Schedule

Events for:
Monday, September 16th - Friday, September 20th

Monday, September 16th

9:00am **Alex Kamenev - SCGP 102**

Speaker: Alex Kamenev

Title: Transport in SYK nanostructures and arrays

Abstract: I will discuss heat and charge transport through quantum dots and arrays constructed of SYK (non Fermi liquid) building blocks. The key theoretical tool is to extent the Schwarzian action to include hopping, or kinetic energy. We then develop an RG treatment of such an extended Schwarzian theory. It reveals existence of a quantum phase transition, which separates an insulating non-Fermi liquid from a metallic Fermi liquid. In between there is a wide, finite temperature critical regime, characterized as a "strange" metal with linear in T resistivity.

10:00am **Coffee/Tea**

10:30am **Xiangyu Cao - SCGP 102**

Speaker: Xiangyu Cao

Title: Quantum critical points in low-rank SYK models

Abstract: Motivated by a recent atom-cavity experiment proposal [1], we study a family of solvable variants of the q= 4 Sachdev-Ye-Kitaev (SYK) model whose coupling matrix $J_{ij,kl}$ has tunable rank and eigenvalue distribution. (This is an extension of earlier works [2,3,4].) While SYK is recovered when the rank is super-extensive (much larger than the number of Majorana fermions), and the model becomes non-interacting in the sub-extensive rank regime, the extensive-rank regime has rich low-T behaviors, depending on the eigenvalue distribution. We obtain a classification of possible critical points, unifying and extending earlier results. They include two critical lines with tunable scaling dimension, a Fermi liquid with broken time-reversal symmetry, and a non-Fermi liquid with large specific heat $C_V \sim T^{\nu} \gg T$. This talk is based on joint work with Jaewon Kim and Ehud Altman (UC Berkeley). [1] Gregory Bentsen, et al, arXiv:1904.10966 (2019) [2] Ippei Danshita, Masanori Hanada, Masaki Tezuka, Prog. Theor. Exp. Phys. 2017, 083I01 [3] Zhen Bi, et al, PRB 95 205105 (2017) [4] Ilya Esterlis, Jörg Schmalian, arXiv:1906.04747 (2019)

11:30am **Sergei Flach - SCGP 102**

Speaker: Sergei Flach

Title: Dynamical Glass: Ergodization Dynamics in Weakly Non-Integrable Many-Body Systems

12:30pm **Lunch**

2:00pm **Thomas Guhr - SCGP 102**

Speaker: Thomas Guhr

Title: Many-Body Quantum Chaos: Chains of Kicked, Interacting Spins

3:00pm **Coffee/Tea**

3:30pm **Eugene Kanzieper - SCGP 102**

Speaker: Eugene Kanzieper

Title: Probing spectral statistics through the power spectrum

4:30pm **Gernot Akemann - SCGP 102**

Speaker: Gernot Akemann

Title: Universal Signature from Integrability to Chaos in Open Quantum Systems

Abstract: We study the transition between integrable and chaotic behaviour in dissipative open quantum systems, revisiting a conjecture of Grobe, Haake and Sommers. The spacing distribution of the complex eigenvalues of the Liouville operator is compared with the Poisson distribution in 2D in the integrable limit, and that of complex Gaussian non- Hermitian random matrices, the Ginibre ensemble, in the chaotic regime. The intermediate regime is well described by the spacing distribution of a static two-dimensional Coulomb gas with harmonic potential at inverse temperature $\beta\in[0,2]$, that we generate numerically in order to fit β. The physical system we use for comparison is a boundary driven XXZ quantum spin-chain with up to next-to-nearest neighbor interaction, which is known to display such a transition. Furthermore, in the bulk of the spectrum the spacing distribution of the complex Ginibre ensemble is shown to agree with that of real and quaternion valued matrices and thus universal, where the former was previously known. This is in stark contrast to random matrices with real eigenvalues, where all 3 symmetry classes are different.

Tuesday, September 17th

9:00am **Igor Klebanov - SCGP 102**

Speaker: Igor Klebanov

Title: Dynamics of Tensor and SYK Models

10:00am **Coffee/Tea**

10:30am **Herman Verlinde - SCGP 102**

Speaker: Herman Verlinde

Title: A duality between SYK and 2+1 de Sitter gravity

11:30am **Anatoli Polkovnikov - SCGP 102**

Speaker: Anatoli Polkovnikov

Title: Infinite temperature adiabatic flows in ergodic systems

Abstract: I will discuss the structure generators of adiabatic transformations in ergodic Hamiltonians.Using an example of a specific nonnintegrablee Ising chain I will show that they are highly anisotropic allowing one to define adiabatic flows connecting families of Hamiltonians. These flows are very reminiscent of RG flows. I will also show that near singular (massively degenerate) points one can define special states which are very stable to adiabatic deformations. Such states bear direct analogy both to recently introduced quantum scars and to many body dark states in the language of quantum optics.

