Q 29 Poster Quanteneffekte

Zeit: Dienstag 16:30–18:30 Raum: Labsaal

Q 29.1 Di 16:30 Labsaal

A narrow-band single photon source at room temperature — •Asli Ugur[1], Chunlang Wang[1], Vladimir Tchernychev[2], and Harald Weinfurter[1,3] — [1]Department für Physik, LMU München, Germany — [2]Experimentalphysik III, Ruhr-Universität Bochum, Bochum, Germany — [3]Max-Planck-Institut für Quantenoptik, Garching, Germany

For applications in quantum cryptography a robust narrow-band single photon source is desirable. We report on single photon emission from SiV (silicon-vacancy) centers in diamond fabricated by ion implantation. Single SiV centers are photostable and have a spectrum consisting of a sharp zero phonon line (FWHM about 5 nm) at 738 nm and only very weak vibronic sidebands at room temperature. The short luminescence lifetime of 1.2 ns enables an efficient generation of single photons. To supress nonradiative transitions of single SiV centers, nitrogen doping by ion implantation was employed. We also discuss the use of a diamond solid immersion lens to improve the collection efficiency of single photons.

Q 29.2 Di 16:30 Labsaal

Cavity-QED experiments with single trapped Ca$^+$ ions — •Carlos Russo[1], Eoin Phillips[1], Helena Barros[1], Thomas Monz[1], Christoph Becher[2], Piet Schmidt[1], and Rainer Blatt[1,3] — [1]Institut für Experimentalphysik, Universität Innsbruck, Technikerstraße 25, A-6020, Austria — [2]Universität des Saarlandes, Postfach 151150, D-66041 Saarbrücken, Germany — [3]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Technikerstraße 21a, A-6020 Innsbruck, Austria

The storage of a string of ions in a linear Paul trap combined with the use of tailored laser pulses has been shown to be a scalable platform for the implementation of quantum algorithms and multi-particle entanglement, thus fulfilling DiVicenzo's criteria for quantum computing. However, the ability to interconvert stationary and flying qubits is an additional criteria to achieve the full power of quantum information processing. It allows quantum information to be transferred between specified nodes of a given network of quantum computers.

In our setup, a single trapped ^{40}Ca$^+$ ion is coupled to an optical resonator. By exploiting cavity-QED effects, such a system can be used to demonstrate the mapping of quantum information stored in a basis of electronic states of the ion (stationary qubit) into a basis of photonic states (flying qubit). The deterministic generation of single photons is a crucial first step. Moreover, the very same system can be used to implement a single ion laser and atom-photon entanglement. We will report on the status of our experiments towards these goals.

Q 29.3 Di 16:30 Labsaal

Coherent Population Transfer by STIRAP in a Solid StateSystem — •Jens Klein and Thomas Halfmann — Fachbereich Physik, TU Kaiserslautern,Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern

Laser assisted manipulation of population distributions in atomic and molecular media *in the gas phase* using coherent effects and adiabatic processes is extensively studied and well understood. However, it is solid state media which are - due to their high density - of special interest for applications such as data storage, data processing and quantum computing. Coherent population transfer by STIRAP (Stimulated Raman Adiabatic Passage) [1] has never been implemented in solid state systems.

The aim of the experiment presented here is to demonstrate the STIRAP method in a YSO-crystal doped with Pr^{3+} ions to manipulate population distributions in the hyperfine structure states of the dopant with possible applications in optical data storage. The laser pulses to adress the different transitions are derived from a single cw laser system by intensity modulation and frequency shifting using acusto-optic modulators. The experiment is implemented at a temperature of 4K to reduce homogeneous broadening produced by phonon scattering. The residual inhomogeneous linewidth is effectively reduced by spectral hole burning, i.e. selecting single ensembles of atoms.

[1] N.V. Vitanov, T. Halfmann, B.W. Shore, and K. Bergmann, emphLaser-induced Population Transfer by Adiabatic Passage Techniques, *Ann. Rev. Phys. Chem.* 52, 763-809 (2001)

Q 29.4 Di 16:30 Labsaal

Coherent Population Transfer via the Ionization Continuum in Helium — •Thorsten Peters[1], Leonid P. Yatsenko[1,2], and Thomas Halfmann[1] — [1]Fachbereich Physik, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Physics, National Academy of Sciences of Ukraine, prospect Nauki 46, Kiev-39, 03650, Ukraine

Coherent population transfer in a Λ-type level scheme using two delayed laser pulses in counter-intuitive pulse sequence (STIRAP configuration) is a well established tool to manipulate population distributions in systems of bound quantum states. It has been proposed theoretically that STIRAP should also work involving a continuum as intermediate state, since the transfer efficiency does not depend on losses from the intermediate state. However, STIRAP via a continuum was never investigated experimentally. Here we present the successful experimental implementation of coherent population transfer, i.e. STIRAP, via a continuum [1]. Population is selectively driven from the metastable state $2s\ ^1S_0$ in Helium via the ionization continuum to the target state $4s\ ^1S_0$ by a STIRAP-like sequence of laser pulses. The experimental results are being compared with numerical simulations with respect to transfer vs. pulse delay.

