Q 29: Photonik 2

Time: Tuesday 14:00–16:00 Location: V38.01

Q 29.1 Tue 14:00 V38.01

Feedback control of atomic spin states in an optical cavity — •Stefan Brakhane[1], Wolfgang Alt[1], Miguel Martinez-Dorantes[1], Tobias Kampschulte[1], René Reimann[1], Artur Widera[2], and Dieter Meschede[1] — [1]Institut für Angewandte Physik der Universität Bonn,Wegelerstr. 8,53115 Bonn — [2]Fachbereich Physik der TU Kaiserslautern,Erwin-Schrödinger-Str.,67663 Kaiserslautern

Detection and manipulation of atomic spin states is essential for many experimental realizations of quantum gates. Feedback schemes to stabilize the states and their superpositions can counteract perturbations caused by the environment [1].

In our experiment we deduce the atomic spin states of one and two caesium atoms by measuring the transmission of a probe laser through a high-finesse cavity. A digital signal processor calculates time-dependent probabilities for the spin states in real-time utilizing a Bayesian update formalism [2]. Using these probabilities in a feedback loop allows us to experimentally create and stabilize any arbitrary mixture of atomic spin states inside the cavity.

[1] Sayrin *et al.*, Nature **477**, 73 (2011)
[2] S. Reick, K. Mølmer *et al.*, J. Opt. Soc. Am. B **27**, A152 (2010)

Q 29.2 Tue 14:15 V38.01

Fine structure of reflection — •Jörg Götte[1] and Mark Dennis[2] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden — [2]School of Physics, University of Bristol, HH Wills Physics Lab, Tyndall Avenue, Bristol BS8 1TL, UK

The reflection of a light beam from a planar interface is a everyday familiar phenomenon - as long as we do not look too closely. Looking at a length scale comparable to the wavelength of the light reveals that confined beams of light may appear shifted upon reflection, both within the plane of incidence (Goos-Hänchen shift) and orthogonal to it (Imbert-Fedorov shift). These lateral and transverse spatial shifts find their analogues in the angular domain and light beams may also experience a small deflection upon reflection.

The nature of these shifts depends on Fresnel coefficients and hence on the material parameters, as well as the polarization and the spatial structure of the incident light beam. Upon reflection from an interface the homogeneity of the incident polarization is generally destroyed, which is why it is possible to observe different shifts through different settings of a polarization analyser.

An intriguing method to explore this family of shift effects is the use of optical vortices as positional markers. Upon reflection a higher order vortex splits up into a 'constellation' of simple vortices which is characteristic for the nature of reflection. We show how the constellation of vortices offers a closer look at the effects of reflection at the centre of the beam and how this is directly connected to shifts of the overall beam intensity.

Q 29.3 Tue 14:30 V38.01

Quantum teleportation between two remote single atoms — •Carolin Hahn, Christian Nölleke, Andreas Reiserer, Andreas Neuzner, Stephan Ritter, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

One of the fascinating consequences of quantum mechanics is the possibility to teleport a quantum state. It allows for the transmission of a quantum state over arbitrary distances and therefore enables long-distance quantum communication based on a quantum repeater scheme. Central to current experimental efforts in this direction is the teleportation between remote quantum memories forming the nodes of future quantum networks. We aim for quantum teleportation between two such nodes in independent laboratories, each consisting of a single atom trapped in an optical cavity. The envisioned teleportation scheme makes use of two major capabilities of these atom-cavity systems: the creation of atom-photon entanglement and faithful quantum state transfer from one atom onto the polarization of a single photon. These techniques have to be combined with a Bell state measurement on the two photons. Their interference on a beamsplitter and subsequent polarization-dependent detection allows for probabilistic teleportation of arbitrary quantum states between the two single atoms. Our progress towards the realization of this goal will be discussed.

Q 29.4 Tue 14:45 V38.01

Signal-to-noise ratio for EIT-based photon storage in warm vapour — •Tobias Latka, Andreas Neuzner, Christian Noelleke, Andreas Reiserer, Stephan Ritter, Eden Figueroa, and Gerhard Rempe — Max Planck Institut of Quantum Optics, Hans Kopfermann Str. 1, 85748 Garching

A quantum repeater is an essential element for the realization of long distance quantum communication. Paramount to this task is the implementation of optical quantum memories. Simple, warm atomic vapour systems have clear potential to achieve this goal as they are truly practical and easy to operate. In this work we explore the signal-to-noise ratio of an EIT-based quantum interconnect with incident fields at the single-photon level as a means to determine their feasibility to operate in the quantum regime. In order to perform this task accurately, filtering of the optical control field is a prerequisite. We discuss our filtering results in which we have achieved ~ 120 dB attenuation factor, and explore the possibilities of this setup as a quantum engineering device to achieve full control over the temporal shape of single photons generated from a cavity QED based source.