12:30pm **Lunch**

2:00pm **Lea Santos**

Speaker: Lea Santos

Title: Time Scales and Manifestations of Chaos in Many-Body Quantum Dynamics

Abstract: A major open question in studies of nonequilibrium quantum dynamics is the identification of the time scales involved in the relaxation process of isolated many-body systems. While there is consensus on what equilibration and thermalization mean in these systems, there is no agreement on how long they take to reach equilibrium. To answer this question, we look for dynamical manifestations of spectral correlations in different observables and use them to discuss a generalization of the Thouless time to interacting systems and to show that the relaxation time grows with system size. Our studies also include an analysis of the self-averaging properties of systems out of equilibrium. We show numerically and analytically that self-averaging properties depend not only on the presence or absence of chaos, but also on the quantity and the time scale considered.

3:00pm **Coffee/Tea**

3:30pm **Peter Reimann - SCGP 102**

Speaker: Peter Reimann

Title: Typical relaxation of perturbed many-body quantum systems

4:30pm **Marcos Rigol - SCGP 102**

Speaker: Marcos Rigol

Title: Entanglement entropy of highly excited eigenstates of many-body lattice Hamiltonians

Abstract: The average entanglement entropy of subsystems of random pure states is (nearly) maximal [1]. In this talk, we discuss how the average entanglement entropy of subsystems of highly excited eigenstates of integrable and nonintegrable many-body lattice Hamiltonians (with a conservation law) differ from that of random pure states. For translationally invariant quadratic models (or spin models mappable to them) we prove that, when the subsystem size is not a vanishing fraction of the entire system, the average eigenstate entanglement exhibits a leading volume-law term that is different from that of random pure states [2]. We argue that such a leading term is universal for translationally invariant quadratic models [3]. For the quantum Ising model, we show that the subleading term is constant at the critical field for the quantum phase transition and vanishes otherwise (in the thermodynamic limit); i.e., the critical field can be identified from subleading corrections to the average (over all eigenstates) entanglement entropy [3]. For highly excited eigenstates of a particle-number-conserving quantum chaotic model away from half filling, we find that the deviation from the maximal value grows with the square root of the system's volume, when 1/2 of the system is traced out. Such a deviation is proved to occur in random pure states with a fixed particle number and normally distributed real coefficients [4].

Wednesday, September 18th

9:00am **John Chalker - SCGP 102**

Speaker: John Chalker

Title: Spectral correlations and the Thouless time in spatially extended Floquet quantum circuits

Abstract: I will give an overview of recent work on minimal models for quantum chaos in spatially extended many-body quantum systems. I will desribe simple, solvable models for quantum dynamics with a periodically time-dependent (i.e. Floquet) evolution operator in lattice systems with q-state “spins” at each site. Neighbouring sites are coupled by unitary quantum gates. Taking these unitaries to be random, the models are solvable in the large q limit. I will focus on spectral fluctuations of the Floquet operator. In the time domain, fluctuations are described by random matrix theory at long times but are much larger at short times; the Thouless time marks the crossover in behaviour. I will give results for the dependence of the Thouless time on system size in systems with and without a locally conserved density. A. Chan, A. De Luca, and J. T. Chalker, Phys. Rev. Lett. 121, 060601 (2018) and Phys. Rev. X 8, 041019 (2018); A. J. Friedman, A. Chan, A. De Luca, and J. T. Chalker, arXiv:1906.07736.

10:00am **Coffee/Tea**

10:30am **David Huse - SCGP 102**

Speaker: David Huse

Title: Measurement-induced purification/entanglement phase transitions

11:30am **Yevgeny Bar Lev - SCGP 102**

Speaker: Yevgeny Bar Lev

Title: Multifractality and its role in anomalous transport in the disordered XXZ spin-chain

Abstract: The disordered XXZ model is a prototype model of the many-body localization transition (MBL). Despite numerous studies of this model, the available numerical evidence of multifractality of its eigenstates is not very conclusive due severe finite size effects. Moreover it is not clear if similarly to the case of single-particle physics, multifractal properties of the many-body eigenstates are related to anomalous relaxation and transport. In this talk I will present a detailed analysis of multifractality of eigenstates in the disordered XXZ spin-chain which was performed using a massively parallel, numerically exact method and I will discuss the implication of our results on anomalous dynamical features of disordered many-body models.

