37. EAS -Tagung "Extreme Atomic Systems"

14.–19. Februar 2016, Riezlern/Kleinwalsertal

– list of abstracts –

Mehrdad Baghery, mpipks Dresden

Finding the global minimum using Gaussian processes

Minimising functions is crucial to many problems in ranging from astrophysics to quantum optimal design. Among these lies the problem of finding the minimum of expensive-to-evaluate functions, rendering the fact that the minimum has to be found by making as few observations as possible.
In order to tackle this problem, we introduce an auxiliary function (expressed as a Gaussian process) which mimics the original function as more and more observations are made. This function is relatively cheap-to-evaluate, and more importantly, its derivatives are analytically expressible. By finding the minimum of this auxiliary function using textbook gradient-based minimisation algorithms, it is possible to find the minimum of the original function.

Robert Bennett, Universität Freiburg

Unified boundary conditions and Casimir forces for fields with arbitrary spin

The electromagnetic Casimir effect is well-known and has been extensively studied for the last half-century. This attractive force between parallel plates arises from the imposition of boundary conditions upon the fluctuating spin-1 photon field, so a natural further question is wether fields of different spin can cause similar forces when confined in the same way. However, so far it has not been clear what the appropriate boundary conditions for physically-confined spinor fields may be. Here we present work that generalises the physically well-motivated electromagnetic boundary conditions to fields of arbitrary spin, thus arriving at physically reasonable boundary conditions and Casimir forces for a selection of interesting fields. For example, the so-called 'bag model' boundary conditions from nuclear physics emerge from our generalised boundary condition as a special case, as do the linearised gravity boundary conditions suggested in a remarkable recent proposal concerning possible measurement of gravitonic Casimir forces.

Gergana Borisova, MPI für Kernphysik Heidelberg

The spatial electron correlation and the ionization of helium in strong, ultra cold laser pulses

Motivated by a transient-absorption spectroscopy experiment, where a difference in the ionization of singly and doubly excited states with similar ionization energy was observed, the electron-electron correlation dynamics was investigated. We show results from the investigation of the electron dynamics in the helium atom interacting with strong laser fields on an attosecond time scale. We analyzed the electron-electron correlation dynamics responsible for the enhancement of the ionization in doubly excited helium by means of the time-dependent population of these states during and right after the laser pulse. For this we employ a numerical quantum-mechanical model based on solving the one-dimensional time-dependent Schrdinger equation for two electrons.

Stefano M Cavaletto, MPI für Kernphysik Heidelberg
Control of strong-field excited systems in optical and x-ray spectra

Optical frequency combs had a revolutionary impact on precision spectroscopy and metrology. This was recently enabled at extreme-ultraviolet frequencies via methods based on high-harmonic generation (HHG). We put forward a three-level scheme in which the absorption spectrum of a short pulse, tuned to an x-ray transition, is manipulated by an optical-frequency-comb laser which couples the excited state to a nearby level [S. M. Cavaletto *et al.*, *Nature Photonics* **8**, 520 (2014)]. The comb structure displayed by the x-ray absorption spectrum might eventually represent an alternative scheme for x-ray frequency-comb generation, overcoming the limitations of present HHG-based methods. We then present related line-shape-manipulation schemes based on transient-absorption spectroscopy. We use a V-type three-level scheme to model rubidium atoms, whose spin-orbit split states are simultaneously excited from the ground state by pump/probe optical pulses centered at 780 nm. Thereby, we investigate which information on atomic phase evolutions can be extracted from time-delay-dependent absorption spectra [Z. Liu, S. M. Cavaletto, *et al.*, *Phys. Rev. Lett.* **115**, 033003 (2015)].

