QSOE13

Participant	Title	Abstract
Frithjof Anders	Influence of vibrational modes on the quantum transport through a nano-device	We use the recently proposed scattering states numerical renormalization group (SNRG) approach to calculate $I(V)$ and the differential conductance through a single molecular level coupled to a local molecular phonon. We also discuss the equilibrium physics of the model and demonstrate that the low-energy Hamiltonian is given by an effective interacting resonant level model. The suppression of the current for asymmetric junctions with increasing electron-phonon coupling, the hallmark of the Franck-Condon blockade, is discussed. We will give an outlook to possible theoretical explanations for the experimentally found hysteretic behavior in the I-V curves.
Enrico Arrigoni	Steady-State Nonequilibrium Dynamical Mean Field Theory: an auxiliary Lindblad Master Equation approach	We present a method to compute electronic steady state properties of strongly correlated quantum systems out of equilibrium within dynamical mean-field theory (DMFT). The DMFT solver is based on the exact solution of an auxiliary system consisting of a small number of bath sites coupled to the interacting impurity and to two Markovian reservoirs. The steady state Green's function of the auxiliary system is solved by exact diagonalisation of the corresponding many-body Lindblad equation. The approach can be regarded as the non-equilibrium extension of the exact-diagonalization based DMFT.
Michael Bauer	Dynamics in Correlated Materials Probed by Femtosecond XUV Photoemission	The combination of femtosecond light sources in the UV spectral regime and the technique of photoelectron spectroscopy provides a unique tool for tracking ultrafast processes in condensed matter systems that couple to electronic degrees of freedom. Angular resolution enables one in this context to monitor the temporal evolution of the valence electronic band structure of a solid at selected - and possibly critical - points in momentum space [1]. The application of XUV photon pulses from high harmonic generation light sources [2] enlarges the accessible momentum regime considerably so that band structure transients within the entire Brillouin zone or even beyond can be recorded [3]. In this contribution, different examples of our work using time-resolved XUV-ARPES will be presented. I will show how this technique enables one to monitor the relaxation dynamics of hot carriers in graphite in a very direct manner by probing the involved electronic states located at the boundary of the Brillouin zone [4]. In a second example I will report on results on the laser-induced melting of charge density wave phases in different compounds out of the class of the transition metal dichalcogenides [5]. This systematic study provides conclusive evidence for the existence of the excitonic insulator phase in 1T -TiSe2 [6]. Finally, some recent time-resolved ARPES data on BaFe2As2 will be presented. We observe a characteristic in-phase oscillation in the electronic structure at the - and the X-point associated with the excitation of the As A1g mode. Potential implications of this experimental finding are made based on a theoretical model which considers the effect of the Fe-As-Fe bond angle onto the electronic structure of BaFe2As2. [1] F. Schmitt et al., Science 321, 1649 (2008). [2] A. Rundquist, et al., Science, 280 1412 (1998). [3] S. Mathias et al., Rev. Sci. Instr. 78, 083105 (2007). [4] A. Stange et al., Eur. Phys. J. Web of Conferences 41, 04022 (2013). [5] T. Rohwer et al., Nature 471, 490 (2011). [6] S. Hellmann et al., Nature Comm. 3, 1069 (2012).
Wolfgang Belzig	Entanglement generation in a quantum system out of equilibrium	We discuss entanglement generation in a closed system of one or two atomic quantum dots (qubits) coupled to a pool of cold interacting bosons. The system exhibits rich entanglement dynamics. We show that both the number of bosons in the pool and the boson-boson interaction crucially affect the entanglement characteristics of the system. The tripartite system of two atomic quantum dots and a pool of bosons reduces to a qubit-qutrit-qubit realization. We consider entanglement possibilities of the pure system as well as of reduced ones by tracing out one of the constituents, and show how the entanglement can be controlled by varying system parameters. We demonstrate that the qutrit, as expected, plays a leading role in entangling of the two qubits and the maximum entanglement depends in a nontrivial way on the pool characteristics.
Jean-Sébastien Bernier	Emergence of spatially extended pair coherence through incoherent local environmental coupling	I will demonstrate that quantum coherence can be generated by the interplay of coupling to an incoherent environment and kinetic processes. I will show that this joint effect even occurs in a repulsively interacting fermionic system initially prepared in an incoherent Mott insulating state. In this particular case, coupling a dissipative noise field to the local spin density produces coherent pairs of fermions. The generated pair coherence, while metastable, is long lived and spatially extended. This conceptually surprising approach provides a novel path towards a better control of quantum many-body correlations.
Edouard Boulat	Out-of-equilibrium properties of integrable quantum impurity systems in their strong coupling regime	Quantum impurity models can be very naturally driven out-of-equilibrium, by connecting them to several baths in different equilibrium states. The description of the steady state resulting from biasing the baths is still an open problem in the generic case where interactions are present. In the case of integrable impurity models, it turns out that the exact solution *in equilibrium* cannot be straightforwardly extended to describe the out-of-equilibrium properties. In this talk, I will show that in some integrable impurity models, their exists a method allowing for an exact and systematic expansion in the bias, at arbitrary order, valid to describe dynamical forcing. This method will be applied to the specific example of the interacting resonant level model, where electrical and thermal currents are computed for AC forcing.
