ABSTRACTS

Speaker: Dmitry Abanin

Title: Non-Abelian Symmetries and Disorder: A Broad Non-Ergodic Regime and Anomalous Thermalization

Abstract:

Speaker: Alexander Brinkman

Title: Topological effects in a Bi based 3D Dirac semimetal

Abstract: Bismuth doped with antimony supports a three-dimensional Dirac cone (also dubbed "3D graphene") at the Sb-induced band inversion point. When a magnetic field is applied, the degenerate Dirac cone splits into two Weyl cones of opposite chirality. For parallel E and B fields, the chirality polarization (chiral anomaly) gives rise to a strong and negative magnetoresistance in Hall bar devices. A node with a certain chirality behaves as a magnetic monopole field in momentum space and can be detected in a non-local geometry. These monopoles are observed to diffuse over micrometer length scales. The Dirac semimetal is ideally suited for realizing Majorana bound states in superconducting hybrids because of a topological protection against backscattering, preventing the 4pi-periodic Andreev states from opening a gap at zero energy. We observe a strong contribution of 4pi-periodic Andreev bound states to the supercurrent in Nb-Bi1-xSbx-Nb devices. The large g-factor allows tuning of the Josephson junctions from 0 to pi regimes.

Speaker: Andrea Capelli

Title: Universal Transport Properties in the Quantum Hall Effect

Abstract: After reviewing the transport coefficients related to anomalies of the edge theory, I discuss the universality of the orbital spin and Hall viscosity. Its role in the edge theory is that of a Casimir effect or chemical potential shift, that is universal and measurable under certain conditions.

Speaker: Olalla Castro-Alvaredo

Title: Entanglement Content of Localized Excitations

Abstract: In this talk I will present a summary of work carried out over the past two years in collaboration with Cecilia De Fazio, Benjamin Doyon and István Szécsényi. In our work we have studied the increase of the entanglement entropy and logarithmic negativity in zero-density excited states of QFT, as compared with values in the ground state. We have found that in the infinite-volume limit, such increase takes a remarkably simple form for a wide variety of quantum systems. This simple form can be obtained from a very technical form factor derivation, but also from a simple qubit picture, a graph theoretical interpretation and numerical simulations. In this talk I will present the main results and give a flavour of the various techniques used.

Speaker: Nigel Cooper

Title: Topological Phases of Matter out of Equilibrium

Abstract: We study the topological properties of quantum many-particle systems undergoing unitary time evolution. We establish the existence of a topological classification in these non-equilibrium settings which naturally inherits phenomenology familiar from equilibrium: it is robust against disorder and interactions, and exhibits a non-equilibrium bulk-boundary correspondence. Direct physical consequences of the non-equilibrium topological classification are discussed.

Speaker: Eugene Demler

Title: Many-body dynamics in pump and probe experiments: From light amplification to terahertz STM

Abstract: I will discuss new theoretical approaches for analyzing pump and probe experiments in solid state systems. The focus will be on combining theoretical techniques from condensed matter physics and quantum optics. Several examples will be discussed, including light amplification in photo-excited superconductors and insulators, ultrafast molecular dynamics in terahertz-STM experiments

Speaker: Benjamin Doyon

Title: Hydrodynamics of integrable systems: diffusion, dynamical correlation functions, full counting statistics for transport

Abstract: Hydrodynamics proposes that the effective dynamical degrees of freedom of a many-body system can be reduced, at large scales, to those given by the available local conservation laws. I will overview the main ingredients of the general theory of hydrodynamics for multiple conservation laws. I will explain in particular how it gives access to dynamical correlation functions at large space-time scales, including of order parameters, and to full counting statistics for transport in equilibrium and non-equilibrium states. I will then review the hydrodynamic theory of integrable systems, and express some of our recent exact results, with applications to models such as the Heisenberg chain, the Lieb-Liniger model and the sine-Gordon model.

Speaker: Jerome Dubail

Title: Generalized Hydrodynamics on an Atom Chip

Abstract: "I will give an introduction to the hydrodynamic description of one-dimensional quantum fluids which possess infinitely many conserved quantities (known as "integrable"), established in 2016 [1,2]. I will contrast this new framework with the standard hydrodynamic description of fluids, and explain how it circumvents the usual assumption of local equilibration. Then I will describe the recent cold atom experiment (done by I. Bouchoule and M. Schemmer in Palaiseau) which demonstrated that the new theory provides the correct description of the dynamics of the one-dimensional Bose gas." [1] O. A. Castro-Alvaredo et al., Emergent Hydrodynamics in Integrable Quantum Systems Out of Equilibrium, Phys. Rev. X 6, 041065 (2016) [2] B. Bertini et al., Transport in Out-of-Equilibrium XXZ Chains: Exact Profiles of Charges and Currents, Phys. Rev. Lett. 117, 207201 (2016), [3] M. Schemmer et al., Generalized Hydrodynamics on an Atom Chip, Phys. Rev. Lett. 122, 090601 (2019).

