Giulio Amato, Universität Freiburg
Quantum transport between two equilibrating reservoirs

We study quantum transport across an open quantum system connecting two finite reservoirs initially prepared with a finite particle number imbalance. The equilibration process of the reservoirs leads to a non-stationary current which vanishes once a global equilibrium condition is reached. This behaviour has been experimentally observed in quantum transport setups of fermionic ultracold atoms, with tunable interparticle interactions [1]. We devise a theoretical model based on a set of coupled quantum-classical master equations, describing the evolution of the system together with the temporal variation of the particle number in the reservoirs. We apply this formalism to investigate nonstationary bosonic currents across a one dimensional Bose-Hubbard lattice.
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Benedikt Ames, Universität Freiburg
Signatures of dipole-dipole interaction in 2D-spectroscopic signals of atomic gases

Recent experimental studies have revealed collective effects in 2D fluorescence spectra of dilute atomic gases. These signals persist down to the lowest experimentally accessible densities on the order of $10^7\,\mathrm{cm}^{-3}$ [1]. Given the large interatomic distances in this regime, the exchange of transverse photons is expected to play a significant role in the dipole-dipole interaction.
In order to identify the dominant contributions to the latter, we investigate a model that includes the retarded interaction as mediated by the quantized field and as such is valid across all length scales. In a first approach, we study the time evolution of the system in a master equation formulation that has previously been applied to coherent backscattering in the double scattering regime [2]. Secondly, we treat the same system perturbatively in the atom-laser coupling. By varying the strength of the coupling, we establish conditions under which the master equation approach yields the same results as the perturbative calculation.
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Markus Beims, mpipks Dresden
Quantum classical transition and quantum activation of ratchet currents in the parameter space

The quantum ratchet current is studied in the parameter space of the dissipative kicked rotor model coupled to a zero-temperature quantum environment. We show that vacuum fluctuations blur the generic isoperiodic stable structures found in the classical case. Such structures tend to survive when a measure of statistical dependence between the quantum and classical currents are displayed in the parameter space. In addition, we show that quantum fluctuations can be used to overcome transport barriers in the phase space. Related quantum ratchet current activation regions are spotted in the parameter space. Results are discussed based on quantum, semiclassical, and classical calculations. While the semiclassical dynamics involves vacuum fluctuations, the classical map is driven by thermal noise.

Paul Birk, MPI für Kernphysik Heidelberg
Strong-field-driven electron dynamics closely above the ionization threshold

Strong-field-driven electron dynamics closely above the first ionization threshold of helium are investigated by means of attosecond transient absorption spectroscopy. Our recently developed experimental method to record the in-situ reference of an XUV absorption spectrum allows to be highly sensitive to weak light-induced structures in the absorption continuum of helium. These structures originate from couplings between atomic bound states and the electron continuum as well as a ponderomotive shift on the ionized electron. The experimental results are compared with a multi-level simulation, where the bound states and the continuum are represented by appropriately sampled discrete energy levels.

Dana Bloß, Universität Kassel
Combination of a liquid microjet with electron impact induced fluorescence spectroscopy

Liquids and especially liquid water have been subject to intense research for a long time due to their role in many chemical and biological systems. However, the investigation of liquid targets with fundamental methods of atomic and molecular physics, such as soft X-ray induced fluorescence spectroscopy, were a big challenge due to the required vacuum conditions. With the development of the liquid microjet technique, using a micrometer sized fluid jet with low evaporation rate, investigations of liquids with such methods became possible. We already combined a liquid water microjet with fluorescence spectroscopy after photon impact excitation and measured a hitherto unreported emission assigned to the liquid phase of the jet. For more insight in this emission we build up a set-up for the investigation of fluorescence of liquids after electron impact excitation as complementary method und present the first results obtained with this method.

