Q 41 Quanteneffekte IV

Zeit: Mittwoch 10:40–12:55 Raum: HII

Q 41.1 Mi 10:40 HII

Characterising and manipulating the motion of a single ion — •Daniel Rotter[1], Francois Dubin[1], Manas Mukherjee[1], Carlos Russo[1], Christoph Becher[2], Jürgen Eschner[3], and Rainer Blatt[1,4] — [1]Institut fuer Experimentalphysik, Universitaet Innsbruck — [2]Universitaet des Saarlandes, Saarbruecken — [3]ICFO - The Institute of Photonic Sciences, Spain — [4]Institut fuer Quantenoptik und Quanteninformation, Oesterreichische Akademie der Wissenschaften, Austria

We observe the secular motion of a single Ba^+ ion in a Paul trap over more than 6 orders of magnitude in time, allowing for quantitative characterisation and active manipulation of the motional state. The ion is continuously laser-excited at Doppler cooling conditions. A part of the resonance fluorescence is retro-reflected to create interference fringes [1], such that the ion's motion produces an amplitude modulation in the detected photocurrent ("self-homodyning"). Feedback control of amplitude and phase of a single vibrational mode has been achieved [2]. In the $g^{(2)}(\tau)$ correlation function [3], a beating between two oscillations at $\omega_x/2\pi \approx 1$ MHz and $\omega_y/2\pi \approx 1.2$ MHz is measured, which demonstrates long-time phase stability between the corresponding modes. The experimental data are in good agreement with a theoretical model.

[1] J. Eschner et al., Nature **413**, 495 (2001)
[2] P. Bushev et al., quant-ph/0509125
[3] V. Gomer et al., Phys. Rev. A, **58**, R1657, (1998)

Q 41.2 Mi 10:55 HII

Correlations in s-Waves — •Rüdiger Mack and Wolfgang P. Schleich — Abteilung Quantenphysik, Universität Ulm

One of the fundamental facts of quantum mechanics is the correlation between position and momentum. Wigner functions express the correlation in negative domains of phase space. This is a significant difference to classical phase space.

Investigating radial symmetric wave packets, we discovered an astonishing behaviour: One expects, that a freely propagating wave packet spreads due to different momenta contained in the packet. But instead of spreading, the wave shrinks on short time scales.

As a measure of the extend of the wave packet we take the average separation $\langle r\rangle$ of the s-wave from the origin. We find, that the effect of shrinking is limited to low dimensional systems, e.g. $D \leq 2$. We investigate different initial s-waves in order to enlarge this contraction effect. Moreover we address the question of the existence of an optimum wave function.

Q 41.3 Mi 11:10 HII

Decoherence and Classical Dynamics in Markovian Quantum Open Systems — •Olivier Brodier[1] and A. M. Ozorio de Almeida[2] — [1]M.P.I.P.K.S. Nothnitzer Str. 38 D-01187 DRESDEN GERMANY — [2]C.B.P.F. Rua Xavier Sigaud, 150 22290-180 RIO DE JANEIRO BRASIL

We derive a semiclassical propagator for the characteristic function, that is the Fourier transform of the Weyl representation of the density operator, for a general Markovian open quantum system with linear coupling to environment.

The theory describes quantitatively how decoherence time strongly depends on local phase space structure of the system.

The case of a quadratic Hamiltonian is calculated exactly. The general case is treated semiclassically in a doubled phase space.

Q 41.4 Mi 11:25 HII

Quantum Theory of Light Emission from a Semiconductor Quantum-Dot — •Thomas Feldtmann, Lukas Schneebeli, Mackillo Kira, and Stephan W. Koch — Department of Physics and Materials Sciences Center, Philipps-University, Renthof 5, 35032 Marburg, Germany

A number of recent experiments have proven that spectrally isolated quantum dots are capable of emitting non-classical light. For example, pronounced antibunching effects can turn the dot into a source of single photons [1,2] or pairs of strongly correlated photons [3]. This truly quantum-mechanical behavior opens the door to future applications of quantum-dots in quantum cryptography as well as quantum computing and data storaging.

Here, we present a fully quantized theory of light emission from a semiconductor quantum-dot. Coulomb interaction and light-matter coupling are treated consistently on the same level of sophistication. We use a cluster-expansion approach that can be extended to higher-order correlations so as to calculate the quantum statistics of emission.

[1] P. Michler et al., Science **290**, 2282 (2000)
[2] C. Santori et al., Phys. Rev. Lett. **86**, 1502 (2001)
[3] E. Moreau et al., Phys. Rev. Lett. **87**, 183601 (2001)

Q 41.5 Mi 11:40 HII

Signatures of the Unruh effect — •Ralf Schuetzhold — Technische Universitaet Dresden, Institut fuer Theoretische Physik, 01062 Dresden

With the ultra-high field strengths which may become available in the near future (via the compression of electromagnetic pulses), it might be possible to observe signatures of the Unruh effect from strongly accelerated electrons/positrons. After a short review of the main mechanism, the possibility of discriminating the photons created via the Unruh effect from purely classical radiation is discussed.