Giovanni Cerchiari, MPI für Kernphysik Heidelberg
Experimental investigations for negative ions laser-cooling

Laser cooling is a well-established technique that has been demonstrated on positive and neutral particles. While theoretical studies [1] predict the possibility to apply the same methodologies to anions, no experimental results have yet been achieved in this field. We performed experimental studies on atomic anions looking for a good candidate to be directly laser-cooled. A successful realization of this technique has straightforward application in sympathetic cooling of other negative ions. Mixing in the same trap our negative ion with antiprotons could potentially cool these anti-nuclei close to the absolute zero. At that temperature the antiprotons could produce antihydrogen by charge exchange at a fraction of a Kelvin, generating an ensemble of neutral antimatter for precision weak equivalence principle tests [2].
In our collinear spectroscopy apparatus we identified exploitable transitions for laser cooling in the La^- ion [3]. Our measurement of the hyperfine spectrum led us to a cooling scheme which we will apply in the near future. For this reason we are currently upgrading our apparatus to perform the laser cooling of La^- in a radiofrequency trap.
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Alexander Croy, mpipks Dresden
Nonlinear phononics using atomically thin membranes

In recent years, there has been considerable interest in tailoring material and wave-propagation properties using structured materials, prominent examples being phononic and photonic crystals. Here, we propose a design that allows for engineering flexural-phonon propagation by facilitating atomically thin membranes. The strong geometric nonlinearity present in such systems leads to phonon-phonon interactions, which allow the study of many-body effects. Using a continuum mechanics description of a periodically pinned graphene membrane, we investigate the properties of the resulting phononic crystal and demonstrate that defects in the pinning lattice support localized modes. Two such modes in close proximity interact via the elastic energy, and constitute a simple model of a phononic dimer. We show that the defect Hamiltonian in the rotating-wave approximation is equivalent to a classical

Bose-Hubbard model. By tuning the properties of the pinning lattice and the amplitudes of the flexural vibrations, we observe a bifurcation corresponding to the transition from "Rabi" to "Josephson" dynamics. Creating lattices of interacting defect modes provides a viable path for realizing quantum many-body phononics.

Alexander Dorn, MPI für Kernphysik
Interference in electron impact ionization of hydrogen molecules

Ionization of diatomic molecules can be considered as emission of two coherent waves from two centers and - in this simple picture - should result in a characteristic interference pattern. There exist many attempts to identify oscillations in the cross section in case of particle impact ionization of the fundamental H_2 molecule. All experiments average over the molecular axis alignment strongly reducing the significance of the results. Here we present a kinematically complete (e,2e) study where the molecular alignment is measured. The observed oscillation of the cross section is out-of-phase with the expected interference pattern demonstrating a more complex scattering dynamics than predicted by the simple double-slit interference model.

Stefan Fischer, Universität Freiburg
Semiclassical approximations of Aharonov-Bohm vector potentials

While a comprehensible analysis of the full quantum mechanical solutions for systems of charged particles propagating in the presence of classically inaccessible magnetic fields is often obstructed by their complicated form, in semiclassical approximations distinct features of the dynamics collapse into discontinuities. The aim of this talk is to disclose the physical origin of such discontinuities.

Valentin Gebhart, Universität Freiburg
Casimir–Polder interaction of neutrons with surfaces

Searching for an example of the elusive repulsive dispersion force we study the CasimirPolder interaction of a neutron with a metal or dielectric plate. By using macroscopic quantum electrodynamics and perturbation theory we examine the position-dependent potential of the magnetizable neutron in front of a plate with arbitrary dielectric properties. We indeed find a purely repulsive dispersion interaction whose amplitude is very sensitive to the model used for the plate per- mittivity. Finally, we discuss the relevance of the proposed interaction in neutron-interferometry experiments [1].

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Frank Großmann, Technische Universität Dresden
Semiclassical hybrid method for IR spectroscopy

We are extending recently introduced semiclassical hybrid methodology [Journal of Chemical Physics 125, 014111 (2006)] to the calculation of correlation functions for IR spectroscopy. This is achieved by a partial linearization of the exponent of the full semiclassical approximation gained by a two-fold application of the Herman-Kluk initial value propagator. The double phase space integration is transformed to mean and difference variables and the linearization is performed in the difference variable. Connections to the Wigner-Weyl formalism by Ozorio de Almeida and coworkers using chord and center variables are pointed out.