Eric Brunner, Universität Freiburg
Quantifying partial distinguishability in many-body systems

Many-particle interference is an essential ingredient in the complex dynamics of quantum systems and a consequence of the particles indistinguishability. We consider particles whose state space is augmented by an internal degree of freedom, which allows one to adjust their mutual distinguishability. Within this framework we quantify (partial) distinguishability of many-body states and investigate its influence on the expectation values of many-particle observables. These ideas can equally be applied to study correlations at the output of multi-mode interferometers, as well as the dynamics of interacting many-body systems. This paves the way for a generalization of the Hong-Ou-Mandel indistinguishability test to bosonic and fermionic systems of more than two particles.

Edoardo Carnio, Universität Freiburg
Resolution of the exponent puzzle for the Anderson transition in doped semiconductors

Thanks to the increase in computational power of the past decades, we can now study and predict the properties of materials starting from their atomistic composition. One of the fundamental manifestations of the quantum mechanical nature of disordered materials is the Anderson metal-insulator transition (MIT). In this work we employ *ab initio* methods to study the MIT in a realistic model of a doped semiconductor. We use linear-scaling density functional theory to simulate prototypes of sulfur-doped silicon (Si:S). From these we build larger tight-binding models close to the critical concentration of the MIT. When the dopant concentration is increased, an impurity band forms and eventually delocalizes. We characterize the MIT via multifractal finite-size scaling, obtaining estimates of the phase diagram and the critical exponent. Our results suggest an explanation of the long-standing exponent puzzle, which we link to the hybridization of conduction and impurity bands.Thanks to the increase in computational power of the past decades, we can now study and predict the properties of materials starting from their atomistic composition. One of the fundamental manifestations of the quantum mechanical nature of disordered materials is the Anderson metal-insulator transition (MIT). In this work we employ *ab initio* methods to study the MIT in a realistic model of a doped semiconductor. We use linear-scaling density functional theory to simulate prototypes of sulfur-doped silicon (Si:S). From these we build larger tight-binding models close to the critical concentration of the MIT. When the dopant concentration is increased, an impurity band forms and eventually delocalizes. We characterize the MIT via multifractal finite-size scaling, obtaining estimates of the phase diagram and the critical exponent. Our results suggest an explanation of the long-standing exponent puzzle, which we link to the hybridization of conduction and impurity bands.

Matthew Eiles, mpipks Dresden
Extreme correlation and repulsive interactions in highly excited atomic alkali anions

Abstract: At high energies, single-photon photodetachment of alkali negative ions populates final states where both the ejected electron and the residual valence electron possess high angular momenta. The photodetached electron interacts strongly with the anisotropic core, and thus the partial cross sections for these channels display non-Wigner threshold behavior reflecting these large, and occasionally repulsive, interactions. Our fully quantum-mechanical theoretical study enables a deeper interpretation of these partial cross sections. Comparisons of the behavior in different channels and between different atomic speciessodium, potassium, and cesiumshow the critical role of near degeneracies in the energy spectrum and demonstrate that much of the behavior of the partial photodetachment cross sections stems from the permanent, rather than induced, electric dipole moments of these nearly degenerate channels. This provides a concrete example of a system where negative dispersion forces play a decisive role.

Stephan Fritzsche, Helmholtz-Institut Jena & Universität Jena
Atoms in twisted lights

In this contribution, I shall discuss recent results on the excitation and ionization of atoms by twisted light. Emphasis will be placed especially on the interaction of localized atomic targets and with (Bessel) beams of varying intensity. Almost no JAC this time.

Sebastian Gemsheim, mpipks Dresden
High harmonic generation with twisted electrons

Achieving a greater control over the attosecond bursts of radiation emitted during high harmonic generation process is a sought-after goal. In this work, we try to accomplish this goal by using twisted electrons possessing orbital angular momentum. Thus, we derived a full quantum mechanical expression for the emission spectrum in a laser-assisted scattering scenario, extending semi-classical results in 1D from earlier works to a 3D case. We use these expressions to extract high harmonic emission characteristics and compare them with those obtained with more traditional approaches.

