

Q 59: Quanteneffekte (Lichtstreuung II)

Zeit: Donnerstag 14:00–16:00

Raum: 5E

Q 59.1 Do 14:00 5E

Generating EPR-entangled radiation with a beam of atoms — ●SUSANNE PIELAWA^{1,2}, GIOVANNA MORIGI¹, DAVID VITALI³, and LUIZ DAVIDOVICH⁴ — ¹Dept. de Física, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain — ²ICFO-Institute of Photonic Sciences, E-08860 Castelldefels (Barcelona), Spain — ³Dipt. di Física, Università di Camerino, I-62032 Camerino, Italy — ⁴Inst. de Física, Universidade Federal do Rio de Janeiro, Brasil

We propose a scheme for generating two-mode squeezing in resonators using a beam of atoms with statistical arrival times. A classical field drives the atoms inside the cavity transversally, saturating the dipole transition and thereby setting it on resonance with two non-degenerate cavity modes. By suitably preparing the atoms initial state, the stationary state after a sufficient atomic statistics is a two-mode squeezed state, whose degree of entanglement is controlled by the external parameters of atomic beam and pumping field. The scheme can be realized in the parameter regimes of present experiments with microwave resonators [1,2]. In the outlook we discuss possible extensions to the optical regime. [1]J. M. Raimond, M. Brune, and S. Haroche, *Rev. Mod. Phys.* 73, 565-582 (2001). [2]H. Walther, B.T.H. Varcoe, B.-G. Englert and T. Becker, *Rep. Prog. Phys.* 69, 1325-1382 (2006).

Q 59.2 Do 14:15 5E

Light propagation beyond the multiphoton resonance condition — ●JÖRG EVERS¹ and MOHAMMAD MAHMOUDI^{1,2} — ¹Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — ²Physics Department, Zanjan University, P. O. Box 45195-313, Zanjan, Iran

The light propagation of a probe field pulse is studied in atomic media where the applied laser fields form a closed interaction loop [1]. Such systems have interesting properties, but only admit a time-independent analysis if the laser field detunings satisfy the so-called multiphoton resonance condition. This condition, however, is violated in light propagation in particular for short pulses with a large frequency width. To overcome this limitation, we solve the time dependent problem using a Floquet decomposition of the equations of motion, and identify the processes contributing to the medium response. We then show that our four-level double- Λ type model system allows for sub- and superluminal light propagation with small absorption or even gain, controlled by one of the coupling field Rabi frequencies.

[1] M. Mahmoudi and J. Evers, *Phys. Rev. A*. in print (quant-ph/0609206)

Q 59.3 Do 14:30 5E

Towards coupling of two distant emitters — ●ROBERT LETTOW¹, STEPHAN GÖTZINGER¹, VILLE AHTEE², ERKKI IKONEN², and VAHID SANDOGHDAR¹ — ¹Laboratory of Physical Chemistry, ETH Zürich, CH-8093 Zürich — ²Metrology Research Institute, Helsinki University of Technology, Finland

We report on experiments where two organic dye molecules are coupled over a long distance. Although both coherent and incoherent coupling of emitters have been demonstrated in the near field via the dipole-dipole interaction, coupling of two quantum optical systems separated by more than a wavelength remains a challenge due to several experimental difficulties. In the gas phase the detection and excitation efficiencies are very low while in the solid state usually the spectral inhomogeneity, the coupling to phonons and a low absorption cross section pose problems. In our laboratory, we have set up an experiment where single molecules in two different samples are detected simultaneously at liquid helium temperature. By using microscope objectives of high numerical aperture, we achieve very efficient excitation of the molecules and collection of their emitted photons. Furthermore, by applying local electric fields, we tune the Fourier limited zero-phonon lines of the two molecules to make them spectrally indistinguishable. We present the current status of this experiment and discuss future plans.

Q 59.4 Do 14:45 5E

Amplification of Terahertz pulses in thin gases — ●GERHARD SCHWAAB, KONSTANZE SCHRÖCK, and MARTINA HAVENITH — Physikalische Chemie II, Ruhr-Universität Bochum, D-44780 Bochum

We have carried out Terahertz Time-Domain Spectroscopy in a plasma

at low pressure and observed a simultaneous absorption and amplification process within each single rotational transition. We were able to model the observation and could show that it is a direct consequence of the short interaction time of the pulsed THz radiation with the plasma. The interaction time is shorter than the average collision time between the molecules. Thus, during measurement time the molecular and photonic states may be considered entangled.

