Q 23: Quantum Effects: Light Scattering and Propagation II / QED I

Time: Wednesday 10:30–12:30 Location: A 320

Group Report Q 23.1 We 10:30 A 320

Thermal Casimir–Polder forces — •Stefan Yoshi Buhmann[1], Simen Ådnøy Ellingsen[2], and Stefan Scheel[1] — [1]Quantum Optics and Laser Science, Blackett Laboratory, Imperial College London, Prince Consort Road, London SW7 2AZ, United Kingdom — [2]Department of Energy and Process Engineering, Norwegian University of Science and Technology, N-7491 Trondheim, Norway

We discuss the influence of thermal photons on the Casimir–Polder force between atoms and bodies within the framework of macroscopic quantum electrodynamics. The internal evolution of an atom is found to be governed by environment-dependent heating and cooling rates [1]; examples are given for the ground-state heating rates of polar molecules near a room-temperature surface. On this basis, the time-dependent Casimir–Polder force between an atom and a body at finite temperature is studied [2]. It is shown that a thermal non-equilibrium may lead to resonant forces even on ground-state atoms [3]. We discuss the prospect of enhancing these forces via cavities to facilitate atom manipulation [4]. After the atom has reached thermal equilibrium with its environment, the atom is subject to the nonresonant Lifshitz force only.

[1] S. Y. Buhmann *et al.* Phys. Rev. A **78**, 052901 (2008).
[2] S. Y. Buhmann, S. Scheel, Phys. Rev. Lett. **100**, 253201 (2008).
[3] S. Å. Ellingsen *et al.*, Phys. Rev. A **79**, 052903 (2009).
[4] S. Å. Ellingsen *et al.*, Phys. Rev. A **80**, 022901 (2009).

Q 23.2 We 11:00 A 320

Casimir force on amplifying bodies — •Agnes Sambale[1], Dirk-Gunnar Welsch[1], and Stefan Yoshi Buhmann[2] — [1]Theoretisch-Physikalisches Institut, F.-Schiller-Universität Jena, Germany — [2]Blacket Laboratory, Imperial College London, United Kingdom

Although most studies on the Casimir forces have so far assumed absorbing bodies, it has recently been realized that besides importance in fundamental research, dispersion forces on amplifying (meta)materials can lead to far-reaching applications. For instance, amplifying media may enhance the influence of left-handed material properties or even lead to repulsive forces.

Within the framework of macroscopic quantum electrodynamics in arbitrary linear media and Lorentz force approach, we present a formula for the Casimir force acting on an amplifying, locally responding, and isotropic polarisable body (Phys. Rev. A 80, 051801(R), 2009). We show that the force can be decomposed into a resonant part arising from emission processes and an off-resonant part looking formally the same as for a purely absorbing medium. We demonstrate that the Casimir force on a weakly polarisable (partially) amplifying body in a purely absorbing environment can be expressed as a sum over the Casimir–Polder forces on the excited atoms the body consists of. This result reveals the common (microscopic) origin of dispersion forces even for excited systems.

Q 23.3 We 11:15 A 320

Direct Measurement of intermediate-range Casimir-Polder potentials — •Helmar Bender, Phillippe Courteille, Carsten Marzok, Christian Stehle, Claus Zimmermann, and Sebastian Slama — Physikalisches Institut, Eberhard Karls Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen

The zero-point vacuum fluctuations of the electromagnetic field are a result of fundamental importance in quantum electrodynamics (QED). One of its few measurable effects is the force between a groundstate atom and a solid surface. Measurements of the corresponding Casimir-Polder (CP) potential exist for both, the short distance regime and the long distance regime where retardation has to be taken into account.

We present the first direct measurement of the CP-potential in the intermediate regime at distances of about 150-250 nm where retardation slowly comes into play. The measurement is based on the reflection of ultracold Rb-atoms from evanescent wave barriers. With this method we are able to deduce the CP-potential as a function of the distance without making any prior assumptions on its shape.

The results are compared to the analytical expressions existent for the long- and the short range regime as well as to a full QED-calculation. The full QED-calculation agrees best with our data.