Nikolay Golubev, Ecole Polytechnique Federale de Lausanne (EPFL)
A new approach for calculating the logarithmic derivative of the time-dependent wavefunction

Computational treatment of quantum dynamics in molecules is often based, in one form or another, on the solution of the time-dependent Schrodinger equation. Due to extreme complexity of that problem, a lot of efforts were directed on the development of efficient approaches which allow to tackle dynamics in realistic systems. One of the most promising recent ideas is to use a specific ansatz for the full molecular wavefunction which is known as the exact factorization approach. In this case, the correlated motion of nuclei and electrons in a system is represented by the two coupled equations which contains terms responsible for the electron-nuclear couplings. Despite the bright promise of the exact factorization, the equations of motion appearing within this formalism are extremely complicated to solve. Namely, one of the key complexities is the necessity to calculate the logarithmic derivative $\nabla\chi(\mathbf{R}, t)/\chi(\mathbf{R}, t)$ of the time-dependent nuclear wave packet. Although at first glance the logarithmic derivative seems to be a straightforward quantity to calculate, it becomes clear upon closer inspection that its direct numerical evaluation is ill-defined. Here we present a new approach for the direct propagation of the logarithmic derivative in time. We hope that our study will stimulate further theoretical research aiming at developing computational approaches based on the factorized form of the molecular wavefunction.

Maximilian Hartmann, MPI für Kernphysik, Heidelberg
Direct observation of core-hole wave packet dynamics in xenon probed by strong-field coupling

While wave-packet dynamics among valence electrons have been investigated in several recent studies, wave packet dynamics involving atomic inner-shell excitations have not been observed so far. Here, we report on the observation of ultrafast coherent dynamics among 4d-hole-excited states in xenon using attosecond transient absorption spectroscopy. We initiate the wave packet by promoting an electron from the 4d core shell to the 6p valence shell via single-photon excitation by using coherent extreme ultraviolet radiation from high-order harmonic generation (HHG) in the presence of a time-delayed ultrashort near-infrared (NIR) laser pulse. The dynamics among the fine-structure levels in the core and the valence-shells lead to a characteristic modulation of the absorption spectra in the region of temporal pulse overlap. Our results open the way for element-specific and thus site-selective studies of coherent dynamics in larger systems where valence electrons can be delocalized across the structure, while the core electrons remain localized to specific atoms.

Jiri Hofbrucker, Universität Jena
Unexpected polarization transfer echos in atomic inner-shell two-photon ionization

Unexpected polarization transfer from incident to fluorescence photon is discovered in the case of two-photon inner-shell ionization by circularly polarized light. Beside the expected complete polarization transfer induced at incident photon energy tuned to intermediate resonances, echos of the polarization transfer occur at higher nonresonant incident photon energies due to vanishing of the dominant ionization channel. Measuring the polarization properties of the fluorescence light promises an opportunity to extract ionization properties out of an experiment with an unprecedented accuracy and carry out a critical comparison with available theory.

Andrew Hunter, mpipks Dresden
A Rydberg atomcoupled to a 2D lattice of ultracold ground state atoms

We investigate the spectrum of a Rydberg atom embedded in a two-dimensional lattice of ground state atoms. The strength of the interaction between the Rydberg electron and the neutral atoms is determined by the s-wave electron-atom scattering length. In the high lattice density regime, where many hundreds of atoms lie within the Rydberg wave function, we find that a class of perturbed states breaks away energetically from the others. These are circular states, highly localised in angular momentum. This is in stark contrast to the more familiar scenario of the trilobite" molecule, where just one perturbing atom couples together many angular momenta and a single state, highly localised in space, splits away from the degenerate Rydberg manifold. We derive new scaling laws which stem from the planar structure of the perturbers, and with these we obtain a universal form of the energy spectrum in the high density limit. We also investigate the perturbed spectrums dependence on the lattice properties.