Uwe Bovensiepen	Femtosecond laser-induced changes of the cuprate electronic structure	In the cuprate superconductors the nature of single particle excitations and their interaction with collective excitations present considerable challenges. For example, the "70 meV kink" in the electronic structure and associated mass renormalization is controversially discussed. One underlying problem is that the energy scales associated with the considered collective modes fall within a similar energy range, thereby making a clear distinction non-trivial. Using femtosecond laser-based time- and angle-resolved photoemission, we offer new insights into the origin of this mass renormalization by exploring interactions in the time domain. We show that the interaction producing the kink can be perturbed on timescales of a few tens of femtoseconds. Further we identified effective photo-doping which suggests novel schemes for electro-optical applications.
Giuseppe Piero Brandino	Quench Dynamics in the trapped Lieb-Liniger gas	We present a study of the effects of a quantum quench for a trapped Bose gas in one dimension, released into a cosine potential. After showing the ability of our numerical approach to correctly describe the spectrum of the system, we study the time evolution of a set of observables and we give hints of the existence of new effectively conserved charges in the perturbed and nonintegrable model. These might be of interest in the interpretation of quantum integrability breaking based on its classical equivalent (KAM theorem).
Jean-Philippe Brantut	Conduction properties of trapped Fermi gases	
Heinz-Peter Breuer	Quantum Non-Markovianity in Open Systems	The dynamics of open quantum systems is usually modeled by means of Markovian processes in which the open system irretrievably loses information to its surroundings. However, in complex many-body systems a reduced set of dynamical variables often shows a pronounced non-Markovian behavior which is characterized by a flow of information from the environment back to the open system. This backflow of information implies the presence of memory effects and represents the key feature of non-Markovian quantum dynamics. We will explain the general theoretical characterization and quantification of non-Markovianity in the quantum regime, and discuss recent experiments which allow to control the information flow between system and environment and to monitor the transition from the Markovian to the non-Markovian regime. Moreover, we will develop schemes for the experimental detection of system-environment correlations, and introduce the concept of nonlocal memory effects in composite open systems.
Christoph Bruder	Superfluid drag of two-species Bose-Einstein condensates in optical lattices	The talk will consider two-species Bose-Einstein condensates in quasi two-dimensional optical lattices of varying geometry and potential depth [1]. Based on the numerically exact Bloch and Wannier functions obtained using the plane-wave expansion method, we quantify the drag (entrainment coupling) between the condensate components. This drag originates from the (short range) interspecies interaction and increases with the kinetic energy. As a result of the interplay between interaction and kinetic energy effects, the superfluid-drag coefficient shows a non-monotonic dependence on the lattice depth. To make contact with future experiments, we quantitatively investigate the drag for mass ratios corresponding to relevant atomic species. [1] P. Hofer, C. Bruder, and V.M. Stojanovic, Phys. Rev. A 86, 033627 (2012).
Iacopo Carusotto	Theory and experiments with quantum fluids of light	A few years after the rst observation of Bose-Einstein condensation, quantum gases of dressed photons in semiconductor microcavities (the so-called exciton-polaritons) are a powerful workbench for the study of phase transitions and many-body effects in a novel non-equilibrium context. In this talk, I will rst briey review remarkable experiments investigating superuid hydrodynamics effects in photon uids hitting localized defects: depending on the ow speed, a wide range of behaviors have been observed, from

		superuid ow, to the super-sonic Mach cone, to the nucleation of topological excitations such as solitons and vortices. I will then illustrate recent theoretical studies in the direction of generating strongly correlated photon gases, from Tonks-Girardeau gases of impenetrable photons in one-dimension, to quantum Hall liquids in the presence of articial magnetic elds. Advantages and disadvantages of the different material platforms in view of generating and detecting strongly correlated gases will be reviewed, in particular laterally patterned microcavity and micropillar devices in the optical range, and circuit-QED devices in the microwave domain.
Michael Chapman	Non-equilibrium quantum spin dynamics--from spin-nematic squeezing to dynamical stabilization	We present our recent measurements of the non-equilibrium spin dynamics of a spin-1 Bose-Einstein condensate initialized to the hyperbolic fixed point of the phase space by quenching the system through a quantum phase transition. In the mean-field limit, this is a non-evolving configuration analogous to an inverted pendulum; however, the quantum fluctuations of the many-body state generate characteristic quantum spin dynamics that we have investigated in three experiments. In the first, we demonstrate that early time evolution leads to Gaussian spin-nematic quadrature squeezing that improves on the standard quantum limit by up to 8–10 dB [1]. This squeezing is associated with negligible occupation of the squeezed modes, and is analogous to optical two-mode vacuum squeezing. In the second experiment, we have studied the evolution beyond the low-depletion limit in detail and demonstrated that evolution along the separatrix creates a rich variety of non-Gaussian states, which we characterize by measurements of the full probability distribution of the spin populations [2]. In the third experiment, we demonstrate dynamic stabilization of the spin dynamics by periodic manipulation of the phase of the states [3]. To stabilize the system, periodic microwave pulses are applied that manipulate the spin-nematic quantum correlations and coherently limit their growth. The range of pulse periods and phase shifts with which the condensate can be stabilized is measured and compares well with a linear stability analysis of the problem. These results are many-body analogues to 'Kapitza's pendulum' and rf Paul traps and demonstrate new methods of manipulating out-of-equilibrium quantum many-body systems, drawing together ideas from classical Hamiltonian dynamics and quantum squeezing of collective states. [1] C. D. Hamley, et al., Nature Physics 8(4), 305 (2012). [2] C.S. Gerving, et al., Nat. Commun., 3:1169, (2012). [3] T.M. Hoang, et al, arXiv:1209.4363v1 [cond-mat.quant-gas] (2012), submitted.
