Q 15: Quanteneffekte: Verschränkung und Dekohärenz 1

Time: Monday 16:30–19:00 Location: V7.01

Q 15.1 Mon 16:30 V7.01

Entangling NV$^-$ center in single nanodiamonds by means of vibrational coupling — •Andreas Albrecht[1], Alex Retzker[1], Fedor Jelezko[2], and Martin B Plenio[1] — [1]Institut für Theoretische Physik, Universität Ulm, D-89069 Ulm — [2]Institut für Quantenoptik, Universität Ulm, D-89069 Ulm

A theoretical proposal about how different NV centers within a single nanodiamond can be manipulated by controlled gate operations is presented. This scheme exploits the coupling to a common vibrational mode. The differences in the electron phonon coupling among different energy levels of the nitrogen vacancy center allow for the addressing of individual vibrational sidebands. An effective Lamb-Dicke coupling parameter is obtained and analyzed dependent on the diamond size. Moreover it will be shown that this coupling provides a basis for performing coherent controlled gate operations and therefore enables the generation of entanglement between different NV centers.

Q 15.2 Mon 16:45 V7.01

Tripartite nonlocality and continuous-variable entanglement in thermal states of trapped ions — Jie Li[1], Thomás Fogarty[2], •Cecilia Cormick[3], John Goold[2,4], Thomas Busch[2], and Mauro Paternostro[1] — [1]School of Mathematics and Physics, Queen's University, Belfast BT7 1NN, United Kingdom — [2]Physics Department, University College Cork, Cork, Ireland — [3]Theoretische Physik, Universität des Saarlandes, D-66041 Saarbrücken, Germany — [4]Clarendon Laboratory, University of Oxford, United Kingdom

We study a system of three trapped ions in an anisotropic bidimensional trap. By focusing on the transverse modes of the ions, we show that the mutual ion-ion Coulomb interactions set entanglement of a genuine tripartite nature, to some extent persistent to the thermal nature of the vibronic modes. We tackle this issue by addressing a nonlocality test in the phase space of the ionic system and quantifying the genuine residual tripartite entanglement in the continuous variable state of the transverse modes.

Q 15.3 Mon 17:00 V7.01

Bright entangled state of light — •Timur Iskhakov[1], Maria Chekhova[1,2], and Gerd Leuchs[1] — [1]Max-Planck Institute for the Science of Light Guenther-Scharowsky-Str. 1 / Bau 24, Erlangen D-91058, Germany — [2]Physics Department, M.V.Lomonosov Moscow State University, Leninskiye Gory 1-2, Moscow 119991, Russia

Our work is devoted to the generation and the analysis of the quantum properties of a macroscopic entangled state of light. In fact this is the bright analog of the two-photon singlet Bell state, which was theoretically proposed in [1]. At the stage of preparation this state is pure and can be described by the same Hamiltonian as its two-phonon predecessor but with stronger pumping. In literature, this state is known as 'polarization scalar light', as it is absolutely non-polarized and its intensity and all the intensity moments are invariant to arbitrary polarization transformations or a state that is free of polarization noise (the noise of all Stokes observables is simultaneously suppressed below the shot noise level). It is the second property that allows the state to violate the separability criterion formulated in [2]. In the experiment this macroscopic state (10^5 photons per pulse) was produced by quantum interference of two orthogonally polarized bright two-color squeezed vacuums and was analyzed in a standard Stokes measurement setup. Although the inevitable optical losses did not allow us to observe the absolute noise suppression of the Stokes observables the degree of noise suppression was sufficient to demonstrate that the state is not separable.

[1] V. P. Karassiov, J. Phys. A 26, 4345 (1993).
[2] Ch. Simon and D. Bouwmeester, Phys. Rev. Lett. 91, 053601 (2003).

Q 15.4 Mon 17:15 V7.01

Generation of correlated photon pairs in different frequency ranges — •Mihai Macovei, Fernando Oster, and Christoph H Keitel — Max-Planck Institute for Nuclear Physics, Saupfercheckweg 1, D-69117 Heidelberg

The feasibility to generate entangled photon pairs at variable frequencies is investigated. For this purpose, we consider the interaction of an off-resonant laser field with a two-level system possessing broken inversion symmetry. We show that the system generates non-classical photon pairs exhibiting strong intensity-intensity correlations. The intensity of the applied laser tunes the degree of correlation while the detuning controls the frequency of one of the photons which can be in the THz-domain. Furthermore, we observe the violation of a Cauchy-Schwarz inequality characterizing these photons.

Q 15.5 Mon 17:30 V7.01

Coherent Dynamics under Ambient Conditions in Photosynthesis — •Zachary Walters — Max Planck Institute for Physics of Complex Systems, Noethnitzer Strasse 38, Dresden, Sachsen, Deutschland

Photosynthesis requires efficient transfer of electronic excitation from molecular complexes where sunlight is absorbed to reaction centers where the energy can be harvested. Recent experiments with photosynthetic antenna complexes have found that this process involves long-lived coherence between constituent pigment molecules, or chromophores, which make up these complexes. Expected to decay in less than 100 fs, coherences were observed to persist for picosecond timescales, despite having no apparent separation between system and environment. This talk presents a simple theory of long-lived coherence in the limit of strong interactions between a system and a thermal environment, yielding arbitrarily long lifetimes in both the high- and low temperature limit. Spectral lineshapes and excitonic transfer times are shown to give good agreement with experiment for the PE545 antenna complex of the cryptophyte algae CS24.