Speaker: Fabian Essler

Title: Integrable Lindblad Equations

Abstract:

Speaker: Tilman Esslinger

Title: From Floquet engineering to dynamical gauge fields

Abstract: The coupling between gauge and matter fields plays an important role in many models of high-energy and condensed matter physics. In these models, the gauge fields are dynamical quantum degrees of freedom in the sense that they are influenced by the spatial configuration and motion of the matter field. So far, synthetic magnetic fields for atoms in optical lattices were intrinsically classical, as these did not feature back-action from the atoms. I will report on a scheme realizing the fundamental ingredient for a density-dependent gauge field by engineering non-trivial Peierls phases that depend on the site occupation of fermions in a Hubbard model. Our scheme relies on breaking time-reversal symmetry by driving the optical lattice simultaneously at two frequencies. In the experiment we quantify the amplitude of the resulting density-assisted tunnelling matrix element on a Hubbard dimer and directly measure its Peierls phase with respect to the single-particle hopping.

Speaker: Paul Fendley

Title: SPT, AKLT, CFT, and Onsager

Abstract: I explain how everything in the title arises in a nearest-neighbour parafermion Hamiltonian, using self-duality as an essential tool

Speaker: Victor Galitski

Title: Cavity Quantum Enhancement of Superconductivity and Superconducting Polaritons

Abstract: Driving a conventional superconductor with an appropriately tuned classical electromagnetic field can lead to an enhancement of superconductivity via a redistribution of the quasiparticles into a more favorable non-equilibrium distribution – a phenomenon known as the Eliashberg effect. In the first part of the talk, I will discuss coupling a two-dimensional superconducting film to the quantized electromagnetic modes of a microwave resonator cavity, which leads to a quantum version of the Eliashberg effect. We find that when the photon and quasiparticle systems are out of thermal equilibrium, a redistribution of quasiparticles into a more favorable non-equilibrium steady-state occurs, thereby enhancing superconductivity in the sample. We predict that by tailoring the cavity environment (e.g. the photon occupation and spectral functions), enhancement can be observed in a variety of parameter regimes, offering a large degree of tunability. In the second part of the talk, I will focus on generalizing polaritonic states to a variety of hybrid modes possible in superconducting systems interacting with cavity photons. Following the recent success of realizing exciton-polariton condensates in cavities, the hybridization of cavity photons with the closest analog of excitons within a superconductor – states called Bardasis-Schrieffer modes – will be discussed. Though Bardasis-Schrieffer modes do not typically couple directly to light, one can engineer a coupling with an externally imposed supercurrent, leading to the formation of hybridized Bardasis-Schrieffer-polariton states. These new excitations have nontrivial overlap with both the original photon states and d-wave superconducting fluctuations, implying that their condensation could produce a finite d-wave component of the superconducting order parameter – an exotic s±id superconducting state.

Speaker: Sara Haravifard

Title: Emergent Bound States and Impurity Pairs in chemically doped Shastry-Sutherland system

Abstract: Impurities often play a defining role in the ground states of frustrated quantum magnets. Studies of their effects are crucial in understanding of the various valence bond (VB) and resonating valence bond (RVB) states and other novel phases in these materials. SrCu2(BO3)2, an experimental realization of the Shastry-Sutherland (SS) lattice, provides a unique model system for such studies using both experimental and numerical approaches. Here we report effects of impurities on the crystals of bound states, and doping-induced emergent ground states in Mg-doped SrCu2(BO3)2, which remain stable up to high magnetic fields. Using four complementary magnetometry techniques and theoretical simulations, a rich impurity-induced phenomenology at high fields is discovered. The results demonstrate a rare example in which even a small doping concentration interacts strongly with both triplets and bound states of triplets, and thus plays a significant role in the magnetization process even at high magnetic fields. Our findings provide insights into the study of impurity effects in geometrically frustrated quantum magnets.