12:30pm **Lunch**

2:00pm **Jordan Cotler - SCGP 102**

Speaker: Jordan Colter

Title: Low-dimensional de Sitter quantum gravity and random matrix theory

Abstract: I will discuss Jackiw-Teitelboim (JT) quantum gravity in 2D nearly de Sitter (dS) spacetime, as well as pure de Sitter quantum gravity in 3D. These are each theories of boundary modes, which include a reparameterization field on each connected component of the boundary as well as topological degrees of freedom. In 2D, the boundary theory is closely related to the Schwarzian path integral, and in 3D to the quantization of coadjoint orbits of the Virasoro group. In the 2D JT setting, I will define a genus expansion by summing over higher genus generalizations of surfaces used in the Hartle-Hawking construction. Assuming a conjecture regarding the volumes of moduli spaces of such surfaces, the de Sitter genus expansion is the continuation of the recently discovered AdS genus expansion. Then both may be understood as coming from the genus expansion of the same double-scaled random matrix model, which would provide a non-perturbative completion of de Sitter JT gravity.

3:00pm **Coffee/Tea**

3:30pm **Juan Maldacena - SCGP 102**

Speaker: Juan Maldacena

Title: Black holes, entropy and entanglement islands

4:30pm **Brian Swingle - SCGP 102**

Speaker: Brian Swingle

Title: Sparse Sachdev-Ye-Kitaev model

Thursday, September 19th

9:00am **Subir Sachdev - SCGP 102**

Speaker: Subir Sachdev

Title: Planckian Metals

10:00am **Coffee/Tea**

10:30am **Grigory Tarnopolsky - SCGP 102**

Speaker: Grigory Tarnopolsky

Title: Soft modes in the complex SYK model

11:30am **Boris Fine - SCGP 102**

Speaker: Boris Fine

Title: Chaotic properties of spin lattices at high temperatures

Abstract: I review our old and new investigations of matters relevant to the behavior of out-of-time-order correlators (OTOCs) in spin lattices including (i) systematic investigations of largest Lyapunov exponents and Lyapunov spectra for classical spin lattices [1,2]; (ii) behavior of Lyapunov spectra near second-order phase transitions [3]; (iii) relation between Loschmidt echoes, largest Lyapunov exponents and OTOCs in lattice models[4,5,6]; and (iv) extracting system's ergodization time from OTOCs[7]. [1] A. S. de Wijn, B. Hess and B. V. Fine, Phys. Rev. Lett. 109, 034101 (2012). [2] A. S. de Wijn, B. Hess, and B. V. Fine, J. Phys. A: Math. Theor. 46, 254012 (2013). [3] A. S. de Wijn, B. Hess, B. V. Fine, Phys. Rev. E 92, 062929 (2015). [4] B. V. Fine, T. A. Elsayed, C. M. Kropf, and A. S. de Wijn, Phys. Rev. E 89, 012923 (2014). [5] T. A. Elsayed and B. V. Fine, Phys. Scr. 2015, 014011, (2015) (eprint arXiv:1409.4763). [6] A. E. Tarkhov, S. Wimberger and B. V. Fine, Phys. Rev. A 96, 023624 (2017). [7] A. E. Tarkhov, B. V. Fine, New J. Phys. 20, 123021 (2018).

12:30pm **Lunch**

2:00pm **Yoram Alhassid - SCGP 102**

Speaker: Yoram Alhassid

Title: Universality in ultra-small metallic grains

Abstract: The single-particle Hamiltonian of a nano-scale metallic grain (nanoparticle) with irregular boundaries or weak disorder is described by random-matrix theory. We show that the randomness of the single-particle wave functions induces a randomness in the two-body interaction matrix elements, and leads to a description of the interaction in terms of a leading-order universal Hamiltonian and an induced two-body random-matrix ensemble that are determined by the underlying space-time symmetries. We discuss universal fluctuations in transport and in thermodynamic properties of the nanoparticle. Of particular interest is the fluctuation-dominated regime, in which the BCS theory of superconductivity breaks down. We also discuss effects of the induced two-body random-matrix ensemble.

