equilibrium conditions in the framework of AdS/CFT, relevant at early stage of heavy-ion collisions. Using a gravitational collapse model, we found that a finite axial charge density in the plasma slows down thermalization. As the medium thermalizes, we found the magnitude of chiral magnetic conductivity and the response time delay grow. We also found a dynamical peak in the spectral function of axial current. The dynamical peak has a component that is reminiscent of chiral magnetic wave.

1:55pm **Koushik Balasubramanian - SCGP 102**

Title: Losing Forward Momentum Holographically

Abstract: TBA

2:20pm **Jinfeng Liao - SCGP 102**

Title: In search of anomalous transport effects in heavy ion collisions

Abstract: The heavy ion collision provides a unique many-body environment where local domains of strongly interacting chiral medium may occur and in a sense allow environmental symmetry "violation" phenomena. This talk discusses some recent progress in both the theoretical understanding and experimental search of various anomalous transport effects (such as the Chiral Magnetic Effect, Chiral Separation Effect, Chiral Electric Separation Effect, Chiral Electric/Magnetic Waves, etc) in the hot QCD fluid created by such experiments.

2:55pm **Discussion - SCGP 102**

3:45pm **Tea Time - SCGP Cafe**

4:15pm **SCGP/Physics Colloquium: Dam Son, "Hydrodynamics and quantum anomalies" - SCGP 103**

Speaker: Dam Son (University of Chicago)

Title: "Hydrodynamics and quantum anomalies"

Abstract: Hydrodynamics is the theory describing collective behaviors of fluids and gases. It has a very long history and is usually considered to belong to the realm of classical physics. In recent years, it has been found that, in many cases, hydrodynamics can manifest a purely quantum effect --- anomalies. We will see how this new appreciation of the interplay between quantum and classical physics has emerged, unexpectedly, through the idea of gauge/gravity duality, which originates in modern string theory. I will briefly mention the possible relevance of the new findings to the physics of the quark gluon plasma.

5:15pm **Informal Discussion**

Wednesday, February 19th

8:30am **Breakfast - SCGP Cafe**

9:30am **Maria A. H. Vozmediano - SCGP 102**

Title: Axial magnetic fields in condensed matter. Two examples.

Abstract: The axial magnetic effect, i.e., the generation of an energy current parallel to a magnetic field coupling with opposite signs to left and right fermions has been predicted in the quark–gluon plasma. Axial magnetic fields, impossible to exist in the original context, are naturally realized in some condensed matter systems opening the experimental access to these phenomena. We describe two examples: "axial" pseudomagnetic fields in (2+1) dimensions arising from elastic deformations of the graphene lattice, and a (3+1) example in the so called Weyl semi-metals.

10:05am **Shinsei Ryu - SCGP 102**

Title: Cross-correlated response in topological superconductors

Abstract: TBA

10:40am **Coffee Break - SCGP Cafe**

11:10am **Mukund Rangamani - SCGP 102**

Title: Effective actions for anomalous hydrodynamics

Abstract: In recent years we have come to appreciate that the microscopic dynamics of quantum field theory leave behind indelible signatures in long range, near-equilibrium phenomena. We will describe an effective field theory which captures some of these effects. In particular, we should that an effective field theory of local fluid elements captures the constraints on hydrodynamic transport stemming from the presence of quantum anomalies. The effective action employs crucially the anomaly inflow mechanism and involves some novel modifications to the usual thermofield double construction.

11:45am **Eugenio Megias Fernandez - SCGP 102**

Title: TBA

Abstract: TBA

12:20pm **Lunch - SCGP Cafe**

2:00pm **Francisco Jose Pena Benitez - SCGP 102**

Title: Dynamics of the chiral vortical effect and its implications for Heavy ion collisions

Abstract: TBA

2:25pm **Frasher Loshaj - SCGP 102**

Title: Quantum anomalies and real-time dynamics in QED_2

Abstract: TBA

2:40pm **Gustavo Monteiro - SCGP 102**

Title: Hamiltonian Formulation of Hydrodynamics in the Presence of Quantum Anomalies

Abstract: TBA

2:55pm **Matthias Kaminski - SCGP 102**

Title: Non-Relativistic Parity-Violating Hydrodynamics in two Spatial Dimensions

Abstract: We construct the non-relativistic parity-violating hydrodynamic description of a two-dimensional dissipative, normal fluid in presence of small U(1) background fields and vorticity. This is achieved by taking the non-relativistic limit of the recently developed relativistic hydrodynamics in 2+1 dimensions. We identify and interpret the resulting parity-violating contributions to the non-relativistic constitutive relations, which include the Hall current flowing perpendicular to the temperature gradient, the Hall viscosity and the Leduc-Righi energy current. Also a comparison of our findings is made with the non-relativistic parity-violating hydrodynamics obtained from a light-cone dimensional reduction.

3:30pm **Tea Time - SCGP Cafe**

4:00pm **Informal Discussion**

Thursday, February 20th

8:30am **Breakfast - SCGP Cafe**

9:30am **Karl Landsteiner - SCGP 102**

Title: Matsubara sums and anomalies

Abstract: TBA

10:05am **Loganayagam Ramalingam - SCGP 102**

Title: Replacement rule in AdS/CFT

Abstract: TBA

10:40am **Coffee Break - SCGP Cafe**

11:10am **Alberto Nicolis - SCGP 102**

Title: Coset techniques, and a brute-force search for Wess-Zumino terms

Abstract: TBA

11:45am **Oleg Ruchayskiy - SCGP 102**

Title: Anomalies and generation of magnetic helicity in the Early Universe

Abstract: TBA

12:20pm **Lunch - SCGP Cafe**

2:00pm **Amos Yarom - SCGP 102**

Title: Anomalies and the thermodynamic partition function

Abstract: TBA

2:35pm **Andrey Gromov - SCGP 102**

Title: Effective field theory for the free electrons in external electromagnetic and gravitational fields

Abstract: TBA

2:50pm **Discussion Chaired by Kristan Jensen - SCGP 102**

3:30pm **Tea Time - SCGP Cafe**

4:15pm **Informal Discussion**

6:30pm **Banquet - SCGP Cafe**

Friday, February 21st

8:30am **Breakfast - SCGP Cafe**

10:05am **Carlos Hoyos - SCGP 102**

Title: Effective theory of two-dimensional chiral superfluids

Abstract: TBA

10:40am **Coffee Break - SCGP Cafe**

11:10am **Luis Lehner - SCGP 102**

Title: Holographic path to turbulence in gravity and back

Abstract: TBA

11:45am **Phillip Szepietowski - SCGP 102**

Title: $1/N^2$ corrections to the holographic Weyl anomaly

Abstract: TBA

12:10pm **Lunch - SCGP Cafe**

2:00pm **Ismail Zahed - SCGP 102**

Title: Chiral superfluids

Abstract: TBA

2:35pm **Hans Hansson - SCGP 102**

Title: Effective Field theories for Abelian fractional quantum Hall hierarchies

Abstract: Abelian FQH hierarchies of Haldane-Halperin type emerge by successive condensations of anyonic quasiparticles. Recently explicit wave functions for all these hierarchy states have been constructed using conformal field theory techniques. In this talk, which reports on work in progress, I discuses the possibility of obtaining these wave functions from effective field theories, and how these theories in turn could be derived from microscopic physics. Of particular importance are the issues related to the orbital spin of the constituent particles.

3:10pm **Informal Discussion**

3:30pm **Tea Time - SCGP Cafe**