Chung-Hou Chung	Non-equilibrium quantum transport through a dissipative resonant level	The resonant-level model represents a paradigmatic quantum system which serves as a basis for many other quantum impurity models. We provide a comprehensive analysis of the non-equilibrium transport near a quantum phase transition in a spinless dissipative resonant-level model, extending earlier work [Phys. Rev. Lett. 102, 216803 (2009)]. A detailed derivation of a rigorous mapping of our system onto an effective Kondo model is presented. A controlled energy-dependent renormalization group approach is applied to compute the non-equilibrium current in the presence of a finite bias voltage V. In the linear response regime V ->0, the system exhibits as a function of the dissipative strength a localized-delocalized quantum transition of the Kosterlitz-Thouless (KT) type. We address fundamental issues of the non-equilibrium transport near the quantum phase transition: Does the bias voltage play the same role as temperature to smear out the transition? What is the scaling of the non-equilibrium conductance near the transition? At finite temperatures, we show that the conductance follows the equilibrium scaling for V< T, while it obeys a distinct non-equilibrium profile for V>T. We furthermore provide new signatures of the transition in the finite-frequency current noise and AC conductance via the recently developed Functional Renormalization Group (FRG) approach. The generalization of our analysis to non-equilibrium transport through a resonant level coupled to two chiral Luttinger-liquid leads, generated by the fractional quantum Hall edge states, is discussed. Our work on dissipative resonant level has direct relevance to the experiments in a quantum dot coupled to resistive environment, such as H. Mebrahtu et al., Nature 488, 61, (2012). Reference: 1. *Chung-Hou Chung, Karyn Le Hur, Gleb Finkelstein, Matthias Vojta, Peter Woelfle, Phys. Rev. B 87, 245310 (2013). 2. *Chung-Hou Chung, Karyn Le Hur, Matthias Vojta, Peter Woelfle, Phys. Rev. Lett. 102, 216803 (2009)
Roberta Citro	Slow quench dynamics in a Luttinger liquid	We investigate the response of a Bosonic gas subjected to a slow parameter change. We focus on the analysis of the response of a Lieb--Liniger Bose gas within a bosonization analysis and compare our results with numerical results obtained for the Bose--Hubbard model taking its continuum limit for different limiting regimes. In a certain regime of parameters, we find unconventional decay of stretched exponential form for the single-particle correlation function. This is very untypical for a one-dimensional system in which typically an algebraic decay occurs.
Eugene Demler	Surprising universality of Wigner crystallization transitions	
Jure Demsar	Exploring quantum solids with femtosecond real-time techniques	Jure Demsar, Institut für Physik, TU Ilmenau; In recent years we are experiencing major advancements in femtosecond time-resolved methods. These techniques render access to the time-evolution of the complex dielectric function from sub-terahertz frequencies to ultraviolet, to the dynamics of changes in the electronic band structure and distribution using time and angular resolved photoemission, or to the underlying structural dynamics via femtosecond time-resolved X-ray or electron diffraction. Such methods provide unique information on the nature and dynamics of low energy excitations,1,2 on the coupling strengths between different degrees of freedom,3,4 and can be used also to control the competing/cooperating order parameters.4,5 Following an introduction to the techniques, I will present some recent studies on order parameter dynamics in superconductors and density wave systems.
Peter Domokos	Many-body physics with ultracold atoms strongly coupled to an optical cavity	We discuss the physics of ultracold bosonic atoms interacting with the radiation field of a high-finesse resonator. We consider the spatial self-organization of the matter wave field, which is a non-equilibrium phase transition. We discuss how the damping of matter wave excitations due to atom-atom collisions is strongly influenced by the global coupling to the resonator field.
Amit Dutta	Quench Dynamics of Edge States in 2-D Topological Insulator Ribbons	We study the dynamics of edge states of the two dimensional BHZ Hamiltonian in a ribbon geometry following a sudden quench to the quantum critical point separating the topological insulator phase from the trivial insulator phase. The effective edge state Hamiltonian is a collection of decoupled qubit-like two-level systems which get coupled to bulk states following the quench. We notice a pronounced collapse and revival of the Lochschmidt echo for low-energy edge states illustrating the oscillation of the state between the two edges. We also observe a similar collapse and revival in the spin Hall current carried by these edge states, leading to a persistence of its time-averaged value.
