Strongly Coupled and Systems Away to From Equilibrium Workshop Talk Schedule

Events for:
Monday, February 24th - Friday, February 28th

Monday, February 24th

8:30am **Breakfast/registration**

9:30am **Remarks from the organizers**

9:45am **Larry Yaffe**

Title: Approaches to Non-Equilibrium QFT

Abstract: TBA

10:45am **Coffee Break**

11:15am **Meigan Aronson**

Title: Quantum Criticality in Strongly Correlated Electron Matter: a Perspective from Experimental Condensed Matter Physics

Abstract: T=0 phase transitions or `Quantum Critical Points' are found in virtually every class of correlated electron system, including cuprates, heavy fermions, Fe-based pnictides, and organic conductors, and their presence fundamentally changes the properties of the underlying metal from which these ordered phases emerge. The associated critical modes can lead to the nucleation of novel phases, provide pairing for unconventional superconductors, and can even lead to the destruction of the metallic state via the localization of electrons. I will review here the basic experimental signatures of quantum critical matter, selected from classes of materials whose underlying physics is very different, and outline our emerging understanding of their unusual collective instabilities.

12:15pm **Lunch**

2:00pm **Martin Zwierlein**

Title: Solitonic Waves in a Fermionic Superfluid

Abstract: Solitons - solitary waves that maintain their shape as they propagate — occur as water waves in narrow canals, as light pulses in optical fibres and as quantum mechanical matter waves in superfluids and superconductors. Their highly nonlinear and localized nature makes them very sensitive probes of the medium in which they propagate. We create long-lived solitary waves in a strongly interacting superfluid of fermionic atoms and directly observe their motion [1]. As the interactions are tuned from the regime of Bose–Einstein condensation of tightly bound molecules towards the Bardeen–Cooper–Schrieffer limit of long-range Cooper pairs, the waves' effective mass increases dramatically, to more than 200 times their bare mass. This mass enhancement is more than 50 times larger than the theoretically predicted value for planar solitons. I will present new experiments that reveal the microscopic nature of the observed solitary waves. Our work provides a benchmark for theories of non-equilibrium dynamics of strongly interacting fermions. [1] Tarik Yefsah, Ariel T. Sommer, Mark J.H. Ku, Lawrence W. Cheuk, Wenjie Ji, Waseem S. Bakr, Martin W. Zwierlein, Heavy Solitons in a Fermionic Superfluid, Nature 499, 426-430 (2013)

3:30pm **Tea Time**

4:00pm **Raju Venugopalan**

Title: Turbulent thermalization process in highly occupied non-Abelian plasmas

Abstract: TBA

Tuesday, February 25th

8:30am **Breakfast**

9:30am **Gordon Baym**

Title: Self-consistent approach to non-equilibrium systems

Abstract: In recent years theoretical, computational, and experimental advances have pushed the development of the technique of self-consistent calculations of equilibrium and non-equilibrium properties of many-particle systems. Generalized Boltzmann equations are now finding application in a wide range of physical systems, from the very small (e.g., single molecule conduction) to the very large (e.g., quark-gluon plasmas, and the early universe). This talk will review the basic concepts of the formalism, and its modern applications in a variety of systems.

10:30am **Coffee Break**

11:00am **Berndt Mueller**

Title: Realizing Landau's Dream: What experiments tell us about the liquid quark-gluon plasma and what theorists need to understand

Abstract: TBA

12:00pm **Lunch**

1:15pm **Johanna Erdmenger**

Title: Time dependence in a holographic model for the Kondo effect

Abstract: The Kondo model describes the interaction of fermions with a magnetic impurity. We present a holographic version of the Kondo model. Our gauge/gravity duality setup describes an UV-IR renormalisation group flow. This flow is triggered by a `double trace' operator. As expected from large N field theory results, the IR behaviour is governed by the condensation of a scalar field. We include time dependence by quenching this system. Reference: J. Erdmenger, C. Hoyos, A. O'Bannon and J. Wu, A Holographic Model of the Kondo Effect, JHEP 1312 (2013) 086, [arXiv:1310.3271 [hep-th]].