3:00pm **Coffee/Tea**

3:30pm **Barbara Dietz - SCGP 102**

Speaker: Barbara Dietz

Title: Application of RMT to Scattering Experiments with Microwave Billiards and Nuclear Data

Abstract: In the first part of my talk I will review experiments with flat microwave resonators with induced time-reversal invariance violation of which the scattering matrix formalism is equivalent to that developed for the RMT description of compound nuclear reactions. The aim of the experiments was the derivation and experimental verifiation of a variety of statistical measures for the fluctuation properties in the spectra of the associated scattering matrix. Recently, we validated analytical expressions for the distribution of the off-diagonal cross sections based on these microwave data and then applied them to excitation functions of the compound-nuclear reaction $^{37}{\rm Cl}(p,\alpha)^{34}S$. In the second part of my talk I will speak about a thorough study of the fluctuation properties in the energy spectra of $^{\bf 208}${\bf Pb}. High resolution experiments have recently lead to a complete identification of the energy values, spin, and parity of 151 nuclear levels up to an excitation energy of $E_x= 6.20$~MeV in $^{\bf 208}${\bf Pb}. In a first approach we grouped states with the same spin and parity into subspectra, analyzed standard statistical measures for short- and long-range correlations in each sequence of unfolded energy levels and then computed their ensemble average and compared them to RMT results. In a second approach, following an idea of Rosenzweig and Porter, we considered the complete spectrum composed of the spacings between adjacent the unfolded energy levels of the independent subspectra. We analyzed their fluctuation properties using the method of Bayesian inference. We, furthermorem performed the same analysis with spectra computed on the basis of shell model calculations with different interactions (SDI, KB, M3Y).

4:30pm **Jorge Hirsch - SCGP 102**

Speaker: Jorge Hirsch

Title: Classical and Quantum dynamics in atom-photon systems

Friday, September 20th

9:00am **Klaus Richter - SCGP 102**

Speaker: Klaus Richter

Title: From short-time to late-time dynamics: many-particle interference in interacting bosonic systems

Abstract: Concepts based on many-particle interference have proven very fruitful for better understanding various many-body phenomena, such as quantum dynamics of cold atoms, many-body localization and more recently information scrambling. We will address such phenomena by using semiclassical path integral techniques based on interfering Feynman paths, bridging classical and quantum many-body approaches. On the one hand we use short-time dynamical information to compute many-body level densities. We show that the crossover from an ideal Bose gas to the strongly correlated, fermionized gas, exhibits universal behavior: Systems with very few up to many particles share the same underlying spectral features. On the other hand, corresponding semiclassical techniques for large-N Bose-Hubbard systems, which are based on coherent sums over solutions of the corresponding mean-field equations, enable us to account for quantum entanglement at intermediate to post-Ehrenfest (scrambling) time scales where classical and quantum evolution diverges: We compute out-of-time-order correlators (OTOCs) and discuss the quantum mechanisms leading to their saturation for quantum chaotic and to quasi-periodic recurrences of OTOCs for quantum critical many-body systems.

10:00am **Coffee/Tea**

10:30am **Steven Tomsovic - SCGP 102**

Speaker: Steven Tomsovic

Title: Post-Ehrenfest many-body quantum interferences in ultracold atoms: complex saddle trajectories

Abstract: Far out-of-equilibrium many-body quantum dynamics in isolated systems necessarily generate interferences beyond an Ehrenfest time scale, where quantum and classical expectation values diverge. Ultracold atomic gases provide a promising setting to explore these phenomena. Theoretically speaking, the heavily-relied-upon truncated Wigner approximation leaves out these interferences. We develop a semiclassical theory of coherent state propagation for many-body bosonic systems, which properly incorporates such missing quantum effects. For mesoscopically populated Bose-Hubbard systems, it is shown that this theory captures post-Ehrenfest quantum interference phenomena very accurately, and contains relevant phase information to perform many-body spectroscopy with high precision. The search for complex saddle trajectories and constructive interference effects of discrete symmetries will be discussed.

11:30am **Mario Kieburg - SCGP 102**

Speaker: Mario Kieburg

Title: A General Mechanism of Broadening for Degenerate Eigenvalues

Abstract: The broadening of eigenvalues due to the influence of a perturbation is a general mechanism observed in many systems and models. Especially eigenvalues that lie in spectral gaps or outliers are extremely sensitive to perturbations and even more when they are degenerate. This is the reason why they have attracted a lot of attention in various disciplines. The question that arises is whether the broadening is universal and if yes what is the corresponding distribution. Lately, some examples in lattice QCD and condensed matter theory suggests that in first approximation when the interaction with the perturbation is tiny the broadening follows standard Gaussian random matrix theory at finite matrix size. And indeed, together with Adam Mielke, Mads Rud Larsen and Kim Splittorff, we have shown that a matrix version of the central theorem exists for all ten symmetry classes of the Hermitian matrices and even for non-Hermitian operators. I will give a brief report on it in my talk.

12:30pm **Lunch**