Q 21: Quanteneffekte (Offene und Wenigteilchensysteme)

Zeit: Dienstag 10:30–12:30 Raum: 5E

Q 21.1 Di 10:30 5E

Monitoring approach to open quantum dynamics — •Klaus Hornberger — Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-Universität München

A general method will be discussed to obtain Markovian master equations which describe the interaction with the environment in a non-perturbative and microscopic fashion [1,2]. It is based on combining time-dependent scattering theory with the concept of continuous quantum measurements. As two nontrivial applications, I will outline how this yields the master equation for the internal dynamics of a trapped molecule in a gaseous environment, and the exact quantum linear Boltzmann equation for a Brownian point particle.

[1] K. Hornberger, Phys. Rev. Lett. 97, 060601 (2006).
[2] K. Hornberger, quant-ph/0612078

Q 21.2 Di 10:45 5E

Casimir force between planar mirrors in the real world — •Francesco Intravaia and Carsten Henkel — Universitaet Potsdam, Institut fuer Physik, Am Neuen Palais 10, 14469 Potsdam, Germany

In the field of nanotechnology, there is a considerable interest in manipulating the Casimir force (both in magnitude and sign) playing with geometry and material structure. The benefit one can possibly achieve under realistic experimental conditions depends on properties like microscopic surface roughness, finite conductivity, material temperature, as shown by the comparison of accurate measurements with theory [1]. Regarding the sign of the force, we have recently identified a parameter range for Casimir repulsion within a certain class of artificial (or meta-) materials [2]. Our current activities aim at improving the understanding of dispersion forces between non-local or dissipative media that pose intriguing theoretical challenges on their own. Both aspects play a role for the finite-temperature correction to the Casimir force, for example, on which a consensus is currently lacking. We investigate a particular non-local model that allows us to perform calculations from first principles and to assess the limits and scope of the widely used Lifshitz formula.

[1]S. K. Lamoreaux. The casimir force: background, experiments, and applications. Reports on Progress in Physics 68, 201-236, 2005.
[2]C. Henkel and K. Joulain. Casimir force between designed materials: What is possible and what not. Europhys. Lett.72, 929-935, 2005.

Q 21.3 Di 11:00 5E

Application of the quantum jump approach to a spin-boson model — •Jens Timo Neumann[1], Gerhard C. Hegerfeldt[1], and Lawrence S. Schulman[2] — [1]Institut für Theoretische Physik, Univ. Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Physics Department, Clarkson University, Potsdam, NY 13699-5820, USA

The quantum jump approach has proved itself as a useful tool for the investigation of many quantum optical issues as, e.g., photon statistics, cooperative effects of atoms in a trap, or quantum optical models for arrival-time measurements for ultracold atoms. It treats the limit of continuous photon modes under the assumption that the Markov property holds. In this talk, the domain of applicability of the quantum jump approach is extended beyond quantum optics. In particular, we investigate the application of the quantum jump approach to a spin-boson model. We also investigate by means of numerical examples the validity of the quantum jump approach as a convenient and accurate approximation to situations where one actually has to deal with a number of discrete bath modes.

1. G. C. Hegerfeldt, J. T. Neumann, and L. S. Schulman, J. Phys. A **39**, 14447 (2006)
2. G. C. Hegerfeldt, J. T. Neumann, and L. S. Schulman, quant-ph/0610041 (2006), to appear in Phys. Rev. A [scheduled: issue 1 of Phys. Rev. A **75** (2007)]

Q 21.4 Di 11:15 5E

Quantum Efficiency of Atomic Extraction from an Ultracold Atomic Reservoir — Bernd Mohring[1], Giovanna Morigi[2], •Eric Lutz[3], and Wolfgang P. Schleich[1] — [1]Institut für Quantenphysik, Universität Ulm, 89069 Ulm, Germany — [2]Grup d'Optica, Departament de Física, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain — [3]Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

We study the efficiency of coherent extraction of cold atoms from a reservoir, a Bose-Einstein condensate (BEC), as in the setup proposed in [1]. Here, the atoms are coherently transferred from a BEC to the ground state of a steep microtrap in the collisional blockade regime by means of a laser. In this setup, the condensate excitations constitute a source of quantum noise, which is non-Markovian in the parameter regime of interest. To describe the dynamics for this realization of quantum tweezers we derive a master equation. Using the time-convolutionless projection operator technique [2] we obtain a closed equation for the reduced system — ground state of the condensate and ground state of the microtrap — which allows us to investigate the quantum efficiency of extraction.