Q 41.6 Mi 11:55 HII

Statistical signatures of coherent back scattering of light — •Carlos Viviescas[1], Vyacheslav Schatokhin[2], and Andreas Buchleitner[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, D-01187 Dresden — [2]B. I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Skaryna Ave. 70, BY-220072 Minsk

Using a nonperturvative approach, we study the imprint of coherent backscattering in the photocount statistics of laser light scattering on a cloud of cold atoms. In particular, also the contribution of inelastically scattered photons is accounted for, at higher intensities of the injected radiation.

Q 41.7 Mi 12:10 HII

The efficiency of quantum tweezers — •Bernd Mohring[1], Giovanna Morigi[2], Eric Lutz[1], and Wolfgang P. Schleich[1] — [1]Abteilung Quantenphysik, Universität Ulm, 89069 Ulm, Germany — [2]Grup d'Optica, Departament de Física, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

We investigate the efficiency of recent proposals [1,2] that have shown how atoms can be extracted on demand from a Bose-Einstein condensate. Such proposals use the selective coupling between the condensate and the ground state of a steep trap in the regime in which the many-body spectrum of the steep trap is spectrally resolved. We study the limitations introduced by coupling the condensate over a finite time in the regime where condensate excitations are not spectrally resolved.

[1] R. B. Diener *et al.*, Phys. Rev. Lett. **89**, 070401 (2002)
[2] B. Mohring *et al.*, Phys. Rev. A **71**, 053601 (2005)

Q 41.8 Mi 12:25 HII

Universal Optical Amplification without a nonlinearity — •Metin Sabuncu[1], Vincent Josse[1], Nicolas Cerf[2], Gerd Leuchs[1], and Ulrik L Andersen[1] — [1]Institute of Optics, Information and Photonics (Max Planck Research Group), University of Erlangen-Nuremberg, Günther-Scharowsky-Str. 1, Bau 24, 91058 Erlangen, Germany — [2]QUIC, Ecole Polytechnique, CP 165, Universite Libre de Bruxelles, 1050 Bruxelles, Belgium

A phase insensitive amplifier is a device which isotropically amplifies a quantum state in phase space, independent of any relative phase apparent in the state. Common examples are the fibre amplifier, the parametric amplifier and the laser amplifier.These amplifiers require an efficient coupling of the signal to the amplifying medium via a nonlinear interaction making the realization highly intricate. We propose and realize a novel phase insensitive amplifier which consists of only linear optics, homodyne detectors and electro-optic feed forward. We show that with this setup we can in principle set any gain by just simply adjusting a beam splitting ratio and the feed forward gain accordingly. We performed experiments for a spectrum of different gains and verified that our amplifier saturates the fundamental limit given for phase-insensitive amplifiers especially in the low gain regime.

Q 41.9 Mi 12:40 HII

Zwei-Photon Optik — •Daniel Schlenk[1] und Harald Weinfurter[1,2] — [1]Department für Physik der LMU, München — [2]Max-Planck Institut für Quantenoptik, Garching

Bei der Zwei-Photonen Absorptions-Mikroskopie wird eine Probe mit einem stark fokussierten Laser abgetastet. Farbstoffe in der Probe werden über einen Zwei-Photonen Übergang angeregt, und die spontan emittierten Photonen zur Bildentstehung detektiert [1].

Mikroskopie mit impulsverschränkten Photonen ermöglicht eine Steigerung der Auflösung um den Faktor $\sqrt{2}$ im Vergleich zur Anregung mit einem Laser [2,3]. Die impulsverschränkten Photonen entstehen im Prinzip gleichzeitig bei der spontanen parametrischen Fluoreszenz, wodurch Zwei-Photonen Anregung bei einer um mehrere Größenordnungen kleineren mittleren Intensität möglich ist, und somit Schäden an biologischen Proben vermieden werden können.

In unserem Experiment werden verschränkte Photonen bei einer Wellenlänge von 702 nm mittels spontaner parametrischer Fluoreszenz erzeugt und mit einem standard Mirkoskopobjektiv fokussiert. Erste Testmessungen zeigen die verbesserte Fokussierung des Zwei-Photonen Zustands.

[1] W. Denk, J. H. Strickler, and W. W. Webb, Science 248, 73 (1990).
[2] M.C. Teich und B.E.A. Saleh, Cesk. Cas. Fyz 47, 3-8 (1997).
[3] M. B. Nasr et al., Phys. Rev. A 65, 023816 (2002).