Q 23.4 We 11:30 A 320

Counting Statistics in Multi-stable Systems — •Gernot Schaller, Gerold Kiesslich, and Tobias Brandes — Institut für Theoretische Physik, Hardenbergstraße 36, Technische Universität Berlin, D-10623 Berlin, Germany

Using a generic model for stochastic transport through a single quantum dot that is modified by the Coulomb interaction of environmental (weakly coupled) quantum dots, we derive general properties of the full counting statistics for multi-stable Markovian transport systems. We study the temporal crossover from multi-modal to broad uni-modal distributions depending on the initial mixture, the long-term asymptotics and the divergence of the cumulants in the limit of a large number of transport branches. These findings demonstrate that the counting statistics of a single resonant level may be used to probe background charge configurations.

[1.] G. Schaller, G. Kießlich, and T. Brandes, `arXiv:0912.2887`.

[2.] G. Schaller, G. Kießlich, and T. Brandes, Phys. Rev. B **80**, 245107 (2009).

Q 23.5 We 11:45 A 320

Hemispherical resonators with embedded nanocrystal-quantum-dot-emitters — •Johannes Haase[1], Paul Mundra[2], Günter Risse[4], Susumu Shinohara[3], Martina Hentschel[3], Hartmut Fröb[1], Alexander Eychmüller[2], and Karl Leo[1] — [1]Institut für Angewandte Photophysik, TU-Dresden — [2]Physikalische Chemie / Elektrochemie, TU-Dresden — [3]Max-Planck-Institut für Physik komplexer Systeme, Dresden — [4]Gesellschaft zur Förderung von Medizin-, Bio- und Umwelttechnologien e.V., Dresden

Spherical resonators have the outstanding ability to confine light in three dimensions with comparatively highly quality factors Q as a result of the high efficient total internal reflection. By embedding emitters into those cavities, it is possible to couple their emission to the whispering gallery modes (WGM) of the sphere. The incoupling of excitation light and especially the selective excitation of different regions in the sphere, however, is often a problem. We therefore investigate a new method to produce hemispherical resonators on a distributed Bragg reflector (DBR). Consequently, we have a three dimensional confinement at the emission wavelength and a planar side (the DBR), which is transparent at the excitation wavelength. Thus it is possible to selectively excite emitters in different areas of the hemisphere. We show the preparation of these structures with embedded nanocrystal-quantum-dots (NQD) as emitters. Additionally, we report on the results of micro-photoluminescence measurements of these structures, showing a highly efficient incoupling of NQD emission into WGMs. The modes can be described using a two-dimensional model.

Q 23.6 We 12:00 A 320

Polarization noise in hollow-core photonic crystal fibers — •Wenjia Zhong[1,2], Bettina Heim[1,2], Dominique Elser[1,2], Christoph Marquardt[1,2], and Gerd Leuchs[1,2] — [1]Max-Planck-Institut für die Physik des Lichts, Erlangen — [2]Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, Erlangen

Thermally induced Brillouin scattering in glass fibers can lead to phase and polarization noise. Although this kind of noise is weak, it can degrade the purity of quantum states. In hollow-core photonic crystal fibers (HCPCFs), light is guided due to a photonic-bandgap structure consisting of a periodic array of air holes in silica glass. Since the light travels in the central air core, Brillouin scattering is supposed to be reduced as compared to a solid-core fiber. Still a precise characterization is necessary in order to estimate the influence of this noise in quantum experiments.We perform quantum-noise-limited measurements of polarization noise in a HCPCF considering several transverse modes of light.

Q 23.7 We 12:15 A 320

Motional effects on the efficiency of excitation transfer — •Markus Tiersch[1,2], Ali Asadian[1,2], Gian Giacomo Guerreschi[1,2], Jianming Cai[1,2], Sandu Popescu[3,4], and Hans J. Briegel[1,2] — [1]Institut für Quantenoptik und Quanteninformation der Österreichischen Akademie der Wissenschaften, Innsbruck, Austria — [2]Institut für Theoretische Physik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck, Austria — [3]H.H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, U.K. — [4]Hewlett-Packard Laboratories, Stoke Gifford, Bristol BS12 6QZ, U.K.

The transfer of energy plays a vital role in many natural and technological processes. In this work, we study the effects of classical motion on the electronic excitation transfer through a chain of interacting molecules. Our investigation demonstrates that for various types of oscillations, in a suitable range of frequencies, the efficiency of the energy transfer is significantly enhanced. This enhancement is a signature of the collaborative interplay between the coherent evolution of the excitation and the classical motion of the molecules. This effect has no analogue in the classical, incoherent energy transfer. In addition, we discuss control techniques to optimize the excitation transfer along the chain.