Markus Ilchen, Universität Kassel
Nondipol effects in sequential photoionization of argon

The exceptional photon flux of free-electron lasers (FELs) enables multiple photon absorptions within a single femtosecond pulse, which in turn allows for deep insights into the photoionization process itself as well as into evolving ionic states of a target. Using the seeded short wavelength FEL FERMI in Italy, the sequential emission of electrons from gaseous, atomic argon in the neutral as well as the ionic ground state was investigated. A pronounced forward-backward symmetry breaking of the angularly resolved emission patterns with respect to the light propagation direction is experimentally observed and theoretically explained for the region of the Cooper minimum, i.e. around 50 eV, where the asymmetry of electron emission is strongly enhanced. Besides the finalized results for nondipole effects stemming from the direct photoionization of the ionic ground state, further observations will be presented regarding asymmetric Auger electron emission which is still under discussion.

Arkadiusz Kosior, Jagiellonian University Krakow
Unruh effect for interacting particles with ultracold atoms

The Unruh effect is a quantum relativistic effect where the accelerated observer perceives the vacuum as a thermal state. Here we propose the experimental realization of the Unruh effect for interacting ultracold fermions in optical lattices by a sudden quench resulting in vacuum acceleration with varying interactions strengths in the real temperature background. We observe the inversion of statistics for the low lying excitations in the Wightman function as a result of competition between the space-time and BCS Bogoliubov transformations. This paper opens up new perspectives for simulators of quantum gravity.

Dominik Lentrodt, MPI für Kernphysik, Heidelberg
X-ray quantum optics with Mössbauer nuclei

In recent years Mössbauer nuclei have become a platform for quantum optics with X-rays and various effects from the optical domain have already been demonstrated. However, so far all experiments have been in the linear excitation regime of the nuclear ensemble. In order to observe non-linear effects, higher intensities and quantum control of the excitation are required. Here, we present two avenues towards this goal. The first avenue uses concepts from optical cavity QED to enhance the light-matter interaction, with the challenge that x-ray cavities are highly open systems. Using a new ab-initio theory, we show how this so called overlapping modes regime of cavity QED can be exploited for quantum dynamics. In the second avenue we develop x-ray pulse shaping techniques that allow to boost the resonant intensity. Our experimental results for ^{57}Fe further show that the approach allows to coherently control the nuclear excitation featuring an unprecedented phase stability. Together, these methods provide tools to explore nuclear quantum dynamics in extreme regimes and will potentially allow to observe non-linear effects at modern x-ray sources.

Chunhai Lyu, MPI für Kernphysik, Heidelberg
Fully coherent hard-x-ray laser pumped by an x-ray free-electron laser

The advent of x-ray free-electron lasers (XFELs) has tremendously revolutionized the applications of x-rays in physics, chemistry and structural biology. Generated via stimulated amplification of spontaneously emitted x-rays photons by free electrons in undulators, such x-ray sources are typically characterized by pulse-like profiles with high intensities and good spatial coherences. However, the intensity profile of the XFEL pulses is random and endures pulse-to-pulse fluctuations, resulting in a poor temporal coherence and a broad bandwidth. In this talk, I will discuss a potential scheme to obtain a high-intensity, fully coherent x-ray laser in the hard-x-ray regime. This is achieved by the stimulated emission of atomic transitions in He-like highly charged ions, with the population inversion being pumped by fast XFEL K-shell photoionizations of Li-like ions existing in a laser-produced plasma. The output x-ray laser, with a transform-limited intensity profile and a narrow bandwidth, may be applicable in the study of x-ray quantum optics and metrology, investigating nonlinear interactions between x-rays and matter, or in high-precision spectroscopy studies in laboratory astrophysics.