Nikolay Kabachnik, Moscow State University

Interference effects in angular streaking with a rotating terahertz field

A method of angular streaking with a rotating terahertz electric field for photoelectrons produced by femtosecond extreme ultraviolet pulses is suggested and theoretically analyzed. The method can be used for free electron laser (FEL) pulse characterization on a shot-to-shot basis. It is shown that in related measurements a new phenomenon appears: formation of very bright and sharp features in the angular resolved electron spectra measured in the plane perpendicular to the collinear beam direction. These features are similar to the conventional caustics in the wave propagation. The caustics are accompanied by a well developed interference structure. The intensity distribution along the caustic is determined by the envelope of the FEL pulse.

Sajal Kumar Giri, MPIPKS Dresden

On the way of quantum control with intensee XUV pulses

Recent experimental developments have motivated us to study light-matter interactions in high-frequency regime. One can introduce envelope Hamiltonian to study the interaction of intense XUV pulses with a pulse length comparable to the orbital time of the bound electrons. It is based on the Kramers-Henneberger representation in connection with a Floquet expansion of the strong-field dynamics but keeps the time dependence of the pulse envelope explicit. All the essential physics can be captured by envelope Hamiltonian, namely, photon absorption, light induced shifts, non-adiabatic transitions. At this point one can expect to control the ionization by shaping the envelope. The envelope Hamiltonian also opens the possibility to study the quantum control phenomenon in perturbative approach.

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Lukas Medisauskas, mpipks Dresden

Circularly polarized high harmonics from Ne atoms

An elegant solution to generate circularly polarized harmonics relies on combining circularly polarized fundamental with counter-rotating second harmonic. The harmonic spectra generated by such driving field consists of pairs of left- and right- circularly polarized harmonics. Here, we theoretically investigate this process for a model Ne atoms.

We demonstrate that the harmonic spectra is distinctively different when atomic orbitals with non-zero angular momentum, e.g., 2p, and orbitals with zero angular momentum, e.g., 1s, are considered. Namely,the height of left- and right- circularly polarized harmonics is different by an order of magnitude when 2p orbitals are used. The effect is due the the suppression of the contribution from orbitals counter-rotating with the driving field, i.e., 2p-, and involves the interplay of ionization, recombination and continuum electron propagation dynamics.

In the time domain, the generated spectra from Ne corresponds to a train of attosecond pulses with close to circular polarization. Hence, we demonstrate an amplitude gating scheme that allows to isolate a single attosecond radiation burst and thus attain highly elliptical isolated attosecond pulses.

Igor Mekhov, University of Oxford
Exploiting quantum light in quantum gas physics

Although light is the main tool in quantum gas physics, its quantumness is usually neglected in most of works. We show that elevating light to a quantum variable leads to a plethora of novel many-body phenomena, unobtainable in classical optical setups. Light serves as a quantum nondemolition (QND) probe of strongly correlated atomic states. We introduce the quantum backaction of weak global measurement in the problems of strongly correlated systems, which efficiently competes with standard local processes in optical lattices. It leads to novel dynamical effects: multimode Schrdinger cat and NOON states, nonlocal quantum Zeno dynamics, measurement-induced break-up and protection of fermion pairs, long-range correlated tunnelling, etc. The generated spatial modes of matter waves show genuinely multipartite entanglement and non-Gaussian properties beyond optical analogues (e.g. two-mode squeezing and squeezed vacuum). Trapping quantum gases inside a high-Q cavity, creates a paradigm of quantum trapping potentials (quantum optical lattices) opening field of cavity QED of strongly correlated systems. We demonstrate the emergence of novel many-body phases due to the quantumness of light: delocalized dimers, trimers, etc. of matter waves, even beyond the density orders such as density waves and supersolids. We prove that cavity QED of strongly correlated systems will bridge physics of systems with global collective interactions (e.g. Dicke model) and those with short-range interactions (e.g. Hubbard and Heisenberg models), thus uniting the paradigms of quantum optics and condensed matter physics.