Martin Eckstein	Hamiltonian based impurity solvers for nonequilibrium dynamical mean-field theory	Nonequilibrium DMFT can be used to simulate dynamics in strongly correlated systems on short timescales, such as quench dynamics in ultra-cold atoms, or femtosecond pump-probe experiments in correlated materials. In DMFT, the lattice problem is mapped to a quantum impurity model, consisting of a single site which is coupled to a bath of noninteracting degrees of freedom. Up to now, Quantum Monte Carlo and diagrammatic approached have been used to solve this problem, which rely on an action representation of the impurity problem. In this talk, I discuss the mapping of the DMFT impurity problem onto an Anderson impurity Hamiltonian, which can then be solved using the Krylov technique. First results are presented for a quench in the Hubbard model, starting from the atomic limit of unconnected sites. [1] Ch. Gramsch, K. Balzer, M. Eckstein, M. Kollar, arXiv:1306.6315. [2] F. Hofmann, M. Eckstein, E. Arrigoni, M. Potthoff, arXiv:1306.6340.
Jens Eisert	Fast and slow quenches	This talk will be concerned with many-body systems out of equilibrium, following fast and slow quenches. We address theoretical progress on the questions of how non-integrable systems apparently thermalise via non-equilibrium dynamics and how correlations spread in the course of slow quenches. We put these results into context with recent experimental work on systems of ultra-cold atoms slowly undergoing a phase transition in instances of quantum simulators.

		(Mentions joint work with M. Friesdorf, A. Riera, M. del Rey, S. Braun, U. Schneider, I. Bloch)
Viktor Eisler	Quantum fronts and random matrices	One-dimensional free fermions are studied with emphasis on propagating fronts emerging from a step initial condition. The probability distribution of the number of particles at the edge of the front is determined exactly. It is found that the full counting statistics coincide with the eigenvalue statistics of the edge spectrum of matrices from the Gaussian unitary ensemble. The correspondence established between the random matrix eigenvalues and the particle positions yields the order statistics of the rightmost particles in the front and, furthermore, it implies their subdiffusive spreading.
Fabian Essler	Quantum Quenches in Integrable Models	I discuss a new approach to the non-equilibrium time evolution in integrable models after a quantum quench.
Hans Gerd Evertz	Bound states and Quantum Bowling	The Heisenberg spin chain (XXZ model) contains bound states, so-called string states, which have been difficult to see experimentally. Employing time dependent DMRG, we discuss a nonequilibrium setup with a local quench in which these states become prominent (PRL 108, 077206, 2012). They persist even when integrability breaking perturbations are included. Following our setup, such bound states have recently been observed in a cold atom experiment (arXiv:1305.6598). The second part of the talk will introduce "Quantum Bowling", the scattering of propagating soliton-like particles from a wall of bound particles, in the XXZ model and the 1d Bose and Fermi Hubbard models. We show that there is a simple but very surprising pattern of scattering, very different from classical behavior (arxiv:1302.2667). Several potential applications will be discussed, including a fermionic Quantum Newton's cradle.
Rosario Fazio	Quantum Quenches, Linear Response and Superfluidity Out of Equilibrium	TBA
Roberto Emilio Franco Peñaloza	Universality and the thermoelectric transport properties through semiconductor nanostructures	Lucas E. V. Sala (1), R. Franco (1,2) and L. N. Oliveira (1). 1. Instituto de F\'{\i}sica de S\~ao Carlos, Universidade de S\~ao Paulo, 13560-970 S\~ao Carlos, SP – Brazil. 2. Departamento de F\'{\i}sica, Universidad Nacional de Colombia, A. A 5997, Bogotà – Colombia. We will discuss the temperature-dependent thermoelectric transport properties of semiconductor nanostructures comprising a quantum dot coupled to quantum wires, that is, the thermal dependences of the electrical conductance, thermal conductance and thermopower. The physics of electrical and thermal conduction through the nanostructures is controlled by the antiferromagnetic interaction between the magnetic moment of the dot and the spins of the conduction electrons in the wires. At low temperatures, the conduction electrons tend to screen the dot moment, which originates the Kondo effect. We explore the universality of the thermoelectric properties in the temperature range governed by the Kondo crossover. In this thermal range, general arguments indicate that the temperature dependence of any equilibrium property should be a universal function of the ratio T/T_K, where T_K is the Kondo temperature. Experimental work has nevertheless failed to identified universal behavior [1]. On the theoretical front, the zero-bias electrical conductance through a quantum dot embedded in a quantum wire and the conductance through a quantum wire side-coupled to a quantum dot have recently been shown to map linearly onto the universal conductance for the particle-hole symmetric, spin-degenerate Anderson model [2]. Here we extend this result to the other thermoelectric transport properties, the thermopower and the thermal conductance. Our analysis relies on rigorous renormalization-group arguments. Illustrative numerical renormalization-group [3] results will be presented to bring out the physics in our findings. [1] M. Grobis, I. G. Rau, R. M. Potok, H. Shtrikman, and D. Goldaber-Gordon, Phys. Rev. Lett. 100, 246601 (2008) and references therein. [2] A. C. Seridonio, M. Yoshida and L. N. Oliveira, Phys. Rev. B 80, 235317 (2009); 80, 23518 (2009). [3] K. G. Wilson, Rev. Mod. Phys. 47, 773 (1975); R. Bulla, T. Costi, and T. Pruschke, Rev. Mod. Phys. 80, 55 (2007).