Speaker: Stacey Jeffery

Title: Quadratic speedup for finding marked vertices by quantum walks

Abstract: A quantum walk algorithm can detect the presence of a marked vertex on a graph quadratically faster than the corresponding random walk algorithm (Szegedy, FOCS 2004). However, quantum algorithms that actually find a marked element quadratically faster than a classical random walk were only known for the special case when the marked set consists of just a single vertex, or in the case of some specific graphs. We present a new quantum algorithm for finding a marked vertex in any graph, with any set of marked vertices, quadratically faster than the corresponding classical random walk. This is joint work with Andris Ambainis, András Gilyén, and Martins Kokainis

Speaker: Hosho Katsura

Title: Integrable dissipative spin chains

Abstract: We study two models of dissipative spin chains that can be mapped to integrable non-Hermitian models. The first model is a quantum compass chain with bulk dephasing. I will show that the Liouvillian of the system can be diagonalized exactly by mapping it to a non-Hermitian Kitaev model on a two-leg ladder. The second model is a quantum Ising chain with a particular form of the bulk dissipation. In this case, the Liouvillian turns out to be a non-Hermitian Ashkin-Teller model, which can be further mapped to an XXZ spin chain with pure imaginary anisotropy Δ. In both cases, we obtain exact results for the steady states and the Liouvillian gap (the inverse of the relaxation time) by exploiting the integrability of the systems.

Speaker: Dahlia Klein

Title: Magnetism in the Ultrathin Chromium Trihalides

Abstract: Recently, the family of layered 2D crystalline materials has expanded to include the chromium trihalides (CrX3), a class of insulating magnets. We first employ the magneto-optical Kerr effect to probe the magnetic ordering of CrI3 down to the monolayer limit. Beyond optical techniques, we present a new approach to probe the layer-dependent magnetic ordering of these materials using electrical transport. We fabricate spin-filter magnetic tunnel junctions from two graphite contacts separated by a few-layer crystal of CrX3 that serves as the insulating tunnel barrier. By measuring the differential conductance across the junction, we can electrically detect the magnetic ordering as a function of applied magnetic field and bias voltage. These results reveal interesting magnetic properties in ultrathin CrX3 differing from the bulk crystals. This new concept of magnetic tunnel junctions constructed by stacking 2D materials paves the way for discovering novel magnetic phenomena in the many unexplored layered magnetic insulators, as well as integration of these junctions in the spintronics community due generation of highly spin-polarized currents and large magnetoresistances.

Speaker: Michael Kolodrubetz

Title: Floquet systems with quantized drive

Abstract: Time-periodic (Floquet) drive has become a powerful tool to engineer phases of matter, both in equilibrium and far from equilibrium. In this talk, I argue that treating the degrees of freedom doing the driving – usually photons – as quantized leads to interesting phases of coupled light and matter. I motivate this idea by introducing the Floquet-Thouless energy pump [MHK et al, PRL 120, 150601 (2018)], where topological pumping naturally occurs not on the charge degrees of freedom but by a quantized backaction on the drive. I then show that non-trivial physics can occur in the even simpler case of many body localization [Ng and MHK, arXiv:1809.02606], where the localizing interactions compete against global coupling to the quantized cavity mode. Applications of this physics to many body cavity QED and superconducting circuit QED will be discussed.

Speaker: Austen Lamacraft

Title: Unitary circuits of finite depth and infinite width from quantum channels

Abstract: We introduce an approach to compute reduced density matrices for local quantum unitary circuits of finite depth and infinite width. Suppose the time-evolved state under the circuit is a matrix-product state with bond dimension D; then the reduced density matrix of a half-infinite system has the same spectrum as an appropriate D×D matrix acting on an ancilla space. We show that reduced density matrices at different spatial cuts are related by quantum channels acting on the ancilla space. This quantum channel approach allows for efficient numerical evaluation of the entanglement spectrum and Rényi entropies and their spatial fluctuations at finite times in an infinite system. We benchmark our numerical method on random unitary circuits, where many analytic results are available, and also show how our approach analytically recovers the behaviour of the kicked Ising model at the self-dual point. We study various properties of the spectra of the reduced density matrices and their spatial fluctuations in both the random and translation-invariant cases.

Speaker: Andrew MacKenzie

Title: Electrical transport and spectroscopy studies of the layered delafossite metal PdCrO2

Abstract: The delafossites, named after the French crystallographer Gabriel Delafosse, are triangular lattice layered materials with general formula ABO2. The family includes insulators, large gap semiconductors and a few astonishingly high conductivity metals. I will describe our group's work on one of those metals, PdCrO2, which can be thought of as a natural Mott insulator - metal heterostructure. I will discuss novel spectroscopic signatures observable in angle resolved photoemission spectroscopy (ARPES) due to the coupling between the two sub-systems, offering a novel route to obtaining magnetic information from non-spin-resolved ARPES.