The solution of the time dependent Schrödinger equation yields a linear term that may usually be neglected for long observation times, large frequencies, or non-entangled states. We determine the restrictions for the observation of this effect and calculate the spectrum for a simple diatomic molecule.

We predict an absorption/amplification process that shows a quadratic instead of the typical exponential behaviour. Using this model we are able to explain the spectral features showing a change from emission to absorption as observed previously.

The observed effect should be a general phenomenon for any quantum mechanical system with entangled states when a) the time scale for disturbances exceeds the typical interaction time of the light pulse with the sample and b) the population difference is small.

Q 59.5 Do 15:00 5E

The coherent backscattering spectrum of two atoms — ●VYACHESLAV SHATOKHIN¹, THOMAS WELLENS², BENOIT GREMAUD³, and ANDREAS BUCHLEITNER⁴ — ¹B.I. Stepanov Institute of Physics, National Academy of Sciences, Nazavismosti Avenue 68, 220072 Minsk, Belarus — ²Institut für Theoretische Physik, Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany — ³Laboratoire Kastler Brossel, Université Pierre et Marie Curie, 4 Place Jussieu, 75252 Paris Cedex 05, France — ⁴Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

We present a detailed analytical and numerical analysis of the inelastic coherent backscattering spectrum of laser light incident on cold atoms. We identify frequency domains where the interference contribution can be positive or negative, or exhibit dispersive features. These distinctive features are explained by reciprocity arguments and dressed state two-photon scattering amplitudes.

Q 59.6 Do 15:15 5E

Multiple photon scattering in resonant atomic media — ●TOBIAS KERSCHER and CORD MÜLLER — Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth

We investigate multiple photon scattering in a dense cloud of resonant atoms by means of a self-consistent perturbation theory. The atoms are assumed to be identical two-level systems. In this medium the self-energy Σ determines the photonic dispersion relation.

We present a diagrammatic calculation of Σ to leading order in atomic density and compare it to a coherent potential approximation (CPA). The dressed propagation of light in turn influences the natural line width Γ of the atomic resonance. The near-resonance behaviour of Γ will be discussed.

Q 59.7 Do 15:30 5E

Coherence of light scattered by two coupled atoms — STEFAN RIST¹, GIOVANNA MORIGI¹, ●MARKUS HENNRICH², and JÜRGEN ESCHNER² — ¹Dept. de Física, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain — ²ICFO-The Institute of Photonic Sciences, E-08860 Castelldefels (Barcelona), Spain

We investigate theoretically the properties of the light scattered by two atoms which are imaged onto each other by a lens and a mirror. In a recent experiment using that configuration [1], interference between the light scattered by one atom and the mirror image of the second one was observed as a function of the difference between the optical paths of the light reaching the detector. Here we develop a theoretical model for the experimental situation, which extends the work of Ref. [2] describing the dynamics of a single atom in front of a mirror. The emission spectra of the two atoms are evaluated by taking into account multiple scattering of photons at all orders, thereby determining the corrections to the Wigner-Weisskopf approximation for the atomic linewidth. Novel features in the first order interference spectrum are identified which arise from the interaction between the two atoms, and

which could be revealed in the setup of Ref. [1].

[1] J. Eschner, C. Raab, F. Schmidt-Kaler, and R. Blatt, *Nature* 413, 495 (2001).

[2] U. Dörner and P. Zoller, *Phys. Rev. A* 66, 023816 (2002)

Q 59.8 Do 15:45 5E

Radiation pressure cooling of a micro-mirror — •SIMON GRÖBLACHER^{1,2}, SYLVAIN GIGAN², HANNES BÖHM^{1,2}, FLORIAN BLASER², KATHARINA GUGLER², ANTON ZEILINGER^{1,2}, and MARKUS

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I will present recent results on radiation pressure induced cooling of a massive micro-mirror. This is of relevance for future quantum experiments involving macroscopic physical systems, e.g. entangled states of micro-mirrors.