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Yonghao Mi, MPI für Kernphysik Heidelberg
Strong-field ionization of molecules with two-color laser pulses

Single and double ionization of HD and H2 molecules as well as fragmentation and Coulomb-explosion in strong two-color laser pulses (800nm + 400 nm) at intensities in the $10^14W/cm^2$ regime have been studied utilizing a reaction-microscope. Asymmetries in the emission directions of both electrons and ions are analyzed as a function of the relative phase between the two fields and differences between the various fragmentation-channels are discussed in terms of possible ionization pathways.

Max Möller, Universität Jena
Strong-field photoionization of H_2^+ at mid-infrared wavelength

Increasing the driving laser wavelength into a region above 1 m has lead to a number of interesting phenomena and applications in the field strong-field interactions[1] of atoms such as the of the discovery of low-energy structures[2] or the generation or high harmonics with photon energies above 1 keV[3]. Due to the nuclear degree of freedom, strong-field photoionization of small molecules induces more complex dynamics such as charge-resonant enhanced ionization[4], or laser-induced electron diffraction[5]. Here, the fragmentation of an H_2^+ ion beam by a strong mid-infrared laser field is studied experimentally as a function of intensity.

Three-dimensional coincidence imaging in combination with a well collimated ion beam and high pondermotive potential of the laser allows to perform a kinematically complete experiment where the momentum of the two protons, p_1 and p_2, are measured directly and the electron momentum, p_e, is inferred based on momentum conservation. The experimental results show a double-peak structure in the kinetic energy release (KER) spectrum that indicates a strong dependence of the ionization yield on the inter-nuclear separation, R. It is found that this structure is very sensitive to the intensity. 2D-plots of the ionization yield as function of KER show that the energy-dependent electron yield is sensitive to energy of the two nuclei. Numerical simulations of the time-dependent Schrdinger equation that use a fixed nuclei model of H_2^+ in one dimension are used to gain insight into the physical mechanisms.

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Robert Müller, Helmholtz-Institut Jena

Coulomb effects in laser assisted radiative recombination

Radiative recombination is the capture of a continuum-state electron into a bound state of an ion, accompanied by the emission of a photon. If the system is exposed to an external laser field the process is commonly called laser assisted radiative recombination (LARR). The additional laser field in LARR is supposed to stimulate the formation of antihydrogen. Moreover LARR is part of the three step model of high harmonic generation [1]. In this contribution we present a theoretical analysis of LARR using the separable Coulomb-Volkov continuum ansatz in combination with first order time dependent perturbation theory [2]. Applying this approach detailed calculations are performed for the angle-differential and total LARR cross section for low-Z hydrogen-like ions and laser intensities up to $10^13W/cm^2$. Special emphasis ist put on the effects arising due to the laser dressing of the residual bound state. It is seen that this bound state dressing remarkably affects the total cross section and manifests moreover as asymmetries in the angular and energy distribution of the emitted photons.

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Callum Murray, mpipks Dresden

Decoherence dynamics in a single photon switch

The enormous optical nonlinearities in Rydberg EIT systems have since enabled the demonstration of a single photon switch. Here, the storage of a single gate photon in the medium is used to block the transmission of many other target photons, by turning an otherwise transparent medium opaque. However, the decoherence processes affecting the stored gate photon, when target photons are scattered, strongly affects the operation efficiency of the device. In this talk, a complete characterisation such decoherence will be presented along with the impact this has on the maximum achievable switch fidelity.

Qicheng Ning, mpipks Dresden

Slow electrons from non-adiabatic transitions in a two-electron system

Atomic systems exposed to short high-frequency laser pulses release unexpectedly slow electrons which are the consequence of non-adiabatic transition. Here we extend the study to a two-electron model atom. Both double and single ionization have been calculated and show the peaks of slow electrons. It is confirmed these slow electrons are also generated from non-adiabatic transitions. The role played by electron-electron correlation has been studied.

