A 7: Poster: Atomic systems in external fields

Time: Monday 17:00–19:00 Location: C/Foyer

A 7.1 Mon 17:00 C/Foyer

Testing equivalence principle for antimatter through dynamics in gravitational field — •Oliver Köhn[1] and Giovanni Manfredi[2] — [1]Universität des Saarlandes, Saarbrücken, Deutschland — [2]Centre National de la Recherche Scientifique, Strasbourg, Frankreich

We propose a test for the equivalence principle for antimatter. We consider the dynamics of a particle bouncing on a solid surface and predict an autoresonance phenomenon suitable for testing the equivalence principle. With the surface oscillating independently of the particle position, we calculate the bouncing amplitude of the particle as a function of time, and demonstrate a resonance phenomenon in the dynamics of the particle. The amplitude of the bouncing particle depends on its acceleration under the gravity of the earth and would be affected by the difference in the gravitational and inertial masses of the particle. Measurement of the autoresonance phenomenon therefore provides a test for the equivalence principle for antimatter.

A 7.2 Mon 17:00 C/Foyer

Calculating Tunnel Ionization Time by using a Quantum clock — •Nicolas Teeny, Heiko Bauke, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik Saupfercheckweg 1, 69117 Heidelberg

Tunnel ionization belongs to the fundamental processes of atomic physics and has been investigated in-depth experimentally as well as theoretically. The question, however, how long it takes for an electron to escape from an attractive potential could not yet be answered conclusively. In our contribution, we solve the time-dependent Schrödinger equation numerically [1], in order to determine time-dependent ionization rates and to extract tunneling times. Additionally, we couple a Salecker-Wigner-Peres quantum clock [2, 3] to the tunneling electron and solve the coupled system numerically to explain the calculated tunneling times.

[1] Proc. of SPIE, **8780**, 87801Q (2013)

[2] Phys. Rev., **109**, 571, (1958)

[3] Am. J. Phys., **48**, 552, (1980)

A 7.3 Mon 17:00 C/Foyer

Following the evolution of ICD in time — •Fawad Karimi, Martin Ranke, Markus Pfau, Thomas Gebert, and Ulrike Frühling — Institute of experimental physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

Interatomic Coulombic Decay (ICD) is a non-local auto-ionization process that was predicted by Lorenz Cederbaum in 1997. It is an efficient decay channel used by atoms in loosely bound van der Waals rare gas molecules and clusters. We aim to investigate the ICD lifetime in Neon-Krypton dimers.

The dimers are formed in a co-expansion of a NeKr gas mixture under high pressure through a small aperture in vacuum. In Ne-Kr dimer an ultrashort XUV initiates the ICD by ionizing an inner valence electron of Ne. The relaxation energy of Ne is transferred to Kr atom in form of a virtual photon, which in turn ionizes a 2p Kr electron. The whole process leaves two ionized atoms in a dimer which consequently undergoes a coulomb explosion.

The continuum electron wave packet can be probed with an intense terahertz field, which is superimposed with the XUV pulses (THz-streaking). The change in momentum of electrons due to acceleration in streaking field is proportional to the vector potential of the streaking field at the time of ionization. Thus, the temporal shape of the electron wavepacket is mapped onto changes of electron momenta.

A 7.4 Mon 17:00 C/Foyer

Exciton Interactions in Two Dimensions — •Valentin Walther, Robert Johne, and Thomas Pohl — Max-Planck-Institut für Physik komplexer Systeme, Dresden

Recent experiments have shown that excitons with binding energies of up to 1 eV can be produced in a special class of two-dimensional semiconductors known as TMDCs (transition metal dichalogenides) [1].

We study the excited level structure of such excitons accounting for two-dimensional screening effects. Based on these results we explore the possibility to manipulate the properties by external fields. We determine the resulting interactions at asymptotic distances and discuss the importance of non-adiabatic effects.

[1] A. Chernikov et al., Phys. Rev. Lett. 113, 076802 (2014)

A 7.5 Mon 17:00 C/Foyer

Impact of subwavelength nanofocussing on the carrier-envelope phase controlled strong-field photoemission from nanospheres — •Lennart Seiffert[1], Frederik Süssmann[2], Matthias Kling[2], and Thomas Fennel[1] — [1]Universität Rostock, Universitätsplatz 3, 18051 Rostock, Germany — [2]Max-Planck Institut für Quantenoptik, 85748 Garching, Germany

Localized near-fields at laser-excited nanostructures have opened up a new dimension in attosecond science to enhance, fundamentally modify, and control electronic strong-field processes [1, 2]. Here we consider sub-wavelength nanofocussing in unsupported dielectric nanospheres to generate tailored near-fields and study the resulting strong-field electron dynamics via the angle-resolved photoemission [3]. To further investigate the electron acceleration process we modelled the dynamics using a quasi-classical trajectory-based mean field Monte-Carlo approach, which is extended to account for propagation effects of the near-fields. We demonstrate symmetry breaking and directional controllability of the carrier-envelope-phase dependent emission of recollision electrons due to the propagation-induced near-field deformation. We show that directionality of the photoemission remains largely unaffected by local field ellipticity and nonlinear many-particle charge interaction, even if the latter results in a significant boost of the final electron energies.