Tommaso Mazza, European XFEL, Schenefeld
X-ray absorption spectroscopy of ultrafast-decaying core-excited ionic states in atoms

X-ray pulses with high intensities allow studying non-linear photo-processes in the short wavelength regime in atoms and molecules. These can include sequential and non-sequential multiphoton ionization and excitation processes, involving transient excited states and competing with ultrafast decay pathways. Very recently we could for the first time study the core-hole excitation of transient highly excited atoms by means of resonant Auger electron spectroscopy.

The study was performed at the SQS instrument of the European XFEL. Neon was ionized at the $1s$ shell and sequentially excited to different $1s^0 2s^2 2p^6 nl$ states within the same x-ray fs pulse. The Auger electron yield resulting from the decay of the specific excited states was collected by electron time-of-flight spectrometers. An evolution of the Auger yield and line structure with varying photon energy in the region 970eV 1000eV was observed.

I will report on the experimental results and on how their interpretations could allow the understanding of the electronic structure of transient ultrafast-decaying core-excited atomic (and in perspective molecular) ions.

Lukas Medisauskas, mpipks Dresden
High-harmonic spectroscopy of Floquet-Bloch bands

High-harmonics generation (HHG) intensively studied in atoms and molecules is now being actively investigated in periodic systems. While in the latter case the underlying physical mechanism is reminiscent of the three step model used in atoms, the harmonic spectra is largely determined by the band structure of the material. However, a strong electromagnetic field not only drives the electronic dynamics, but also modifies the underlying states. Such "dressed" states in the laser field can be very different from their field-free counterparts.

A general approach to compute the field-dressed states is based on Floquet methods, which we here apply to the case of low frequency driving, relevant for HHG. By solving the time-dependent Schroedinger equation and using an expansion into photon-number states, we reveal the underlying field-dressed bands responsible for emitted harmonics. We show that these states can have properties that are unlike their field-free counterparts, and that these properties are reflected in the emitted harmonic spectra.

Robert Müller, Physikalisch-Technische Bundesanstalt, Braunschweig
Hyperfine structure of doubly charged ^{229}Th

Janko Nauta, MPI für Kernphysik Heidelberg
Development of a HHG frequency comb for XUV metrology of Highly Charged Ions

Theoretical studies have shown that forbidden optical transitions in highly charged ions (HCI) are the most sensitive systems for probing the variation of the fine structure constant α [1]. Moreover, they have been proposed as novel frequency standards due to their low polarizability and insensitivity to black body radiation [2]. We plan to perform high resolution spectroscopy of cold HCI [3] in the extreme ultraviolet region (XUV), where many transitions, from dipole-allowed (E1) to highly forbidden, take place. To this end, we are developing an enhancement cavity to amplify femtosecond pulses from a phase-stabilized infrared frequency comb at 100 MHz [4]. High-order harmonics will be generated in the tight focus of the cavity, and can be used for direct frequency comb spectroscopy of HCI to determine absolute transition energies. Recent progress and results will be presented, including velocity map imaging of multi-photon ionization in the cavity focus.

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Mama Kabir Njoya Mforifoum, Universität Freiburg
Quantum walks of two cobosons

A quantum walker is a particle evolving coherently over a network of sites and therefore has the ability to interfere with itself, contrary to its classical counterpart. The extension to two-particle quantum walks leads to the introduction of interactions and many-particle interference depending on the particles statistics (bosonic or fermionic) and their distinguishability. We compare the quantum walk of two interacting cobosons (two pairs of bounded fermions) on a 1D lattice with that of two elementary bosons, and investigate to which extent the composite nature of the cobosons a ects their dynamics.

Jan-Hendrik Oelmann, MPI für Kernphysik Heidelberg
Development of an XUV frequency comb for precision spectroscopy of highly charged ions

Highly charged ions (HCI) have a few tightly bound electrons and many interesting properties for probing fundamental physics and developing new frequency standards [1]. Many optical transitions of HCI are located in the extreme ultraviolet (XUV) and conventional light sources are not suited for studying these transistions with highest precision. For this reason, we are developing an XUV frequency comb by transferring the coherence and stability of an infrared frequency comb to the XUV by means of high-harmonic generation (HHG) [2]. Reaching intensity levels in the order of $10^{13}\,W/cm^2$ necessary for HHG, while operating at high repetition rates (100 MHz), is challenging.