David Guéry-Odelin	Matter wave scattering on complex potentials	TBA
Fabian Heidrich-Meisner	Non-equilibrium dynamics of interacting bosons in one dimensional optical lattices	In recent experiments with ultracold atomic gases [1,2], the expansion dynamics of both interacting fermions and bosons has been studied, induced by quenching the trapping potential to zero. Interactions, dimensionality, and integrabilty all play an important role. There are several interesting questions: First, one can address the emergence of ballistic dynamics due to non-trivial conservation laws, and study the effect of integrability breaking [3]. Second, measuring the momentum distribution or densities during the expansion may serve as a probe of the initial state. Third, the form of the momentum distribution function in the asymptotic limit of infinitely long expansion times may be fully constrained by conservation laws [4]. I will present examples for all these cases, showing for instance that different ways of breaking the integrability of hard-core bosons in 1D result in a strong or mild suppression of ballistic dynamics. For both the Bose- and the Fermi-Hubbard model, the presence of a Mott insulator in the initial state leaves clear fingerprints in the asymptotic form of experimentally accessible quantities [3,5]. [1] Schneider et al., Nat. Phys. 8, 213 (2012) [2] Ronzheimer et al., Phys. Rev. Lett., in press (2013), arXiv:1301.5329 [3] Langer et al., Phys. Rev. A 85, 043618 (2012) [4] Bolech et al., Phys. Rev. Lett. 109, 110602 (2012) [5] Vidmar et al., in preparation
Walter Hofstetter	TBA	TBA
David Huse	Localization protected quantum order	tba
Massimo Inguscio	A One-Dimensional Liquid of Multispin Fermions	TBA
Jonathan Keeling	Non-equilibrium coherence in light-matter system (TBC)	TBC
Stefan Kehrein	Dynamical phase transition in the transverse field Ising model	t.b.a.
Michael Köhl	Spin dynamics in two-dimensional Fermi gases	Harnessing spins as carriers for information has emerged as an elegant extension to the transport of electrical charges. The coherence of such spin transport in spintronic circuits is determined by the lifetime of spin excitations and by spin diffusion. Fermionic quantum gases are a unique system to study the fundamentals of spin transport from first principles since interactions can be precisely tailored and the dynamics is on time scales which are directly observable. In particular at unitarity, spin transport is dictated by diffusion and is expected to reach a universal, quantum-limited diffusivity on the order of /m. Here, we study the non-equilibrium dynamics of a two-dimensional Fermi gas following a quench into a metastable, transversely polarized spin state. Using the spin-echo technique, we measure the yet lowest (in any system) transverse spin diffusion constant of 0.25(3) /m. For weak interactions, we observe a coherent collective transverse spin-wave mode that exhibits mode softening when approaching the strongly interacting regime.
Marcus Kollar	Prethermalization and thermalization of weakly interacting quantum systems	When a quantum many-body system is suddenly forced out of equilibrium, it is expected to relax to the thermal state predicted by statistical mechanics, which depends only on energy and particle number. However, integrable systems usually relax instead to a nonthermal state, because a detailed memory on the initial conditions persists due to the many constants of motion. A special situation arises for weakly interacting systems: because of the nearby integrable, noninteracting Hamiltonian they are first trapped in a so-called prethermalized state, and can thermalize only at a later stage. This prethermalization plateau is again due to a large number of - now only approximate - constants of motion and can be represented by a generalized Gibbs ensemble. As the time evolution continues, we can describe the decay

		of this quasistationary state and the crossover to the thermal state by a kinetic integro-differential equation, with good quantitative agreement for quenches to small Hubbard interaction. This approach provides a controlled and conceptually straightforward description of the thermalization dynamics and establishes that thermalization canoccur even in the perturbative regime.
Robert Konik	Post-Quench Dynamics in the Lieb-Liniger Model: Glimmers of Quantum KAM	
Andreas Läuchli	Spreading of correlations in quenches with finite-temperature initial condition	TBA
Salvatore R. Manmana	Far-from-Equilibrium Quantum Magnetism with Ultracold Polar Molecules	A Recent proposal has indicated how to emulate tunable models of quantum magnetism with ultracold polar molecules. We discuss how a nonequilibrium set-up amenable to present molecule optical lattice experiments can be used to verify and benchmark the models and realize interesting correlated states, e.g., in the context of metrology. Our proposal can be applied irrespective of the experiments currently being well below unit filling and not quantum degenerate, and relies on a nonequilibrium protocol that can be viewed either as Ramsey spectroscopy or an interaction quench. To obtain a global understanding of the behavior, we treat short times pertubatively, develop analytic techniques to treat the Ising interaction limit, and apply the time-dependent density matrix renormalization group to disordered systems with long range interactions.
Volker Meden	Luttinger liquid properties of the steady state after a quantum quench	We study the dynamics resulting out of an abrupt change of the two-particle interaction in models of closed one-dimensional Fermi systems: the field theoretical Tomonaga-Luttinger model and a microscopic lattice model. Using a nonperturbative approach which is controlled for small two-particle interactions we are able to reach large times allowing us to access the properties of the nonthermal steady state of the lattice model. Comparing those to the exact solution of the full dynamics in the Tomonaga-Luttinger model we provide evidence for universal Luttinger liquid behavior of the steady state. This complements an earlier work on the the time evolution \emph this state [Phys.~Rev.~Lett.~{\bf 109}, 126406 (2012)]. We show that a single impurity leads to open and perfect chain fixed points similar to the ones found in equilibrium [Phys.~Rev.~Lett.~{\bf 68}, 1220 (1992)].