Q 15.6 Mon 17:45 V7.01

Quantum transport efficiency and Fourier's law — •Markus Tiersch[1,2], Daniel Manzano[1,2,3], Ali Asadian[1], and Hans J. Briegel[1,2] — [1]Institut für Theoretische Physik, Universität Innsbruck, Österreich — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Österreich — [3]Instituto Carlos I de Fisica Teorica y Computacional, University of Granada, Spain

Transport properties of quantum systems are of primary interest in many field of physics. Recent examples include the exciton transport through bio-molecular systems of photosynthetic organisms. By means of paradigmatic model systems of quantum optics and solid state physics, namely networks of coupled two-level systems, we analyze the steady-state energy transfer in a non-equilibrium scenario created by two thermal reservoirs. We study how the energy current depends on the system size, and discuss the validity of Fourier's law of heat conduction for, both, diffusive and ballistic transport regimes, and in presence and absence of disorder. We discuss the implications of these results on energy transfer in biological light harvesting systems, and outline the role of quantum coherences and entanglement in these scenarios.

Q 15.7 Mon 18:00 V7.01

Entanglement of remote quantum systems by environmental modes — •Friedemann Queisser[1], Rochus Klesse[2], and Thomas Zell[2] — [1]Fakultät für Physik, Universität Duisburg-Essen, Lotharstrasse 1, D-47057 Duisburg, Germany — [2]Universität zu Köln, Institut für Theoretische Physik Zülpicher Str. 77, D-50937 Köln, Germany

We investigate the generation of quantum mechanical entanglement of two remote oscillators that are locally coupled to a common bosonic bath. Starting with a Lagrangian formulation of a suitable model, we derive two coupled Quantum Langevin Equations that exactly describe the time evolution of the two local oscillators in presence of the coupling to the bosonic bath. Numerically obtained solutions of the Langevin Equations allow us to study the entanglement generation between the oscillators in terms of the time evolution of the logarithmic negativity. Our results confirm and extend our previously obtained findings, namely that significant entanglement between oscillators embedded in a free bosonic bath can only be achieved if the system are within a microscopic distance. We also consider the case where the bosonic spectral density is substantially modified by imposing boundary conditions on the bath modes. For boundary conditions corresponding to a wave-guide like geometry of the bath we find significantly enlarged entanglement generation. This phenomenon is additionally illustrated within an approximative model that allows for an analytical treatment.

Q 15.8 Mon 18:15 V7.01

Decoherence of Interacting Quantum Oscillators and Quantum Synchronization — •Björn Bartels — Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität Freiburg, Albertstr. 19, 79104 Freiburg, Germany — Institut für Theoretische Physik, Universität Würzburg, 97074 Würzburg, Germany

Decoherence is responsible for the absence of quantum mechanical effects in our everyday life. In particular, in macroscopic systems there is a preferred direction of time, whereas quantum mechanics is invariant under time reversal. In classical mechanics, two coupled dissipative oscillators evolving into a synchronized state represent a typical example of an irreversible process. In this talk, we consider the quantum dynamics of two interacting harmonic oscillators coupled to a bosonic heat bath, in order to investigate the possibility of synchronization in quantum systems without loss of their non-classicality.

Q 15.9 Mon 18:30 V7.01

Optimal Control of Spin Ensembles with Inhomogeneous Control Field — •Björn Bartels and Florian Mintert — Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität Freiburg, Albertstr. 19, 79104 Freiburg, Germany

Our aim is to control spin ensembles in the presence of inhomogeneities of an externally applied control field. Optimal control theory provides us with tools to do this with high accuracy, but typical control pulses contain a broad frequency spectrum with components that might lie outside the experimentally accessible range. To avoid this, we employ pulse shaping techniques in frequency space, what allows us to limit a control pulse to predefined frequency components.

Q 15.10 Mon 18:45 V7.01

A model for a self propelling photon — •Karl Otto Greulich — Fritz Lipmann Institut Beutenbergstr 11 07745 Jena

Theoretical descriptions which rely on a point like photon neither give information on the birth (emission from a single atom or molecule) of a photon nor on why a photon, after its emission, in vacuum perpetually moves with speed c. Since in addition, inspection of experimental details has raised some doubts whether the photon's particle character is unequivocally proven, alternative photon models with some spatial extension can no longer be discarded a priori. Here a model is given where two clouds of Planck charges (e/SQRT alpha where alpha is the fine structure constant, see also G30 and T280 of the Göttingen meeting) oscillate between a state of capacitor like separation and a ring current. This model explains to some extent why light is a transversal electromagnetic wave and why, once started, moves in vacuum with speed c. Also it gives the spin of the photon as 1 and its spatial extension as wavelength / 2 pi. References: K. O. Greulich Int. J. Mol Sci (2010), 11, 304-311; K.O. Greulich SPIE Proceedings 8121-15 and 27 (2011); for downloads see http://www.fli-leibniz.de/www_kog/ then klick *Physics*