Natalia Oreshkina, MPI für Kernphysik Heidelberg

X-ray fluorescence spectrum of the astrophysically relevant highly charged Fe ions driven by strong free-electron-laser fields

Line intensities and oscillator strengths for the controversial 3C and 3D astrophysically relevant lines in neonlike Fe^{16+} ions are calculated. First, a large-scale configuration-interaction calculation of oscillator strengths is performed with the inclusion of higher-order electron-correlation effects. Also, QED effects to the transition energies were calculated. Further considered dynamical effects give a possible resolution of discrepancies of theory and experiment found by recent x-ray free electron laser measurements of these controversial lines. For strong x-ray sources, the modeling of the spectral lines by a peak with an area proportional to the oscillator strength is not sufficient and non-linear dynamical effects have to be taken into account. Thus we advocate the use of light-matter interaction models also valid for strong light fields in the analysis and interpretation of astrophysical and laboratory spectra. In addition to already published resul ts, we investigate the system distinguishing between the coherent and incoherent parts of the emission spectrum. In addition, the spectrum of Fe^{15+}, an autoionizing ion which was also present in the recent laboratory experiment, is also analized.

Thomas Pfeifer, MPI für Kernphysik Heidelberg

Small and neutral atoms and large molecules in strong fields, observed by their dipole response

Juan Pablo Ramírez Valdes, Universität Freiburg

Analytical description of wave packet expansion in a one dimensional disordered potential

We present an analytic description of the asymptotic disorder-averaged probability density of an initially strongly confined wave packet in a one-dimensional weak, random potential with finite correlation length. At long times, the expansion of the wave packet comes to a halt due to destructive interferences leading to Anderson localization, the signature of which is the exponential decay of the energy eigenfunctions. But in the case of a wave packet, there is an additional element in the description: the asymptotic state is determined by the superposition of partial waves with different energies E. Using diagrammatic techniques, it is possible to calculate the asymptotic state at fixed energy E [1]. Combining this result with a self-consistent equation for the spectral density of the wave packet [2], we derive an analytical expression for the asymptotic average density, which is compared with the results of numerical simulations.

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Xueguang Ren, MPI für Kernphysik Heidelberg

Electron-impact induced interatomic relaxation processes in argon dimer studied with a multi-particle coincidence experiment

We study the electron-impact (67 eV) induced ionizing fragmentation and interatomic relaxation processes of Ar dimer (Ar_2) with the multiple-particle coincidence method using a reaction microscope. In the weakly bond systems, e.g. in the Ar dimer, due to the presence of the environment new autoionization channels as known as Interatomic or Intermolecular Coulombic Decay (ICD) can be opened by transferring the deposited excess energy to the neighbor ionizing it and resulting in highly reactive species: low-energy ICD electrons and a pair of energetic ions. Since its first prediction in 1997 by Cederbaum and co-workers, ICD soon led to a strong interest due to its important roles in various mechanisms of radiation biology and chemistry. An additional relaxation process named radiative charge transfer (RCT) may occur in the Ar dimer in which one atom is doubly ionized, and an electron is transferred from a neighbor to the doubly charged Ar^{2+} ion. The system can relax by emitting a photon. Both ICD and RCT processes can result in two repulsive Ar^+ ions. By full 5-particle coincidence measurements, i.e. detecting the kinetic energies of both resulting ions and all three electrons, we unambiguously identify ICD and RCT and trace the decay dynamics as function of the collisional excited state energies which can contribute to the double peak structure in the observed kinetic energy release (KER) spectrum of argon dimer dissociating into $Ar^+ - Ar^+$.

Jan M Rost, mpipks Dresden

Sorting X-ray images

Ulf Saalmann, mpipks Dresden

The zero-engergy structure - classical or quantum?

