Q 44: Quanteneffekte (Interferenz / Sonstige)

Zeit: Donnerstag 14:00–16:15 Raum: 2D

Q 44.1 Do 14:00 2D

Vacuum-induced couplings of dipole moments in a pair of atoms — •Sandra Isabelle Schmid and Jörg Evers — Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

In single atom systems, vacuum-coupling of different transition dipole moments can induce spontaneously generated coherences which give rise to a multitude of interesting effects. These couplings, however, only act between non-orthogonal dipole moments and thus rarely occur in real atoms. But in [1], they were demonstrated in a realistic four-level system in J=1/2 to J=1/2 configuration.

Two nearby atoms can dipole-dipole interact by exchanging virtual photons via the vacuum. This dipole-dipole interaction can also couple transitions with orthogonal dipole moments, which crucially influences the system dynamics [2,3]. Even when averaging over different geometrical setups the effects resulting from these couplings do not vanish [4].

Here, we investigate a system consisting of a pair of atoms in J=1/2 to J=1/2 configuration where both types of couplings occur. In particular, we are interested in the interplay of the two vacuum-mediated interactions. As observables, we discuss the influence of the different couplings on the resonance fluorescence intensity and the spectrum.

[1] M. Kiffner, J. Evers, and C. H. Keitel, Phys. Rev. Lett. **96**, 100403 (2006)
[2] G. S. Agarwal and A. K. Patnaik, Phys. Rev. A **63**, 043805 (2001)
[3] J. Evers, M. Kiffner, M. Macovei, and C. H. Keitel, Phys. Rev. A **73**, 023804 (2006)
[4] S. I. Schmid and J. Evers, arXiv:0709.2103 (2007)

Q 44.2 Do 14:15 2D

Phase space sub-Planck structures: experimental realization in time-frequency domain — •Ludmila Praxmeyer[1], Piotr Wasylczyk[2], Czeslaw Radzewicz[2], and Krzysztof Wodkiewicz[2] — [1]Optical Quantum Information Theory Group, Max Planck Research Group, Institute of Optics, Information and Photonics, 91058 Erlangen, Germany — [2]Faculty of Physics, Warsaw University, Poland

It was shown by Zurek [1] that sub-Planck structures in phase space play a surprisingly important role in the distinguishability of quantum states. A sub-Planck phase space shift applied to a superposition of coherent states is sufficient to produce a state which is orthogonal to the unshifted one! The effect was originally studied for a superposition of four coherent states [1], then it was shown that superpositions of just two coherent states lead to a similar result [2]. We present experimental data of the frequency resolved optical gating (FROG) measurements of light pulses revealing interference features which correspond to sub-Planck structures in phase space [3]. For superpositions of pulses a small, sub-Fourier shift in the carrier frequency leads to a state orthogonal to the initial one, although in the representation of standard time-frequency distributions these states seem to have a non-vanishing overlap.

[1] W. Zurek, Nature 412, 712 (2001).
[2] L. Praxmeyer, K. Wodkiewicz, Laser Phys. Vol.15, No.10, 1477 (2005); L. Praxmeyer, PhD thesis (2005).
[3] L. Praxmeyer, P. Wasylczyk, Cz. Radzewicz, K. Wodkiewicz, Phys. Rev. Lett. 98, 063901 (2007).

Q 44.3 Do 14:30 2D

Interference of resonance fluorescence from two distant atoms — •Felix Rohde, Carsten Schuck, Marc Almendros, Roger Gehr, Francois Dubin, Markus Hennrich, and Jürgen Eschner — ICFO - Institut de Ciencies Fotoniques, Castelldefels (Barcelona), Spain

We trap two single calcium ions simultaneously in two independent ion traps at a distance of about 1 m. The ions are continuously excited using lasers at 397 nm and 866 nm that are frequency-stabilised by a transfer locking scheme to an atomic reference line in cesium. The continuous resonance fluorescence from the two ions is coherently superimposed and recorded with photomultipliers in photon counting mode. We present results on classical and quantum interference in the detected light. Such interference will be used for entangling the two ions by conditional state preparation.

Q 44.4 Do 14:45 2D

Microwave driven Rydberg atoms: from strong localization to single-photon ionization — •Alexej Schelle[1,2], Andreas Buchleitner[2], and Dominique Delande[1] — [1]Laboratoire Kastler Brossel, 4, place Jussieu, F-75252 Paris, cedex 05 — [2]Institute of Physics, Department for Quantum Optics and Statistics, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

We study the atomic counterpart of Anderson localization in atomic driven Rydberg systems. By switching the initial Rydberg state from lower bound states, where destructive quantum interference suppresses the classically predicted ionization threshold, up to the single-photon absorption limit, we observe a transition in the scaling behavior of the ionization threshold field. Unlike in the strong localization regime, where the scaled ionization threshold shows a smooth and universal behavior for hydrogen and lithium atoms, strong oscillations in the few-photon absorption limit indicate the breakdown of the Anderson localization scenario.