[1] B. Mohring *et al.*, Phys. Rev. A **71**, 053601 (2005)
[2] H.-P. Breuer *et al.*, Ann. Phys. (NY) **291**, 36 (2001)

Q 21.5 Di 11:30 5E

Repulsively bound atom paris in an optical lattice — Gregor Thalhammer[1], Klaus Winkler[1], •Florian Lang[1], Rudolf Grimm[1,3], Johannes Hecker Denschlag[1], Andrew Daley[2,3], Adrian Kantian[2,3], Hans Peter Büchler[2,3], and Peter Zoller[2,3] — [1]Institut für Experimentalphysik, Universität Innsbruck, Österreich — [2]Institut für Theoretische Pysik, Universität Innsbruck, Österreich — [3]Institut für Quantenoptik und Quanteninformation, Innsbruck, Österreich

Throughout physics, stable composite objects are usually formed by way of attractive forces, which allow the constituents to lower their energy by binding together. Repulsive forces separate particles in free space. However, in a structured environment such as a periodic potential and in the absence of dissipation, stable composite objects can exist even for repulsive interactions. We have recently[1] observed such an exotic bound state, which comprises a pair of ultracold rubidium atoms in an optical lattice. Consistent with our theoretical analysis, these repulsively bound pairs exhibit long lifetimes, even under conditions when they collide with one another. Signatures of the pairs are also recognized in the characteristic momentum distribution and through spectroscopic measurements. There is no analogue in traditional condensed matter systems of such repulsively bound pairs, owing to the presence of strong decay channels.

[1] *Nature* **441**, 853 (2006)

Q 21.6 Di 11:45 5E

Eine neue 4π-Geometrie zur Anregung eines einzelnen Ions — •Robert Maiwald, Hildegard Konermann, Norbert Lindlein und Gerd Leuchs — Institut für Optik, Information und Photonik, Max-Planck-Forschungsgruppe, Universität Erlangen-Nürnberg, Günther-Scharowsky-Str. 1, Bau 24, 91058 Erlangen, Germany

Es wird eine Methode vorgestellt, welche die optische Anregung eines Dipolübergangs in einem Ion praktisch aus dem gesamten 4π-Raumwinkel ermöglicht. Hierbei wird radial polarisiertes Licht verwendet, welches sowohl kleinste Foki als auch starke Dipolkopplung ermöglicht. Durch eine Kombination aus einer diffraktiven Linse und einem Parabolspiegel wird das Licht konditioniert und fokussiert. Eine für den Zweck optimierte Ionenfalle lässt nahezu den gesamten Raumwinkel als optischen Zugang zu. Durch die vorgeschlagene Anordnung werden direkte Untersuchungen der Photonenabsorption an Ionen möglich, gleichzeitig ist die Methode im Bereich der 4π-Mikroskopie zur effizienten Detektion anwendbar.

Q 21.7 Di 12:00 5E

AC-control of single particle tunneling — •Elisabeth Kierig, Arne Schietinger, Ute Schnorrberger, Jiri Tomkovic, Joachim Welte, and Markus Oberthaler — Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

We report on the results of our experimental studies of periodically driven quantum tunneling systems. By changing the symmetry of the double-well at a special frequency it is possible to strongly suppress tunneling. This effect is known as coherent destruction of tunneling [1].

The experimental setup utilizes a slow intensive beam of metastable argon atoms combined with spatially resolved single atom detection.The periodic double-well potential is realized adding two standing light waves with periodicity λ and $\lambda/2$. A further standing light wave resonant with an open transition allows the preparation of atoms localized in every second well. The driving is implemented by changing the phase between the two standing light waves creating the double-wells.

We compare our experimental findings with the full solution of the Floquet theory and the prediction within the simple two mode model. We find quantitative agreement of the tunneling time as a function of driving frequency and driving amplitude.

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

Q 21.8 Di 12:15 5E

Photon emission of a single trapped ion into a cavity — •Carlos Russo[1], Eoin Philips[1], Helena Barros[1], Andreas Stute[1], Christoph Becher[1,3], Piet Schmidt[1], and Rainer Blatt[1,2] — [1]Institut für Experimentalphysik, Universität Innsbruck,Technikerstraße 25, A-6020 Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Otto-Hittmair-Platz 1, A-6020 Innsbruck, Austria — [3]Fachrichtung 7.3 (Technische Physik), Universität des Saarlandes, Postfach 151150, D-66041 Saarbrücken, Germany

In our setup, a single trapped $^{40}Ca^{+}$ ion is coupled to an optical resonator. We generate photons in the cavity mode continuously, by exploiting vacuum-stimulated Raman transitions between the Zeeman substates of the $S_{1/2}$ and $D_{3/2}$ manifolds. The pump laser at 397 nm is off-resonant to the $S_{1/2} \rightarrow P_{1/2}$ transition, and the cavity is detuned from the $P_{1/2} \rightarrow D_{3/2}$ transition. The $D_{3/2}$ state is continuously repumped by a near-resonant laser at 866 nm. Depending on the pump laser polarisation, we can choose between two photon emission patterns with different spectral properties. In either case, the polarisation of the generated photons is well defined. We find good qualitative agreement of the experimental results with density matrix simulations. A variation of the scheme using pump laser pulses allows for the implementation of a deterministic single photon source.