Julia Meyer	AC Josephson effect in topological Josephson junctions	t.b.a.
Marcin Mierzejewski	Eigenvalue statistics of reduced density matrix during driving and relaxation	We study a subsystem of an isolated one-dimensional correlated metal when it is driven by a steady electric field or when it relaxes after driving. We obtain numerically exact reduced density matrix ρ for subsystems which are sufficiently large to give significant eigenvalue statistics and spectra of $\log(\rho)$. We show that both for generic as well as for the integrable model the statistics follows the universality of Gaussian unitary and orthogonal ensembles for driven and equilibrium systems, respectively. Moreover, the spectra of modestly driven subsystems are well described by the Gibbs thermal distribution with the entropy determined by the time-dependent energy only.
Aditi Mitra	Correlation functions in the prethermalized regime after a quantum quench of a spin-chain	Results are presented for a two-point correlation function of a spin-chain after a quantum quench for an intermediate time regime where inelastic effects are weak. A Callan-Symanzik like equation for the correlation function is explicitly constructed which is used to show the appearance of two scaling regimes. One is for spatial separations within a light-cone, and the second is for spatial separations on the light cone. In both these regimes, the correlation function is found to decay with power-laws with new nonequilibrium exponents that differ from those in equilibrium, as well as from those obtained from a quadratic Luttinger liquid theory.
Roderich Moessner	Dynamics of driven quantum many-body systems	
Giovanna Morigi	ose-Glass Phases of Ultracold Atoms due to Cavity Backaction	We determine the quantum ground-state properties of ultracold bosonic atoms interacting with the mode of a high-finesse resonator. The atoms are confined by an external optical lattice, whose period is incommensurate with the cavity mode wave length, and are driven by a transverse laser, which is resonant with the cavity mode. While for pointlike atoms photon scattering into the cavity is suppressed, for sufficiently strong lasers quantum fluctuations can support the build-up of an intracavity field, which in turn amplifies quantum fluctuations. The dynamics is described by a Bose-Hubbard model where the coefficients due to the cavity field depend on the atomic density at all lattice sites. Quantum Monte Carlo simulations and mean-field calculations show that for large parameter regions cavity backaction forces the atoms into clusters with a checkerboard density distribution. Here, the ground state lacks superfluidity and possesses finite compressibility, typical of a Bose-glass. This system constitutes a novel setting where quantum fluctuations give rise to effects usually associated with disorder.
Giuseppe Mussardo	Time evolution in integrable models and Generalized Gibbs Ensemble	We discuss the quantum integrable models in the limit of large occupation numbers, when the dynamics can be described in terms of classical equation of motion. We make use of Inverse Scattering Method (in the finite gap context) and semi-classical Bethe Ansatz Equations to match time averages of local quantities with ensemble averages which involve the infinite number of conserved quantities
Hanns-Christoph Nägerl	Quench dynamics in strongly correlated Bose-Hubbard chains	We present a series of experiments in the context of 1D physics with ultracold atoms, combining optical lattice potentials with the capability to tune the strength of the onsite particle interaction U. For an array of tilted 1D chains with site-to-site tilt E and initial unity occupation we record the dynamics after a quench to the phase transition point UE by monitoring the number of doublons created as a function of time after the quench. We observe characteristic oscillations from which we deduce a shift of the resonance condition as time progresses. For U/2E and U/3E we observe coupling to next-nearest neighbors and beyond.
Markus Oberthaler	New miscible-immiscible transition in two component Bose Gases	Markus K. Oberthaler Universität Heidelberg, Kirchhoff Institut für Physik, Im Neuenheimer Feld 227, 69120 Heidelberg Two component condensates offer a very promising experimental system for the study of out of equilibrium physics and universal scaling. We will report on our recent findings on the dynamics of two component Rubidium Bose Einstein condensates in zero- and one-dimensional situations. While the tuning between miscible and immiscible using Feshbach resonances is well established we will report on the control by linear coupling of the two components offering a new very well controllable parameter of the underlying Hamiltonian. With that we investigate the quantum dynamics in zero dimensions. The qualitative observations are well captured by the unstable fixed point arising in the classical description of the system. If the system is extended to one dimension the formation of domains can be observed. We investigate in detail the dynamics for different quenches and analyze the observed spin pattern with spatial spin correlation functions. The results suggest that the observations follow a universal scaling as expected close to the critical point of a corresponding quantum phase transition. The new experimental system allows the investigation of both sides – order and disordered - of the transition.