Q 44.5 Do 15:00 2D

Quantum Phase Transitions with Polaritons and Photons — •Michael Hartmann[1,2] and Martin Plenio[1,2] — [1]Institute for Mathematical Sciences, Imperial College London, 53 Exhibition Road, London, SW7 2PG, United Kingdom — [2]QOLS, The Blackett Laboratory, Imperial College London, Prince Consort Road, London, SW7 2BW, United Kingdom

Artificial many-body systems that permit good experimental access and control have become an important tool for the study of quantum phase transitions in the laboratory.

Here we show that arrays of coupled high-Q cavities doped with atoms can be employed to study quantum phase transitions with polaritons and photons. In particular, photons can be driven into a Mott insulator state which corresponds to light in a "crystalized"form.

An important advantage of our approach is that it allows to access and control individual lattice sites.

Q 44.6 Do 15:15 2D

Thermal equilibrium of coupled atom-light states in an ultrahigh pressure buffer gas cell — •Ulrich Vogl, Johannes Nipper, and Martin Weitz — Institut für Angewandte Physik, Wegelerstraße 8, 53115 Bonn

Thermal equilibrium is a prerequisite for most known phase transitions, as Bose-Einstein condensation of dilute atomic gases or many solid state physics concepts. Recently, phase transitions of coupled particle-light degrees of freedom have been investigated in the framework of polariton quasiparticle condensation, and exciton polariton systems gave compelling evidence for a condensation. However, the short polariton lifetimes of around a ps arose questions whether the system is fully thermalized. We investigate the statistical distribution of coupled atom-light excitations in an atomic rubidium gas cell subject to 500 bar buffer gas pressure. The large collisional broadening of this system interpolates between usual atomic physics gas phase and solid/liquid phase conditions. An observed intensity-dependent blue asymmetry of spectra is interpreted as evidence for the approaching of thermal equilibrium of dressed atom-light states.

Q 44.7 Do 15:30 2D

Cooling of a nanomechanical resonator integrated into a superconducting box qubit — •Konstanze Jähne[1,2] and Margareta Wallquist[1,2] — [1]Institute for Theoretical Physics, University of Innsbruck, Innsbruck, Austria — [2]Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, Innsbruck, Austria

We consider the following system: a nanomechanical resonator that is integrated into a superconducting loop of a current-biased superconducting qubit, in particular a Cooper pair box. One can apply a magnetic field to the nanoresonator, which together with the current flowing through it creates a Lorentz force, which gives rise to a switchable coupling between nanoresonator and qubit. Using methods of theoretical quantum optics, we show that it is possible to cool the nanoresonator, if one drives the qubit around its optimal working point with a drive frequency that is red detuned with respect to the qubit transition. Furthermore we investigate under which conditions the nanoresonator can be cooled to its quantum mechanical ground state.

Q 44.8 Do 15:45 2D

Inverse Scattering in Application to the Riemann Problem — •Rüdiger Mack and Wolfgang P. Schleich — Institut für Quantenphysik, Universität Ulm, 89073 Ulm

We present a method to get the values of the Riemann Zeta-function by autocorrelation measure. Therefore we need a potential with specific energy eigenvalues. We calculate this potential with a variety of techniques, either numerical by the Numerov mehtod and analytically, with a JBKW approximation.

Q 44.9 Do 16:00 2D

Resonant Interferometric Lithography beyond the Diffraction Limit — •Jörg Evers[1], Martin Kiffner[1], and M. Suhail Zubairy[1,2] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Institute for Quantum Studies and Department of Physics, Texas A&M University, USA, and Texas A&M University at Qatar

A fundamental limit to the spatial resolution of the interferometric lithography with classical uncorrelated light arises due to diffraction. To overcome this limit, several schemes have been proposed to improve the spatial resolution of interferometric lithography beyond the diffraction limit. These schemes are based on an N-photon absorption process and achieve a spatial resolution of $\lambda/(2N)$, where λ is the wavelength of the light. The indispensable requirement of a multiphoton transition, however, is accompanied by the need for high light field intensities which makes an experimental realization of these schemes impractical.

Here, we present a novel approach for the generation of subwavelength structures in interferometric optical lithography which only comprises resonant atom-field interactions, such that no multiphoton absorber is required [1]. Our scheme relies on the preparation of the system in a position dependent trapping state via phase shifted standing wave patterns. The contrast of the induced pattern does only depend on the ratios of the applied field strengths such that our method in principle works at arbitrarily low laser intensities.

[1] M. Kiffner, J. Evers, and M. S. Zubairy, submitted