2:15pm **Short Break**

2:30pm **Steve Rolston**

Title: Strong Coupling in Ultracold Plasmas

Abstract: TBA

3:00pm **Wilke van der Schee**

Title: Collisions in AdS: the road to experiments

Abstract: Holography has been used for a while as a strongly coupled approach to study the initial stage of heavy-ion collisions. As holographic calculations cannot directly describe QCD, importantly neglecting any weak-coupling effects, it is an interesting question how well these studies fit experimental data. Here, we will focus on longitudinal dynamics, modeled by colliding shock waves in AdS. --> These collisions give a surprisingly universal rapidity profile, where the shape at high collision energies is completely independent of the energy or longitudinal structure of the colliding shocks. It is somewhat complicated to compare this initial profile to the final measured rapidity profile, but we can compute the entropy and thereby make an estimate of the total multiplicity. The result indicates that our infinite coupling profile has somewhat more stopping than in real heavy-ion collisions, which is most likely because of neglecting weak-coupling effects. We finally comment on (future) consequences for real nucleus-nucleus and proton-nucleus collisions. --> References: arxiv:1312.2956 and 1305.4919 (PRL 111)

3:30pm **Tea Time**

4:15pm **Physics & Astronomy Colloquium: Rocky Kolb, "The Decade of the WIMP"**

Wednesday, February 26th

8:30am **Breakfast**

9:30am **Alex Kamenev**

Title: Formalism of non-equilibrium field theory

Abstract: TBA

10:30am **Coffee Break**

11:00am **Natan Andrei**

Title: Quench dynamics of 1-d many body systems

Abstract: TBA

11:30am **Lunch**

1:30pm **Steven Gubser**

Title: Finite momentum at string endpoints, with applications to hard probes

Abstract: Classical string solutions exist with finite momentum at endpoints. I will explain the main features of finite endpoint momentum, including an extension of the Green-Schwarz superstring action. Finite endpoint momentum is useful in the study of holographic energy loss by light quarks. I will show how simple analytic methods suffice to extract the main features of the relevant string motions, and I will present some comparisons with RHIC and LHC heavy ion phenomenology. In a simple "shooting string" model, developed with Ficnar and Gyulassy, an acceptable fit to data can be achieved if the temperature of the quark-gluon plasma at the LHC is about 10% lower than conventional expectations.

2:30pm **Sumit Das**

Title: Quantum Quench and Holography

Abstract: TBA

3:15pm **Short Break**

3:30pm **Tea Time**

4:00pm **Joerg Schmalian**

Title: Universal post-quench dynamics at a quantum critical point

Abstract: TBA

4:30pm **Informal Discussion**

Thursday, February 27th

8:30am **Breakfast**

9:30am **Julian Sonner**

Title: Non-equilibrium Dynamics and Broken Symmetry

Abstract: TBA

10:10am **Gokse Basar**

Title: An AdS / Gross-Neveu Model correspondence

Abstract: TBA

10:50am **Coffee Break**

11:20am **Dominik Schneble**

Title: Superfluid dynamics in driven and tilted incommensurate lattices

Abstract: In my talk I will describe two recent studies on the dynamics of a bosonic quantum gas in an incommensurate optical lattice potential. The first experiment explored the case that the lattice depth was periodically modulated. We found that this system, which maps on a system of coupled kicked quantum rotors, exhibits a surprising transition from dynamical localization to classical momentum diffusion. The second experiment focused on the effects of disorder and interactions for the case of static forcing. We found that weak interactions, which on their own lead to a damping of Bloch oscillations, can counteract the damping effects of disorder, consistent with the presence of screening.

12:00pm **Lunch**

2:00pm **Alexei Tsvelik**

Title: Universal Features of the Excitation Spectrum in Generalized Gibbs Distribution Ensemble

Abstract: It is shown that excitation spectra of Generalized Gibbs Ensembles (GGE) of one-dimensional integrable models with isotopic symmetry contain universal features insensitive to details of the distribution. Namely, the low energy limit of the subsystem of isotopic (for instance, spin) excitations is described by the effective action of a ferromagnet at thermodynamic equilibrium with a single temperature and with the stiffness determined by the initial conditions. The condition of universality is that the entropy per excited particle is small.