Therefore, laser pulses are first amplified in a fiber-based amplifier to 70 W and afterwards resonantly overlapped in a femtosecond enhancement cavity. Then, harmonics will be generated in a target gas in the focus of the cavity, which is operated under ultra-high vacuum conditions [3]. Finally, the XUV light will be guided to trapped and sympathetically cooled HCI [4] in a superconducting Paul trap to perform direct XUV frequency comb spectroscopy. An overview of the experiment will be given and recent developments with a focus on the high-power laser system will be presented.

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Natalia Oreshkina, MPI für Kernphysik Heidelberg
Nuclear polarization correction for heavy muonic systems

The study of muonic atoms provide an opportunity for the extraction of the nuclear parameters like RMS radii, electric quadrupole and magnetic dipole moments, as well as knowledge about the distribution of electric charge inside the nuclei. Being about two hundred times heavier than the electron, the muon has the Bohr radius correspondingly downsized by the same factor. Therefore, the wave functions of muonic bound states have a much bigger overlap with the nucleus, enabling the extraction of information about the nuclear from muonic transitions. For the low-lying states, the largest source of the theoretical uncertainty is so-called nuclear polarization correction. In this work, we present a basis for an accurate treatment of the muonic spectrum for the nuclear polarization effect in deformed muonic atoms..

Huda Otto, Universität Kassel
Energy transfer process in Ar_2-N_2 clusters accompanied by UV/VUV photon emission

The effects of bond formation between particles are of fundamental physico-chemical interest, since bond formation is the basis for the variety of substances. A fascinating bond type is the van-der-waals bond because this binding type enables inert particles, like Ar atoms, to form a bond leading to a moiety called cluster. These artificial clusters are well-suited to investigate fundamental interactions and effects in loosely bound substances, which might be prototypical for light-biological tissue interaction. During this talk, evidences for an interspecies energy transfer in heterogeneous Ar_2-N_2 clusters will be discussed, which were acquired by UV/VUV photon spectroscopy .

Lukas Pausch, Universität Freiburg
Interaction of electron spins with mechanical modes of two-dimensional semiconductors

Mechanical resonators made out of Transition Metal Dichalcogenide (TMDC) Monolayers show interesting mechanical and electronic properties such as a large Q factor [1-2], a sizeable direct band gap and a spin-split conduction band [3]. Strain and curvature have been proven to influence the band structure of TMDC monolayers [4]. In this theoretical study, we investigate the interplay between mechanical motion and electronic band structure of a TMDC monolayer. We use classical continuum mechanics to obtain equations of motion for the vibration of circular TMDC resonators and to solve these equations for the fundamental mode. By considering this solution within a general approach to strained and curved TMDC monolayers [4], we derive a model for the electromechanical coupling in the device and construct a low energy effective model of the conduction band electronic states and mechanical degrees of freedom. Finally, we consider the spin dependant transport across the mechanical resonator device.

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Francesco Petiziol, University of Parma and INFN Milano Bicocca
Coherent control by accelerated quantum adiabatic evolution

Adiabatic driving is one of the pillars of time-dependent quantum control. However, the limitations imposed by coherence times are typically in sharp contrast with the necessity of slow evolutions imposed by the adiabatic theorem. We present a control protocol for speeding up the adiabatic evolution for few-level quantum systems. The method works by adding fast oscillations in the intrinsic parameters of the original Hamiltonian: These oscillations mediate a counterdiabatic Hamiltonian dynamically compensating for diabatic transitions. The speedup is thus attained without requiring additional (not initially available) control matrix elements. The efficiency of the protocol is exemplified in avoided-crossing scenarios such as (generalized) Landau-Zener problems and in the production of entangled quantum states, with immediate applications in atomic physics, quantum optics and circuit QED.

