Q 35: Quanteneffekte: QED / Interferenz und Korrelationen I

Zeit: Mittwoch 14:00–16:00 Raum: VMP 6 HS-E

Q 35.1 Mi 14:00 VMP 6 HS-E

Eddy currents and the thermal Casimir effect — •Francesco Intravaia and Carsten Henkel — Universität Potsdam, Institut für Physik und Astronomie, Karl-Liebknecht-Str. 24/25, 14476 Potsdam, Germany

We study the contribution of eddy currents to the Casimir effect between two thick metallic plates. Using the Drude model for the optical response of the metal, we identify a class of diffusive modes that live in the bulk of the two plates and are electromagnetically coupled across the vacuum gap. Recently, it was pointed out that eddy currents give an important contribution to the heat transfer between two metallic surfaces [1]. It also turns out that the contribution of these modes is responsible for the difficulties in calculating the thermal correction for the Casimir force [2]. Even the applicability of the Nernst heat theorem (third law of thermodynamics) must reviewed: in fact the subspace spanned by the eddy currents can generate a highly degenerate ground state for a temperature-dependent dissipation rate. Features of the eddy spectrum also suggest that these modes may not be in equilibrium for an experiment with a finite characteristic duration. We propose to evaluate an adiabatic pressure in order to take into account this phenomenon.

[1]P.-O. Chapuis, S. Volz, C. Henkel, K. Joulain, and J.-J. Greffet, Phys. Rev. B 77, 035431 (2008).
[2] K. A. Milton, J. Phys. A 37 (2004) R209; G. L. Klimchitskaya and V. M. Mostepanenko, Contemp. Phys. 47 (2006) 13

Q 35.2 Mi 14:15 VMP 6 HS-E

Thermal Casimir and Casimir-Polder interaction with superconductors and metals — •Harald Haakh, Francesco Intravaia, and Carsten Henkel — Universität Potsdam, Institut für Physik und Astronomie, Karl-Liebknecht-Str. 24/25, 14476 Potsdam, Germany

We study the Casimir interactions with superconducting surfaces, with emphasis on finite temperature corrections. This is motivated by current controversies around the interaction between dissipative plates [1]. For the atom-surface interaction, we analyze the magnetic dipole contribution whose resonance frequencies are unusually small relative to the temperature. We use thermal response theory and characterize the superconductor by common optical models. The atom-metal interaction (free) energy allows to recover previous results [2] and is for $T > 0$ strongly suppressed at large distances. The atom-superconductor entropy jumps at T_c, illustrating the "participation"of the atom in the phase transition. The similarities between the two Casimir interactions suggest that the thermal Casimir controversy for metals could be checked by precision measurements of the atom-surface interaction, e.g., using differences between isotopes that differ only in their magnetic properties.

[1] K. A. Milton, J. Phys. A 37 (2004) R209; G. L. Klimchitskaya and V. M. Mostepanenko, Contemp. Phys. 47 (2006) 131
[2] C. Henkel, B. Power, and F. Sols, J. Phys.: Conf. Ser. 19 (2005) 34

Q 35.3 Mi 14:30 VMP 6 HS-E

Photoemission of a Single-Electron Wave-Packet in a Strong Laser Field — •Carsten Müller[1], Justin Peatross[2], Karen Z. Hatsagortsyan[1], and Christoph H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Department of Physics and Astronomy, Brigham Young University, USA

The radiation emitted by a single-electron wave packet in an intense laser field is considered. A relation between the quantum mechanical formulation and its classical counterpart is established via the electron's Wigner function. We show that the partial emissions from different momentum components of the wave packet do not interfere when the driving field is a plane wave. In a focused laser beam, however, quantum interference in the scattered radiation in principle is possible. We outline an experimental setup dedicated to put these conclusions to the test.

[1] J. Peatross, C. Müller, K. Z. Hatsagortsyan, and C. H. Keitel, Phys. Rev. Lett. 100, 153601 (2008)
[2] C. Müller, J. Peatross, K. Z. Hatsagortsyan, and C. H. Keitel, in preparation

Q 35.4 Mi 14:45 VMP 6 HS-E

Cavity QED with Cold Ion Coulomb Crystals — •Magnus Albert, Joan Marler, Aurelien Dantan, Peter Herskind, and Michael Drewsen — QUANTOP, Department of Physics and Astronomy, University of Aarhus, DK-8000 Aarhus C, Denmark

Clouds of cold ions are an interesting alternative system to a single atom/ion for studying CQED effects. When trapped and cooled below a critical temperature, these ions form a spatially ordered state, referred to as an ion Coulomb crystal. In our setup, we trap and cool $^{40}Ca^{+}$ ions in sufficient number to access the so-called strong collective coupling regime, where the collective coupling, $g\sqrt{N}$, exceeds both the dipole decay rate, γ, and the cavity decay rate, κ, without using an extremely high finesse cavity[1]. We will present the first signals of collective strong coupling, in this system - most dramatically manifested via the vacuum Rabi splitting. Finally, we measure the temporal coherence of collective Zeeman sub-states in the $3d^3D_{3/2}$-level by induced Lamor precession. The measured coherence times are of the order of the best reported values for single ions in equivalent magnetic field sensitive states[2]. Our results make the system a promising candidate for the realisation of various quantum information devices, including quantum repeaters and quantum memories.