[1] M. Krüger et al., Nature 475 (2011)

[2] S. Zherebtsov et al., Nature Phys. 7 (2011)

[3] F. Süßmann et al., submitted

A 7.6 Mon 17:00 C/Foyer

Low-energy electrons in strong high frequency pulses — •Qi-Cheng Ning, Koudai Toyota, Ulf Saalmann, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany

In the tunneling ionization regime atoms and molecules, singly ionized by strong mid-infrared laser pulse, produce an unexpected low-energy structure [1], which can be explained by classical soft recollisions [2].

Surprisingly, low-energy electrons have been found numerically also in a higher-frequency regime, where they originate from a pure quantum effect [3]. Its physical picture can now be depicted by the non-adiabatic evolution of the system in a short pulse with duration comparable to the characteristic time scale of the bound electron [4]. We study this case also in a two-electron system. There a low-energy peak structure in the doubly-ionized electron spectrum has been confirmed and studied in terms of electron correlation.

[1] C. I. Balga et al., Nat. Phys. 5, 335 (2009). [2] A. Kastner, U. Saalmann, and J. M. Rost, Phys. Rev. Lett. 108, 033201 (2012). [3] K, Toyota, O. I. Tolstikhin, T. Morishita, and S. Watanabe, Phys. Rev. Lett. 103, 153003 (2009). [4] K. Koudai, U. Saalmann, and J. M. Rost, arXiv.1408.4541.

A 7.7 Mon 17:00 C/Foyer

Magnetometry with NV center ensembles — •Nathan Leefer[1], Kasper Jensen[2], Arne Wickenbrock[3], Dionysis Antypas[1], Yannick Dumeige[4], Mariusz Mrózek[5], and Dmitry Budker[1,2] — [1]Helmholtz Institut-Mainz, Mainz, Germany — [2]Niels Bohr Institute, Copenhagen, Denmark — [3]Johannes Gutenberg-Universität Mainz, Mainz, Germany — [4]Université de Rennes 1, Rennes, France — [5]Jagiellonian University, Kraków, Poland

We recently reported a cavity-enhanced room-temperature magnetic field sensor based on nitrogen-vacancy (NV) centers in diamond. The demonstrated sensitivity was 2.5 $\mathrm{nT}/\sqrt{\mathrm{Hz}}$ for a sensing volume of ~ 90 μm × 90 μm × 200 μm, with an estimated quantum projection-noise limit of 250 $\mathrm{fT}/\sqrt{\mathrm{Hz}}$. Magnetic resonance was detected using absorption of light resonant with the 1042-nm spin-singlet transition. The diamond was placed in an external optical cavity to enhance the absorption, providing significant absorption even at room temperature. We present new progress on improving the sensitivity of this device, some applications for such a miniaturized magnetometer, and new approaches for enhancing infrared absorption by NV centers in diamond without a resonant cavity.

A 7.8 Mon 17:00 C/Foyer

Exploiting light-shift effects for atomic magnetometry — •Arne Wickenbrock[1], Elena Zhivun[2], Brian Patton[2,3], and Dmitry Budker[1,4,5] — [1]Johannes Gutenberg Universität, Mainz, Germany — [2]University of California, Berkeley, California, USA — [3]Technische Universität München, Garching, Germany — [4]Helmholtz Institut Mainz, Mainz, Germany — [5]Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California, USA

We demonstrate a selection of experiments exploiting vector light shift effects for atomic magnetometry. The fictitious magnetic fields of two circular polarized laser beams are used to transform a scalar magnetometer with fT sensitivity to an all-optical vector magnetometer. The sensor exhibits a projected sensitivity of 12 fT/Hz$^{1/2}$ and 5 microrad/Hz$^{1/2}$. A second experiment demonstrates a novel approach to all-optical magnetometry with potential advantages for magnetometer arrays and magnetically sensitive fundamental physics experiments. Intensity modulation of a laser beam at the Larmor frequency directly drives a narrow magnetic resonance in alkali vapor. As a magnetometer the setup achieves a projected shot-noise-limited sensitivity of 1.7 fT/Hz$^{1/2}$ and measures a technical noise floor of 40 fT/Hz$^{1/2}$. These results are essentially identical to a coil-driven scalar magnetometer using the same setup.