Takashi Oka	Driven correlated systems: Hubbard model and QCD	Many-body systems driven by external electric fields show many interesting features. One example is the Floquet topological phase transition [1,2,3], in which the topology of the electronic band structure can be controlled by continuous AC-fields. In graphene, the Haldane model [4] of quantum Hall effect without Landau levels can be effectively realized using circularly polarized light [1,2]. The problem we want to focus here is the effect of correlation. When a strong electric field is applied to a correlated insulator, quantum tunneling takes place leading to an insulator-to-metal transition. We studied this effect in the Mott phase of the Hubbard model [5,6] as well as in the confinement phase of supersymmetric large N QCD[7,8]. The former is studied by td-DMRG, non equilibrium DMFT, Bethe ansatz + Landau-Dykhne, while the latter is via gauge/gravity duality in the D3/D7 setup. The two studies deal with related phenomena, e.g., doublon-hole production vs quark-antiquark production, while the picture we obtain is quite different, e.g., non-equilibrium distribution vs effective Hawking

		temperature. In the talk, we will try to compare the two studies and obtain deeper understanding. If time permits, we will also explain the application to periodically driven Floquet states. [1] T. Oka and H. Aoki: Phys. Rev. B 79, 081406 (2009). [2] T. Kitagawa, T. Oka, A. Brataas, L. Fu, E. Demler: Phys. Rev. B 84, 235108 (2011). [3] N. H. Lindner, G. Refael, V. Galitski: Nat. Phys. 7 490 (2011). [4] F. D. M. Haldane: Phys. Rev. Lett. 61 2015 (1988). [5] T. Oka, H. Aoki: “Nonequilibrium Quantum Breakdown in a Strongly Correlated Electron System”, Lecture Note in Physics Vol. 762, Springer-Verlag, (2008). (arXiv:0803.0422) [6] M. Eckstein, T. Oka, P. Werner: Phys. Rev. Lett. 105, 146404 (2010). [7] K. Hashimoto, T. Oka: arXiv:2013. [8] K. Hashimoto, N. Iizuka, T. Oka: Phys. Rev. D 84, 066005 (2011) .
Giuliano Orso	Localization of bound states in quasi-periodic optical lattices	We discuss the formation of bound states made of two interacting atoms moving in a one dimensional (1D) quasi-periodic optical lattice. The underlying hamiltonian is the Aubry-André model with additional on-site interactions. We derive the quantum phase diagram for localization of both attractively and repulsively bound pairs. We calculate the pair binding energy and show analytically that its behavior as a function of the interaction strength depends crucially on the nature -extended, multifractal, localized- of the single-particle atomic states. Experimental implications of our results are discussed.
Herwig Ott	Dissipation Controlled Dynamics in an Open Many-Body Quantum System	Ultracold quantum gases are usually well isolated from the environment. This allows to study the ground state properties and the unitary dynamics of a many-body quantum system under almost ideal conditions. Introducing a controlled coupling to the environment “opens” the quantum system and non-unitary dynamics can be investigated. Such an approach provides new opportunities to study fundamental aspects of the quantum-to-classical transition and to engineer robust many-body quantum states. In this talk I will present an experimental platform [1,2,3] that allows for the controlled engineering of dissipation in ultracold quantum gases by means of localized particle losses. Changing the strength of the coupling to the environment (loss rate) induces a non-trivial dynamics where we can study generic signatures of open quantum systems. I will also discuss the prospects for realizing dissipative attractors and stable structures in optical lattices.
Michael Pustilnik	Equilibration of a strongly interacting one-dimensional quantum liquid	TBA
Marcos Rigol	Typicality and thermalization in isolated quantum systems	TBA
Achim Rosch	Nonlinear conductance of long quantum wires: Where does the voltage drop?	Where does the voltage drop in a clean, long quantum wire in the presence of interactions? Surprisingly, we find [1] that for long wires and sufficiently large voltages the voltage predominantly drops close to only one end of the quantum wire due to a thermoelectric effect. In the linear response regime, in contrast, the voltage drops linearly across the whole wire in models which are characterized by an infinite conductivity. We show that the physics of the problem is governed by the conservation of energy, charge and momentum and by the contacts to the leads. We study this question for a simple model: spinless fermions with short-ranged interactions. Close to the quantum phase transition where the conductance jumps from zero to one conductance quantum, the conductance obtains an universal form governed by the ratios of temperature, bias voltage and gate voltage. As interactions are highly irrelevant in the low density limit, one can study the problem using Boltzmann equations which include the effects of three-particle scattering. The numerical results are compared to asymptotically exact analytical results and hydrodynamic arguments. [1] T. Micklitz, A. Levchenko, A. Rosch, Phys. Rev. Lett. 109, 036405 (2012)
Lea Santos	Dependence on the initial state for the onset of thermalization	We show that the onset of thermalization in isolated quantum many-body systems is intimately related to the initial states. Initial states that are chaotic with respect to the Hamiltonian dictating the system evolution, i.e. initial states that fill the energy shell ergodically, may lead to thermalization even for models in the integrable domain. On the other hand, initial states with energies too close to the edges of the spectrum may not thermalize even if the system is chaotic. We also discuss the role of the initial states and the presence of interactions in the relaxation process of several few-body observables. Our numerical studies are based on full exact diagonalization of Heisenberg spin-1/2 systems.