[1] T. Peters, L.P. Yatsenko, and T. Halfmann, Phys. Rev. Lett. **95**, 103601/1-4 (2005)

Q 29.5 Di 16:30 Labsaal

Dekohärenz molekularer Konfigurationszustände — •Johannes Trost und Klaus Hornberger — Arnold Sommerfeld Center for Theoretical Physics, LMU München

Superpositionszustände von Enantiomeren, d. h. von isomeren Molekülen unterscheidbarer Struktur, werden im Labor nicht beobachtet. Mit dem Ziel, die Mechanismen aufzuklären, die zur Dekohärenz solcher quantenmechanischer Superpositionen führen, entwickeln wir realistische Modelle für die Kopplung an unterschiedliche Umgebungsfreiheitsgrade. Insbesondere untersuchen wir den Einfluss der Streuung von Gasatomen und Photonen an Superpositionen unterschiedlicher Chiralität.

Q 29.6 Di 16:30 Labsaal

Efficient coherent population transfer induced by retroreflection-induced bichromatic adiabatic passage — •Alvaro Peralta Conde[1], Leonid P. Yatsenko[2], Jens Klein[1], Martin Oberst[1], and Thomas Halfmann[1] — [1]Department of Physics, University of Kaiserslautern, Erwin Schroedinger-Strasse, 67653 Kaiserslautern Germany — [2]Institute of Physics, National Academy of Sciences of Ukraine, Prospect Nauki 46, 03650, Ukraine

We present a simple technique that produces a complete adiabatic passage between two atomic or molecular bound states without the need for frequency-chirped lasers or varying Starks shifts. In this technique a single laser beam intersects twice, e.g. by retroreflection, a supersonic particle beam slightly tilted away from normal incidence, thereby inducing Doppler shifts of the atomic resonance between the initial and target state. The retroreflected beam should be parallel to the incident beam, attenuated and sligthly delayed. Under these conditions, it can be shown [1] that complete and robust population transfer between two quantum states can be achieved. Experimental results have been obtained in metastable Helium [2]. The experimental data are compared to numerical simulation.

[1] L.P. Yatsenko, B.W. Shore N. V. Vitanov and K. Bergmann Phys. Rev. A 68, 043405, (2003).

[2] A. Peralta Conde, L.P. Yatsenko, J. Klein, M. Oberst and T. Halfmann Phys. Rev. A 72, 053808, (2005).

Q 29.7 Di 16:30 Labsaal

Experimental setup for quantum tunneling control — •Ute Schnorrberger, Ramona Ettig, Elisabeth Kierig, and Markus K. Oberthaler — Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

We report on the progress of our experiment studying periodically driven quantum tunneling systems. By tuning the frequency of the periodic driving force we should be able to slow down the tunnel process. At a special frequency it should be even possible to bring it to a complete standstill. This surprising effect is called coherent destruction of tunneling [1] and has yet not been observed directly.

In our experiment we use a slow intensive beam of metastable argon atoms combined with spatially resolved single atom detection. We create a periodic potential with a double-well potential as the unit cell. This is achieved by adding the dipole potentials of two standing light waves with periodicity λ and $\lambda/2$. The initial population of a single well is accomplished utilizing a standing light wave resonant with an open transition. The driving is realized by changing the phase between the two standing light waves creating the double-well potential.

[1] F. Grossmann, T. Dittrich, P. Jung, and P. Hänggi, Phys. Rev. Lett. **67**, 516 (1991)

Q 29.8 Di 16:30 Labsaal

Hamiltonian Ratchets in Optical Lattices — •Sarah Kajari-Schröder and Eric Lutz — Abteilung Quantenphysik, Universität Ulm, 89069 Ulm

Thermal rachets, also called Brownian motors, show a directed current due to rectification of noise. In some systems chaotic dynamics can mimic the effects of thermal fluctuations. The emphasis of our work is the investigation of an experimental realisation of a chaotic Hamiltonian ratchet in a two-dimensional optical lattice. We present a way to achieve the necessary braking of the temporal and spatial symmetry and analyse the mechanisms leading to a directed current without a force or noise.