Speaker: Frederic Mila

Title: Floating Phase versus Chiral Transition in a 1D Hard-Boson Model of Rydberg cold atoms

Abstract: We investigate the nature of the phase transition between the period-three charge-density wave and the disordered phase of a hard-boson model proposed in the context of cold-atom experiments. Building on a density-matrix renormalization group algorithm that takes full advantage of the hard-boson constraints, we study systems with up to 9000 sites and calculate the correlation length and the wave vector of the incommensurate short-range correlations with unprecedented accuracy. We provide strong numerical evidence that there is an intermediate floating phase far enough from the integrable Potts point, while in its vicinity, our numerical data are consistent with a unique transition in the Huse-Fisher chiral universality class.

Speaker: Aditi Mitra

Title: Disorder-free Floquet Symmetry Protected Topological Phases (SPT) in 1D

Abstract: In this talk I will give an overview of Floquet SPT phases in 1D. I will describe the topological invariants needed to understand these systems, and highlight how the entanglement scaling depends on these topological invariants. I will then show that many of the topological features encountered in free SPTs are remarkably robust to adding interactions. This robustness can be understood in the language of strong modes for free fermion SPTs, and almost strong modes for interacting SPTs.

Speaker: Giuseppe Mussardo

Title: Lieb-Liniger Tales

Abstract: We present several physical properties at equilibrium and away from equilibrium of Lieb-Liniger model, such as fragmentation, driven system and its connection to Sinh-Gordon model

Speaker: Masaki Oshikawa

Title: Sum Rules for Linear and Non-Linear Conductivities

Abstract: I will derive the f-sum rule for the electric conductivity for a very wide class of quantum many-particle systems, which is not necessarily described by a kinetic term and density-density
interactions. It is then extended to an infinite family of sum rules on each order of nonlinear conductivities.

Speaker: Didier Poiblanc

Title: Topological chiral spin liquids in quantum antiferromagnets

Abstract: Abelian and non-Abelian topological phases exhibiting protected chiral edge modes are ubiquitous in the realm of the Fractional Quantum Hall (FQH) effect. Here, we investigate a spin-1/2 and spin-1 Hamiltonians on the square lattice which could, potentially, host spin liquid analogs of (bosonic) Abelian Laughlin and non-Abelian Moore-Read FQH states. Using families of fully SU(2)-spin symmetric and translationally invariant chiral Projected Entangled Pair States (PEPS), variational energy optimization is performed using infinite-PEPS methods. From the investigation of the entanglement spectrum, we observe sharply defined chiral edge modes following the prediction of the SU(2)k, k=1,2, Wess-Zumino-Witten theories.

Speaker: Anatoli Polkovnikov

Title: Explicit construction and Floquet realization of counter-diabatic protocols in quantum and classical systems

Abstract: In this talk I will show how one can explicitly construct gauge potentials (generators of adiabatic transformations) in generic complex systems. These gauge potentials can be used to construct counter-diabatic protocols as well as to define geometry of quantum states, compute non-adiabatic response coefficients, define quantum speed limits and optimal paths for state preparation and so on. I will also show how one can realize these gauge potentials using Floquet engineering and demonstrate the utility of this approach using several examples.

Speaker: Tomaz Prosen

Title: Exact Correlation Functions for Dual-Unitary Lattice Models in 1+1 Dimensions

Abstract: We consider a class of quantum lattice models in 1+1 dimensions represented as local quantum circuits that enjoy a particular "dual-unitarity" property. In essence, this property ensures that both the evolution "in time" and that "in space" are given in terms of unitary transfer matrices. We show that for this class of circuits, generically non-integrable, one can compute explicitly all dynamical correlations of local observables. Our result is exact, non-pertubative, and holds for any dimension d of the local Hilbert space. In the minimal case of qubits (d=2) we also present a classification of all dual-unitary circuits which allows us to single out a number of distinct classes for the behaviour of the dynamical correlations. We find "non-interacting" classes, where all correlations are preserved, the ergodic and mixing one, where all correlations decay, and, interestingly, also classes that are are both interacting and non-ergodic

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].

Speaker: Norbert Schuch

Title: Order parameters for topological phases from tensor networks
Abstract: Topologically ordered phases are characterized through order in their entanglement. Tensor networks provide us with a means to directly access these entanglement degrees of freedom. In my talk, I will discuss how tensor network simulations allow us to extract order parameters for anyonic excitations from the entanglement, thereby providing us with means to characterize topological phases and phase transitions despite the non-local nature of their order.

Speaker: Maksym Serbyn

Title: From quantum many-body scars to mixed phase spaces
Abstract:

Speaker: Steve Simon

Title: Thermal Transport of Edge States in the 5/2 Quantum Hall State
Abstract:

Speaker: Luca Tagliacozzo

Title: On robust aspects of the out-of-equilibrium dynamics
Abstract: We will discuss some robust features of the out-of-equilibrium dynamics for systems quenched close to a critical point described by a 1+1D CFT. We will elaborate on the consequence of our observations for tensor network algorithms