Christian Scheppach, Universität Freiburg

Single ion channel statistics

Ion channels are pore-like proteins located in cell membranes and mediate transmembrane ion currents. They open and close stochastically, which is a source of variability in the system. I would like to report experimental results on single voltage-gated calcium channels in pyramidal neurons of layer 5 of the neocortex, with a particular interest in the dendritic calcium spike in these cells. Currents through single calcium channels can be recorded using the patch-clamp technique if barium is used as the permeating ion, and the kinetics of the channels can be studied. At physiological levels of extracellular calcium, the single calcium channel current is too small to be directly resolved, but can still be measured with the fluctuation analysis method, for which a novel protocol using voltage ramps was developed.

Horst Schmidt-Böcking, Universität Frankfurt

The Stern-Gerlach Experiment revisited - its impact on modern quantum physics

The history and scientific results of the Stern-Gerlach-Experiment SGE performed in 1922 are revisited. This experiment gave first direct evidence for angular momentum quantization in the quantum world and for the existence of "Richtungsquantelung" RQ (directional quantization) of all angular momenta in the process of measurement. Furthermore it measured for the first time a ground state property of an atom, it produced for the first time a fully "spin-polarized" atomic beam, and it discovered almost also the electron spin. Historic facts of the original SGE are described. Einsteins "Gedanken experiment" of an improved three-stage SGE are presented together with his conclusion of an existing "Paradoxon". The realization of Einsteins "Gedanken experiment" by Stern, Phipps, Frisch and Segrè is described. Einsteins proposed experimental set-up can be considered as a pre-Rabi apparatus with time-varying fields. The important consequences of a finite and "unlimited sharp" $\hbar$ value for directional quantization RQ and reaction dynamics in the quantum world are discussed. In full agreement with Heisenbergs "Matrizenmechanik" and the Schrödinger equation RQ appears as a general feature of quantum measurements. Last not least the early history of the "almost" electron spin discovery in the SGE is revisited.

Vyacheslav Shatokhin, Universität Freiburg

Spectral correlations in resonance fluorescence

Single-atom resonance fluorescence has been long associated with the famous triplet structure of the emission spectrum under strong laser driving [1] or the effect of photon antibunching [2]. Less known are spectral correlations between photons that are emitted into components of the Mollow triplet [3]. Recent progress in spectroscopy of semiconductor quantum dots has revived interest in theoretical [4] and experimental [5,6] studies of spectral correlations of resonance fluorescence emitted by single (artificial) atoms. In this contribution, we develop a general approach to the calculation of spectral correlation functions in resonance fluorescence. Besides presenting our results, we critically examine some new concepts that have appeared in the recent literature [4,6].

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Veit Stooß, MPI für Kernphysik Heidelberg

Sub-cycle emission switching of atomic dipole forbidden transitions in a time-domain picture

We measure the polarization dynamics of singly excited helium with a temporal resolution better than the optical cycle of the applied laser field, utilizing the method of attosecond transient absorption spectroscopy (ATAS). We identify the spectroscopic fingerprint of instantaneous polarization and breaking of the symmetry of the atoms in an intense visible femtosecond pulse and develop a time-domain picture of the dipole response resulting in such signatures. The examined features belong to virtual states identified earlier [1,2] that are present during the interaction with the strong near-infrared coupling pulse and depend on both intensity and photon energy of the coupling pulse. We analyze their spectral position and the phases of their time-delay dependence by comparison to numerical simulations utilizing perturbation theory and a few-level model of singly excited helium. The goal is to study the behavior of the bound-state dynamics if the coupling induced by the near-infrared changes for different laser detunings and from the weak to the strong coupling regime.