Q 29.9 Di 16:30 Labsaal

Interference and entanglement of two massive particles — •Álvaro Tejero Cantero and Klaus Hornberger — Arnold Sommerfeld Center for Theoretical Physics, LMU München

Non-classical correlations in the motional state of two *massive*, spatially separated particles can be characterised operationally in a measurement setup which probes emission-time entanglement. By combining the time-dependent scattering approach with the Weyl phase-space representation of quantum mechanics, we provide a framework in which the dynamics of the measurement process can be modelled analytically. The formalism is applied to input states which are based on Gaussians, allowing to obtain the two-particle detection probabilities in closed form. The results display the full range of interference phenomena and their interplay with the dispersive dynamics.

Q 29.10 Di 16:30 Labsaal

Normal mode splitting and mechanical effects of an optical lattice in a ring cavity — •Malik Lindholdt, Julian Klinner, Boris Nagorny, and Andreas Hemmerich — Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

A novel regime of atom-cavity physics is explored, arising when large atom samples dispersively interact with high-finesse optical cavities. A stable far detuned optical lattice of several million rubidium atoms is formed inside an optical ring resonator by coupling equal amounts of laser light to each propagation direction of a longitudinal cavity mode. An adjacent longitudinal mode, detuned by about 3 GHz, is used to perform probe transmission spectroscopy of the system. The atom-cavity coupling for the lattice beams and the probe is dispersive and dissipation results only from the finite photon-storage time. The observation of two well-resolved normal modes demonstrates the regime of strong cooperative coupling. The details of the normal mode spectrum reveal mechanical effects associated with the retroaction of the probe upon the optical lattice.

[1] Julian Klinner, Malik Lindholdt, Boris Nagorny and Andreas Hemmerich, quant-ph/0512121

Q 29.11 Di 16:30 Labsaal

Photon antibunching and superbunching via collectivity — •Mihai Macovei, Jörg Evers, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg.

Light sources with unusual properties are required for many current schemes of modern quantum optics [1]. We show here that the fluorescence light emitted by a sample of few-level atoms interacting only via the surrounding thermostat exhibits non-classical properties. In a small sample of three-level atoms in ladder configuration [2], the emitted light can be switched from sub- to super-poissonian and from anti-bunching to super-bunching controlled by the mean number of atoms in the sample. Larger samples allow to generate super-bunched light over a wide range of bath parameters and thus fluorescence light intensities. We also identify parameter ranges where the fields emitted on the two transitions are strongly correlated or anti-correlated, such that the Cauchy-Schwarz inequality is violated indicating quantum entanglement of photons. We further discuss collective non-classical features in spatially extended two-level samples.

[1] D. F. Walls and G. J. Milburn, *Quantum Optics* (Springer-Verlag, 1995).

[2] M. Macovei, J. Evers, and C. H. Keitel, Phys. Rev. A **72**, (in print 2005).

Q 29.12 Di 16:30 Labsaal

Quantum statistical effects on scattered light from a pair of two-level atoms — •Tobias Görler[1], Giovanna Morigi[2], Priscilla Canizares Martinez[3], and Wolfgang P. Schleich[1] — [1]Abteilung Quantenphysik, Universität Ulm, D-89069 Ulm, Germany — [2]Grup d'Optica, Departament de Fisica, Universitat Autonoma de Barcelona, 08193 Bellaterra, Spain — [3]Dipartimento di Fisica, Universita di Camerino, 62032 Camerino, Italy

Light scattering from two cold atoms, which can be seen as a realization of a Young's double slit experiment, has been intensively investigated in theory (e.g. [1], [2]) and experiment (e.g. [3]). However, one may wonder whether the interference fringes are affected by the quantum statistics of cold atoms. In this poster we present results considering anti-/symmetrization of the center of mass distributions and compare elastic and inelastic photon scattering under these conditions.

[1] M. O. Scully and K. Drühl, Phys. Rev. A **25**, 2208 (1982)

[2] W. M. Itano et al., Phys. Rev. A **57**, 4176 (1998)

[3] U. Eichmann et al., Phys. Rev. Lett. **70**, 2359 (1993)

Q 29.13 Di 16:30 Labsaal

Two dimensional quantum networks — •Bernd Mohring[1], Igor Jex[2], and Wolfgang P. Schleich[1] — [1]Abteilung Quantenphysik, Universität Ulm, 89069 Ulm, Germany — [2]Department of Physics, FJFI ČVUT, 115 19 Praha 1, Czech Republic

Localisation in quantum networks has been investigated in a one dimensional system in [1]. We extend this model to two dimensions by using so-called tritters instead of beam splitters. This can be also seen as a two dimensional quantum walk where the probability distribution after a certain number of steps exhibits interesting features. Additionally, we modify this system by introducing a certain type of phase randomness and compare it with the one dimensional case.

[1] P. Törmä *et al.*, Phys. Rev. A **65**, 052110 (2002)