Jörg Schmiedmayer	Do isolated quantum systems relax?	tba
Ulrich Schneider	Mass Transport and Emergence of Coherence in homogeneous Optical Lattices	Transport properties are among the defining characteristics of many important phases in condensed-matter physics, the most prominent example being electrical conductivity. Ultracold atoms in optical lattices offer the possibility to study transport and out-of-equilibrium phenomena in a clean and well-controlled environment. In this talk I will discuss experimental studies on the expansion of initially confined quantum gases of either fermionic [1] or bosonic [2] atoms in the lowest band of a homogeneous optical lattice in various dimensions. In addition I will present recent data on the emergence of coherence in a controlled quench from the Mott insulating into the superfluid regime of the Bose-Hubbard model. [1] U. Schneider et al., Nature Physics 8, 213 (2012) [2] J.P. Ronzheimer et al., ArXiv:1301.5329 (PRL, in press)
Dirk Schuricht	Integrability-based analysis of the hyperfine interaction induced decoherence in quantum dots	We study the decoherence of a spin in a quantum dot due to its hyperfine coupling to a fluctuating bath of nuclear spins. We calculate the spectrum and time evolution of the coherence factor using a Monte Carlo sampling of the exact eigenstates obtained via the algebraic Bethe Ansatz. The exactness of the obtained eigenstates allows us to study the full crossover from strong to weak external magnetic field in a full quantum mechanical treatment. We find a large non-decaying fraction in the zero-field limit which is explained by Bose-Einstein-condensate-like physics. We compare our results to a simple semiclassical picture and find surprisingly good agreement. Finally, we discuss the effect of weakly coupled spins and show that they will eventually lead to complete decoherence.
Klaus Sengstock	Dynamics of quantum gases in higher orbitals and quenches across phase transitions	
Krishnendu Sengupta	A perturbative renormalization group approach for driven quantum systems	TBA
Jesko Sirker	When is a bath a bath? Hermitian and non-Hermitian relaxation dynamics in a toy model	TBA
Sandro Stringari	Superfluidity phenomena in spin-orbit coupled Bose gases	Novel superfluid phenmena exhibited by spin-orbit coupled gases will be discussed. These include the consequence of the breaking of Galilean invariance on the stability of supercurrents, the emergence of a rotonic structure in the excitation spectrum and the occurrence of a double gapless band in the superstripe phase.
Naoto Tsuji	Quantum interaction quench in the presence of a long-range order	Quantum interaction quench defines dynamics after an abrupt change of the interaction parameter for an isolated quantum system, which can be implemented in experiments on cold atomic gases. It offers a fundamental question of whether and how the system thermalizes in an isolated environment. For example, it has been shown for a normal phase of fermionic systems that the so-called prethermalization occurs before thermalization takes place. Here we study the quantum interaction quench problem for the symmetry-broken phases (antiferromagnetism for the repulsive interaction or superconductivity for the attractive interaction) of the fermionic Hubbard model. The time evolution is obtained by the nonequilibrium dynamical mean-field theory. We show that, contrary to the case of the normal phase, the order parameter (which is a local quantity) does not immediately thermalize after the quench but stays to be a nonthermal finite value for a relatively long time even when the effective temperature exceeds the thermal critical temperature. It turns out that the dynamics of the order parameter (e.g., the Higgs mode) is governed a ``nonthermal

		critical point'', rather than the thermal critical point. Around the nonthermal critical point, there emerges a universality that characterizes the nonequilibrium phase transition.
David Weiss	Boson dynamics in a highly occupied 1D lattice	We have searched for the onset of thermalization in a 1D gas due the imperfectly delta-function interactions, which make real 1D gases slightly non-integrable. We find that the observed onset of thermalization is significantly slower than theoretical predictions. We cannot reliably assign the discrepancy to any particular source, but the difference between theory and experiment is at least suggestive of quantum KAM behavior.
Philipp Werner	Nonequilibrium dynamical mean field simulation of inhomogeneous systems	We use dynamical mean field theory to study dynamical phase transitions from antiferromagnetic to paramagnetic states driven by an interaction quench in the fermionic Hubbard model. In the weak-coupling regime, we identify two dynamical transition points where the relaxation behavior qualitatively changes: one corresponds to the thermal phase transition at which the order parameter decays critically slowly in a power law, and the other is connected to the existence of nonthermal antiferromagnetic order in systems with effective temperature above the thermal critical temperature.
Martin Zwierlein	Heavy Solitons in a Fermionic Superfluid	Topological excitations are found throughout nature, in proteins and DNA, as dislocations in crystals, as vortices in superfluids and superconductors, and generally in the wake of symmetry-breaking phase transitions. In fermionic systems, topological defects may provide bound states for fermions that often play a crucial role for the system's transport properties. Famous examples are Andreev bound states inside vortex cores, fractionally charged solitons in relativistic quantum field theory, and the spinless charged solitons responsible for the high conductivity of polymers. However, the free motion of topological defects in electronic systems is hindered by pinning at impurities. We have created long-lived solitons in a strongly interacting fermionic superfluid by imprinting a phase step into the superfluid wavefunction, and directly observed their oscillatory motion in the trapped superfluid [1]. As the interactions are tuned from the regime of Bose-Einstein condensation (BEC) of tightly bound molecules towards the Bardeen-Cooper-Schrieffer (BCS) limit of long-range Cooper pairs, the effective mass of the solitons increases dramatically to more than 200 times their bare mass. This signals their filling with Andreev states and strong quantum fluctuations. For the unitary Fermi gas, the mass enhancement is more than fifty times larger than expectations from mean-field Bogoliubov-de Gennes theory. In the presence of spin imbalance, the solitons created in our experiment represent one limit of the long sought-after Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) state of mobile Cooper pairs. [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, preprint arXiv:1302.4736 (2013)