Q 29.5 Tue 15:00 V38.01

Replicating resonance behavior of plasmonic nanoparticles with simpler building blocks — •Ali Mahdavi[1,2], Eugen Tatartschuk[2], Oleksandr Zhuromskyy[3], and Ekaterina Shamonina[4] — [1]Max-Planck institute for the science of light, Erlangen, Germany — [2]SAOT, University of Erlangen-Nuremberg, Germany — [3]IOIP, University of Erlangen-Nuremberg, Germany — [4]Optical and Semiconductor Devices Group, EEE Department, Imperial College, Exhibition Road, London SW7 2BT, UK

We study by numerical simulation the resonant behavior of metallic nanoparticles, all of them having a cross section of 10*10 nm, in the region of hundreds of THz. The split ring, the most prominent subwavelength resonator, can be described as an LC circuit. However, if it is miniaturized to be as small as several hundreds of nanometers, its resonant behavior does not just simply scale with the size. The resonance frequency saturates and the field modes change significantly. The effects that need to be incorporated here are those of kinetic inductance due to the inertia of the electrons and of plasmon-polaritons at the metal/dielectric interface noticeable as the surface plasma frequency is being approached. We investigated standing wave patterns of surface plasmon polaritons on nanoparticles of different shapes, and according to our results the resonant behavior of each of these particles is similar to that of periodic arrays of nanorods with specific lengths and periodicities. For the first time the interaction of the gap edges of a split ring, previously described in terms of the self-capacitance, has been interpreted in terms of coupled plasmonic modes.

Q 29.6 Tue 15:15 V38.01

Long-range Surface Plasmon Polariton Wave Guides for near-infrared light — •Johannes Trapp[1], Markus Weber[1], and Harald Weinfurter[1,2] — [1]Department für Physik der LMU München, Schellingstr. 4/III, 80799 München — [2]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

Surface Plasmon Polaritons are collective excitations of free electrons in a metal. More precisely, they can be seen as charge density waves propagating along a metal-dielectric interface, with the ability to couple to an electromagnetic field outside the metal. This coupling allows for various applications, like sub-wavelength wave guiding or efficient collection of single photon emission. However, Surface Plasmon Polaritons suffer from short propagations lengths (tens of μm). In order to reduce damping, thin metal strips of few nm thickness are embedded in a dielectric and can then be used to carry the Surface Plasmon Polariton. Now the electromagnetic field is able to spread into the low-loss dielectric on both sides of the metal, thus drastically reducing attenuation. Propagation lengths achieved this way are found to be in the cm-range for optical communication wavelengths [1]. Here we present the excitation and observation of Long-range Surface Plasmon Polaritons in the near-infrared. Propagation distances over 3 mm have been achieved at a free-space wavelength of 785 nm in a polymer-gold-polymer type wave guide.

[1] P. Berini, Phys. Rev. B, **61**, 10484 (2000)

Q 29.7 Tue 15:30 V38.01

All-Optical Control of a Single Plasmonic Nanoantenna-ITO hybrid — •Martina Abb[1], Pablo Albella[2], Nicolas Large[2], Javier Aizpurua[2], and Otto Lambert Muskens[1] — [1]SEPnet and the Department of Physics and Astronomy, University of Southampton, United Kingdom — [2]Donostia International Physics Center, DIPC, and Centro de Fisica de Materiales CSIC-UPV/EHU, Donostia-San Sebastian, Spain

Nanoscale plasmonic components such as nanoantennas are of enormous interest for their capabilities of locally enhancing electromagnetic fields and controlling emission. Active control of such components will enable a new generation of tunable devices.

We recently introduced a new concept of antenna switches relying on photoconductive load-ing of the gap between the two antenna arms [1]. As a potentially ultrafast implementation of that concept, we demonstrate experimentally picosecond all-optical control of a plasmonic nanoantenna embedded in indium tin oxide [2]. We observe a hybrid nonlinear response which is caused by a picosecond energy transfer mechanism involving hot electron injection from gold into ITO. Hybrid plasmonic components are of great interest for active control of optical fields and integration of photonic and electronic functionalities.

[1] N. Large, M. Abb, J. Aizpurua and O. L. Muskens, Nano Lett. **10**, 1741 (2010).

[2] M. Abb, P. Albella, J. Aizpurua and O. L. Muskens, Nano Lett. **11**, 2457 (2011).

Q 29.8 Tue 15:45 V38.01

Scanning near-field microscopy (SNOM) using fluorescent nanodiamonds as a nanoscale light source — •Julia Tisler, Thomas Oeckinghaus, Rainer Stöhr, Roman Kolesov, Rolf Reuter, Friedemann Reinhard, and Jörg Wrachtrup — 3.Physikalisches Institut, Universität Stuttgart, Germany

The nitrogen-vacancy (NV) center in diamond is a color center that is very bright and photostable. This makes it an ideal candidate as a nanoscale light source for scanning near-field optical microscopy (SNOM). With a NV center embedded in a nanodiamond attached to the tip of an atomic force microscope it is possible to perform near-field microscopy beyond the Abbe limit. The dominating near-field interaction between the NV center and the sample is fluorescence resonance energy transfer (FRET). This is a dipole-dipole interaction between two molecules that are very close to each other. In previous experiments we have shown very high transfer efficiencies for single NV centers in nanodiamonds as small as 20 nm in diameter [1]. Here we show the first experiments using such a NV center as a scanning probe. With the method described above we image a graphene sample with a resolution of 20nm. [1] Tisler J. (2011) ACS Nano