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Thomas Pfeifer, MPI für Kernphysik Heidelberg
XUV nonlinear optics and strong-field atomic spectroscopy

In linear optics, the propagation of light in media is not affected by its intensity. However, with the advent of optical lasers it became possible to create electromagnetic fields that drive electrons in materials strongly enough to exceed their linear response. Non-linear optics enabled the generation of the 2nd, 3rd and eventually much higher harmonics, thereby also discovering entirely new dynamical processes, with recollision physics as one key example. Free-electron lasers (FELs) operating at x-ray or extreme-ultraviolet (XUV) photon energies now routinely allow the observation of nonlinear effects such as the absorption of multiple photons of high-frequency light by a single atom. An emerging frontier in our search for new dynamical mechanisms is strong-field high-frequency physics, beyond multi-photon ionization. A place to look for such mechanisms are resonances, where strong coupling is expected to give rise to a competition between Rabi and ionization dynamics.

Here, we discuss recent experiments with atoms driven by intense XUV FEL pulses. In photoexcitation with 60 eV photon energy, we observed an intensity dependence of the absorption spectrum recorded after the transmission through a dense helium sample. We also performed simulations allowing for the strong coupling of the ground state of helium to the 2s2p doubly excited state with its surrounding continuum. The agreement of simulation and experimental data points to the completion of a significant fraction of a Rabi cycle. This indicates the creation of an exotic state of matter: A helium gas in which for a few femtoseconds a macroscopic fraction of atoms is doubly excited.

In XUV-XUV pump-probe experiments in Neon atoms we observe nonlinear effects such as intensity-dependent Stark shifts of resonance transitions in Ne2+. Close to these transitions, we find spectral modifications within 2 fs near temporal overlap. These can be interpreted by coherence effects that are an important requirement to further develop nonlinear coherent (e.g. 2-dimensional) spectroscopy techniques in the XUV.

Fermín Rodríguez Hernández, mpipks Dresden
Laser assisted HHG in H and H_2^+

Jan M Rost, mpipks Dresden
Non-adiabaticity in the ultracold

Sebastian Ulbricht, Physikalisch-Technische Bundesanstalt, Braunschweig
Semi-classical approach to atoms in gravitational fields: Hydrogen in accretion disks

Daniel Waltner, Universität Duisburg-Essen
Particle-evolution operator in kicked spin chains with spin 1/2

A major difficulty in describing interacting many-body systems is the enormous size of the Hilbert space: usually it grows exponentially with the number of particles. In order to overcome this difficulty I will introduce in my talk an evolution in particle instead of time direction. The dimension of the particle-evolution operator grows exponentially with time making it especially appropriate to describe the short-time dynamics of the system. I will consider a kicked chain of spin 1/2 particles with nearest neighbor Ising interaction and on-site magnetic field changing in an ultrafast manner. I will discuss the properties of this particle-evolution operator and the spectral form factor that is used to analyze the correlation properties of the eigenvalues of the underlying quantum system.

Sandro Wimberger, Universität Heidelberg
Quantum walk in momentum space with a Bose-Einstein condensate

We present a discrete-time, one-dimensional quantum walk based on the entanglement between the momentum of ultracold rubidium atoms (the walk space) and two internal atomic states (the coin degree of freedom). Our scheme is highly flexible and can provide a platform for a wide range of applications such as quantum search algorithms, the observation of topological phases, and the realization of walks with higher dimensionality. Along with the investigation of the quantum-to-classical transition, we demonstrate the distinctive features of a quantum walk and contrast them to those of its classical counterpart. Also, by manipulating either the walk or coin operator, we show how the walk dynamics can be steered or even reversed.
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Matthias Wollenhaupt, Universität Oldenburg
Odd electron wave packets from cycloidal ultrashort laser fields