Q 36 Quanteneffekte II

Zeit: Dienstag 10:45–12:45 Raum: HU 1072

Q 36.1 Di 10:45 HU 1072

Efficient polarization squeezing in optical fibers — •Joel Heersink, Vincent Josse, Gerd Leuchs, and Ulrik L. Andersen — IOIP Max-Planck Forschungsgruppe, Uni. Erlangen-Nürnberg, Günther-Scharowsky-Str. 1 Bau 24, 91058 Erlangen

We report on a novel and efficient source of polarization squeezing using a single pass through an optical fiber. Simply passing this Kerr squeezed beam through a carefully aligned 1/2-waveplate and splitting it on a polarization beam splitter, we find polarization squeezing of up to 5.1 +/- 0.3 dB. The experimental setup allows for the direct measurement of the squeezing angle.

Q 36.2 Di 11:00 HU 1072

Photon number squeezing using an all-in-fiber asymmetric Sagnac loop — •Metin Sabuncu[1], Joel Heersink[1], Thomas Hellmuth[2], Gerd Leuchs[1], and Ulrik Andersen[1] — [1]IOIP Max Planck Forschungsgruppe Uni. Erlangen-Nürnberg, Günther-Scharowsky-Str. 1 Bau 24, 91058 Erlangen — [2]Heinrich-Rieger-Strasse 22/1, 73430 Aalen

We produce photon-number squeezed solitons using an all-in-fibre asymmetric Sagnac interferometer. A fixed coupler in the interferometer provides a constant splitting ratio of 93:7 at a wavelength of 1530 nm. 30 metres of polarisation maintaining Panda fibre is used for the Sagnac loop. We investigated the squeezing depending on the power and wavelength of the input beam and saw more than 3 dB of amplitude noise reduction below the shot noise level. Our all-in-fibre squeezing source is promising for applications in the field of quantum information especially due to its compactness and robustness.

Q 36.3 Di 11:15 HU 1072

The Quantum Ulm Sparrow — •O. Crasser[1], C. Feiler[1], A. Wolf[1], V. Pokrovsky[2,3], G. Süssmann[4], and W. P. Schleich[1] — [1]Abteilung für Quantenphysik, Universität Ulm, 89069 Ulm, Germany — [2]Department of Physics, Texas A&M University, College Station, Texas, USA — [3]Landau Institute for Theoretical Physics, Chernogolovka, Moscow District, 142432, Russia — [4]Ludwig-Maximilians-Universität München, Sektion Physik, 85748 Garching, Germany

We consider the scattering of a rotor from a slit which is smaller than the length of the rotor. This scattering situation is reminiscence of the Ulm sparrow trying to fly into its nest with a straw in its beak. The quantum state of rotation is an s-state. We show that in the limit of the kinetic energy being smaller than the energy of the first excited rotational state the transmission probability is exponentially small. Indeed, the rotor feels the wall and has to battle against an effective potential induced by the restriction in the rotation. Hence, tunneling is the only way for the rotor to overcome the barrier. We discuss experimental realizations of the Quantum Ulm Sparrow.

Q 36.4 Di 11:30 HU 1072

Quantum optical time-of-arrival model in three dimensions — •Volker Hannstein[1], Gerhard C. Hegerfeldt[1], and J. G. Muga[2] — [1]Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund-Platz 1. 37077 Göttingen — [2]Departamento de Quimica-Fisica, UPV-EHU, Apdo. 644, Bilbao, Spain

We have investigated the three-dimensional formulation of a recently proposed operational arrival-time model [1]. It is shown that within typical conditions for optical trasitions the results of the simple one-dimensional version are generally valid. Differences that may occur are consequences of Doppler and momentum-transfer effects. Ways to minimize these are discussed.

[1] Damborenea J A, Egusquiza I L, Hegerfeldt G C and Muga J G 2002 *Phys. Rev.* A **66** 052104

Q 36.5 Di 11:45 HU 1072

Resonance Fluorescence of cold trapped atoms — •Wolfgang Merkel[1], Marc Bienert[2], and Giovanna Morigi[3] — [1]Abteilung für Quantenphysik, Universität Ulm, D-89069 Ulm — [2]Centro de Ciencas Físicas UNAM, 62251 Cuernavaca, Mexico — [3]Departament de Fisica, Universitat Autonoma de Barcelona, 08193 Bellaterra, Spain

We investigate theoretically the spectrum of resonance fluorescence of a cold trapped atom in the final stage of laser cooling. We focus on the features due to the mechanical effects of light in the case where the size of the atomic wavepacket is much smaller than the laser wavelength (Lamb-Dicke limit). In particular, we discuss how these spectral features depend on the underlying model describing the internal atomic structure. Our aim is to identify the origin of the spectral features characterizing the motional sidebands. A consideration based on classical arguments is set in contrast to the full quantum mechanical result. To clarify the differences of both considerations we provide a semiclassical analysis of the problem.