[1] P. Herskind, A. Dantan, M.B. Langkilde-Lausen, A. Mortensen, J. L. Sørensen and M. Drewsen, Appl. Phys. B **93**, 373 (2008)
[2] P. Herskind, A. Dantan, J. Marler, M. Albert and M. Drewsen, *Realisation of Collective Strong Coupling with Ion Coulomb Crystals in an Optical Cavity*, submitted

Q 35.5 Mi 15:00 VMP 6 HS-E

Two-photon gateway in one-atom cavity quantum electrodynamics — •Alexander Kubanek, Alexei Ourjoumtsev, Ingrid Schuster, Markus Koch, Pepijn Pinkse, Karim Murr, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

Single atoms absorb and emit light from a resonant laser beam photon by photon. However, an atom strongly coupled to light inside a high-finesse optical cavity forms a new system with an anharmonic energy structure. This anharmonicity allows the selective excitation of a two-photon resonance [1], where the system absorbs and emits pairs of photons. In a photon correlation experiment [2] we demonstrate how the system transforms an incoming random stream of laser photons into a correlated beam of output photons, thereby acting as a two-photon gateway. The Poissonian distributed light changes into super-Poissonian, bunched light. This effect opens up the possibility to control the interaction of two photons by means of one atom.

[1] I.Schuster et al., Nature Phys. 4, 382 (2008)
[2] A.Kubanek et al., Phys. Rev. Lett. 101, 203602 (2008)

Q 35.6 Mi 15:15 VMP 6 HS-E

Momentum-space interferometry with trapped ultracold atoms — •Andreas Ruschhaupt[1], Adolfo del Campo[2], and J. Gonzalo Muga[3] — [1]Institut für Mathematische Physik, TU Braunschweig, Mendelssohnstrasse 3, 38106 Braunschweig — [2]Institute for Mathematical Sciences, Imperial College London, SW7 2PE, UK — [3]Departamento de Quimica-Fisica, Universidad del Pais Vasco, Apartado 644, 48080 Bilbao, Spain

Quantum interferometers are generally set so that phase differences between paths in coordinate space combine constructive or destructively. Indeed, the interfering paths can also meet in momentum space leading to momentum-space fringes. We propose and analyze a method to produce interference in momentum space by phase-imprinting part of a trapped atomic cloud with a detuned laser. For one-particle wave functions analytical expressions are found for the fringe width and shift versus the phase imprinted. The effects of unsharpness or displacement of the phase jump are also studied, as well as many-body effects to determine the potential applicability of momentum-space interferometry.

Reference: arXiv:0810.1720

Q 35.7 Mi 15:30 VMP 6 HS-E

Pump-probe spectroscopy of two-atom entanglement in ultracold gases — •Christiane P. Koch[1] and Ronnie Kosloff[2] — [1]Freie Universität Berlin, Institut für Theoretische Physik, Arnimallee 14, 14195 Berlin — [2]Hebrew University, Dept. of Physical Chemistry, Jerusalem 91904, Israel

Two atoms in an ultracold gas are entangled at short inter-atomic distances due to threshold effects where the potential energy of their interaction dominates the kinetic energy. The entanglement manifests itself in a distinct nodal structure of the pair density at short range. We suggest pump-probe spectroscopy to study this entanglement: A suitably chosen, short laser pulse excites part of the atomic pair density to an electronically excited state. This depletes the ground state pair density in a range of distances, creating a 'hole'. The dynamics of this non-stationary wave packet can be monitored by a time-delayed probe pulse. We find different 'hole' dynamics for coherent and incoherent initial states, corresponding, respectively, to a BEC and an ultracold thermal ensemble.

Q 35.8 Mi 15:45 VMP 6 HS-E

Coherent control of nuclear forward scattering — •Adriana Pálffy, Jörg Evers, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Resonant excitation is the key ingredient to applications in many areas of physics. To some extent, the different areas are unified by common ideas to coherently control the dynamics as it is well known from atomic systems. In nuclear physics, monochromatized synchrotron radiation and upcoming high-frequency laser sources allow for coherent photo-excitation. Such an excitation in a nuclear ensemble is of excitonic nature, leading to coherent nuclear reemission in the forward direction. The coherent decay of the collective nuclear excitation is considerably speeded up with respect to the incoherent decay channels and thus to the natural lifetime. It has been shown experimentally [1] that switching abruptly the direction of the magnetic hyperfine fields can control and even completely suppress the coherent decay channel due to destructive interference.

Here, we study more advanced coherent control schemes based on the experimental setup of [1]. We show that the accelerated nuclear forward scattering allows for the generation of two correlated coherent decay pulses out of one excitation, providing single-photon entanglement in the keV regime. Furthermore, the possibility to selectively populate excited nuclear states or metastable states by controlling branching ratios of coherently-driven transitions is addressed.

[1] Y. V. Shvyd'ko *et al.*, Phys. Rev. Lett. 77, 3232 (1995)