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Joachim Ullrich, Physikalisch-Technische Bundesanstalt (PTB)
The Silicon Route Towards the New Kilogram

In 2018 the General Conference on Weights and Measures, CGPM, of the Metre Convention with 57 Member and 40 Associate States is expected to adopt a resolution to re-define the International System of Units, the SI. The new SI will be established by fixing the numerical values of seven defining constants. In this context, the "Silicon Route" will be one essential method to realize the kilogram. In the talk, the present status, challenges and prospects of the "Silicon Route Towards the New Kilogram" will be presented.

Koen van Kruining, mpipks Dresden
Duality symmetry and helicity conservation of light in matter

In vacuum, electric and magnetic fields can be interchanged without changing the form of Maxwells equations. This is the electric-magnetic duality symmetry and its associated conserved quantity is optical helicity. When light traverses a medium, this symmetry is typically broken. We investigate under what conditions electric-magnetic duality is conserved even for light traversing the most general linear medium and derive a generalised expression for the optical helicity. With the aid of some simple examples we illustrate the consequences of helicity conservation in a medium.

Daniel Viscor, mpipks Dresden
Dipolar photon- and excitation-transport in Rydberg-EIT media

We investigate the effects of excitation-exchange interactions on the propagation dynamics of quantum light through a strongly interacting Rydberg gas under conditions of electromagnetically induced transparency (EIT). Considering the most simple setting of a single Rydberg-polariton interacting with a stored collective Rydberg excitation, we show that long-range excitation-exchange between the two spin wave components gives rise to a photon propagation that differs fundamentally from the more common case of static van der Waals interactions. Using numerical simulations and analytical arguments, we characterise the resulting dissipative and dispersive optical response of the medium and discuss potential applications of the emerging new features.

Danyal Winters, GSI Darmstadt
Laser cooling of stored relativistic heavy ion beams

An overview of recent laser cooling activities with relativistic heavy ion beams at the ESR (GSI, Darmstadt, Germany) and the CSRe (IMP, Lanzhou, China) storage rings will be presented. Some of the latest results will be shown and new developments concerning xuv-detector systems and cw and pulsed laser systems will be addressed. Finally, plans for laser cooling at the future facility FAIR in Darmstadt will be described.

Steffen Wissmann, Universität Freiburg

Recent advances concerning quantum non-Markovianity

Over the past few years there has been a vivid discussion about the rigorous definition of quantum non-Markovian dynamics in open quantum systems which finally led to different proposals using various approaches like violation of CP-divisibility or the concept of an information backflow to name a few. However, none of these definitions is actually linked to the well-known definition of a classical (non-)Markovian stochastic process. In the present talk, I will show how a slight modification of the trace-distance-based measure allows to bridge this gap while retaining the original interpretation in terms of an information backflow. Some consequences of the improved definition will be pointed out and illustrated by means of an example.

Zhongwen Wu, Helmholtz-Institut Jena

Identification to the splitting and sequence of closely-spaced energy levels by angle-resolved analysis of characteristic x rays

Energy-dependent photoexcitation and subsequent radiative decay of atoms have been investigated within the framework of the density matrix theory and second-order perturbation theory. Special attention has been paid to angular distribution and linear polarization of characteristic x rays from (partial) overlapping resonances and how they are affected by level splitting and sequence of these resonances, if analyzed as functions of photon energy of the exciting light. Detailed computations within the multiconfiguration Dirac-Fock method were carried out especially for the $1s^2 2s^2 2p^6 3s\ J_0 = 1/2 + \gamma_1(\hbar\omega) \rightarrow (1s^2 2s 2p^6 3s)_1 3p_{3/2}\ J = 1/2, 3/2 \rightarrow 1s^2 2s^2 2p^6 3s\ J_f = 1/2 + \gamma_2$ excitation and decay of sodium atoms. A remarkably strong dependence of the angular distribution and linear polarization of these x rays upon the level splitting and even the sequence was found especiall y at near-threshold photon energies. Such a dependence arises from finite lifetime of the overlapping resonances. We therefore suggest that accurate measurements of x-ray angular distribution and linear polarization could be used to identify the splitting and sequence of closely-spaced energy levels.