2:40pm **Derek Teaney**

Title: Equilibration of Hawking Radiation in AdS_5

Abstract: TBA

3:30pm **Tea Time**

4:00pm **Jin Wang**

Title: The potential and flux landscape theory for non-equilibrium systems

Abstract: The complex systems are everywhere around us ranging from the physical to the biological objects. These are often open systems with inputs of energy and information from outside. Uncovering the organization principles and physical quantification of the complex non-equilibrium open systems are essential for understanding the global function and stability. This presents us a great challenge. In this talk, we summarize our recent efforts in this direction. We found that the dynamics of the complex systems are determined by the two driving forces. One is the gradient of the underlying landscape and the other is from the curl flux. The underlying landscape is linked to the probability distribution of the steady state and provides a global picture for describing the complex system. We found that the landscape can be used to quantify the global stability and robustness of the system. The non-zero flux breaks the detailed balance and therefore gives a quantitative measure of how far away the system is from the equilibrium state, reflecting the degree of the energy input to the system. Our decomposition of the driving forces of the complex systems into landscape gradient and curl flux establishes the link between the dynamics and the underlying thermodynamic non-equilibrium natures. We applied our theory to several physical and biological systems such as cell cycle, stem cell differentiation and reprograming, neural networks, evolution, ecology and chaos. For cell cycle oscillations, we found the underlying landscape has a Mexican hat ring shape topology. The height of the Mexican hat determines the global stability. The landscape gradient attracts the system down to the oscillation ring. The curl flux is the driving force for coherent oscillation on the ring. Further discussions on non-equilibrium thermodynamics, fluctuation-dissipation theorem and gauge theory will be given. Applications to active matter are expected.

4:40pm **Guy Moore**

Title: Second-order Relativistic Hydrodynamics

Abstract: I review why a hydrodynamic description of relativistic systems, particularly heavy ion collisions, must involve second-order hydrodynamics. I review what we know about the theory and about viscosity and its other coefficients in QCD. I show how second-order coefficients can be found using Kubo relations. Then I use the physics of nonlinear hydrodynamics and long-time tails to place a lower bound on viscosity and to show that some second-order coefficients are not well defined.

5:20pm **Discussion chaired by Barbara Jacak**

6:00pm **Workshop Banquet**

Friday, February 28th

8:30am **Breakfast**

9:30am **Paul Chesler**

Title: TBA

Abstract: TBA

10:10am **Anatoly Dymarsky**

Title: Scale symmetry in quantum field theory

Abstract: TBA

10:40am **Coffee Break**

11:15am **Jon Rameau**

Title: Measurement of the Nearly Perfect Fluid in a Cuprate Strange Metal

Abstract: Recent measurements of the shear viscosity to entropy density ratio ?/s in the quark-gluon plasma (QGP) and atomic Fermi gases at unitarity (UFG), both of which approach a conjectured universal lower limit derived from the AdS/CFT correspondence, have sparked interest in the condensed matter community because of the similar roles played by ?/s in strongly coupled hydrodynamic systems and the T-linear relaxation of quantum critical systems in condensed matter. Encouraged by this notion as well as a number of phenomenological similarities between the QGP, the UFG and the cuprates, we have pursued the idea that strange metal transport in the cuprates is effectively hydrodynamic and so may be well characterized by ?/s. I will discuss the methodology by which ?/s can be measured in condensed matter, give a brief introduction to the Angle Resolved Photoemission Spectroscopy (ARPES) and present recent T-dependent ARPES measurements of ?/s on the optimally doped cuprate Bi2Sr2CaCu2O8+x , showing how ?/s approaches the conjectured AdS bound around Tc. I will also discuss the weak T-dependence of ?/s above Tc, how hydrodynamic transport in strongly correlated electron systems might resolve some long outstanding problems and compare these results directly to those for the QGP and UFG.

12:00pm **Lunch**

3:30pm **Tea Time**