Q 36.6 Di 12:00 HU 1072

Modification of spontaneous emission and energy transfer by high-Q modes of a microsphere resonator — •Andrea Mazzei[1], Leonardo Menezes[1], Stephan Götzinger[1], Vahid Sandoghdar[2], and Oliver Benson[1] — [1]Humboldt Universität zu Berlin, Institut für Physik - AG Nanooptik, Hausvogteiplatz 5-7 10247 Berlin — [2]Laboratory of Physical Chemistry, Swiss Federal Institue of Technology, Ch-8093, Zürich, Switzerland

Coupling single quantum emitters to the modes of a high-Q microsphere, the so-called Whispering Gallery Modes (WGM), is a research topic of great interest, e.g. for Cavity-QED experiments and for the realization a nanolaser. To perform such experiments, a detailed knowledge of the structure of the modes and of the coupling efficiency of active material to the modes is crucial [1, 2]. Using techniques developed in near-field optical microscopy we could measure the so called beta-factor (defined as the ratio of the emission into a certain mode and the total spontaneous emission) of the emission of a single nano-emitter (realized by a 200nm dye-doped bead) into the fundamental WGM. In the same experimental configuration we also studied cavity mediated energy transfer between single nano-emitters as well as induced coupling between the clockwise and counter-clockwise propagating modes.

[1] S. Götzinger, O. Benson, V. Sandoghdar, App. Phys. B 73, 825 (2001)

[2] S. Götzinger et al., Proc SPIE 4969, 207 (2003)

Q 36.7 Di 12:15 HU 1072

Whispering Gallery Mode Resonators in Microstructured Tapered Optical Fibers — •Louyer Yann, Warken Florian, Meschede Dieter, and Rauschenbeutel Arno — Institut für Angewandte Physik, Universität Bonn, Wegelerstr. 8, 53115 Bonn

We present a theoretical description of a novel type of whispering gallery mode (WGM) resonators, realized by microstructuring tapered optical fibers. The resonators have a highly prolate shape giving rise to WGMs for the radial component. Along the resonator axis, the light is trapped between two spatially well separated caustics with an enhanced field strength. By deriving the wave equation and by using the method of adiabatic invariants, we calculate the spatial mode structure and its spectral properties. We predict a mode volume competing with microsphere resonators. At the same time, the predicted free spectral range is much smaller than for microsphere WGMs, promising a more advantageous tunability. These properties open interesting perspectives for confining and controlling light. In particular, in the framework of cavity quantum electrodynamics, a deterministic coupling of laser-trapped atoms to the mode is conceivable.

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Q 36.8 Di 12:30 HU 1072

Feedback control of a single ion's motion — •D. Rotter[1], P. Bushev[2], A. Wilson[1], C. Becher[1], J. Eschner[1,3], and R. Blatt[1,4] — [1]Institut für Experimentalphysik, Universität Innsbruck, Austria — [2]Laboratory of Physical Chemistry, ETH Zürich — [3]Institute for Photonic Sciences (ICFO), Spain — [4]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Austria

We demonstrate feedback cooling of a single trapped ion below the Doppler limit by the method of "cold damping" [1] or homodyne feedback [2]. We also show that the motional phase can be stabilised against the diffusion induced by photon recoils by locking it to an external reference oscillator. In our experiment a single Ba^+ ion in a Paul trap is continuously laser-excited at Doppler cooling conditions. A part of the resonance fluorescence is retro-reflected, thus leading to interference fringes of high contrast [3]. Since the interference is sensitive to the ion-mirror distance, amplitude and phase of the ion's motion are detected with high signal-to-noise ratio in the fluctuation spectrum of the photocurrent. For cold damping, we create an additional friction force proportional to the instantaneous velocity of the ion, by supplying additional electric fields which are -90° phase-shifted against the measured amplitude of the motion. Phase-locked operation is achieved by measuring phase deviations between the ion's motion and the reference oscillator, and feeding them back to the level of the rf trap drive, thus controlling the trap stiffness.

[1] J. M. W. Milatz et al., Physica **19**, 181 (1953).
[2] S. Mancini et al., PRL **80**, 688 (1998).
[3] J. Eschner et al., Nature **413**, 495 (2001).