FM 52: Entanglement: Transport

Time: Wednesday 14:00–15:15 Location: 1009

Invited Talk FM 52.1 Wed 14:00 1009

Entanglement transport in the presence of noise — •Clemens Gneiting — Riken, Wako-shi, Saitama 351-0198, Japan

The reliable transport of quantum properties, such as coherence and entanglement, constitutes one of the essential building blocks for the realization of quantum technologies, ranging from quantum communication devices to quantum computers. Think, for instance, of the distribution of entangled photon pairs in quantum cryptography protocols, or of quantum sensors leveraging many-particle interference. Among the main obstacles towards the successful implementation of such devices is noise, stemming both from the undesired coupling to an environment (dissipation and decoherence) and from uncontrolled parameter fluctuations within the devices themselves (disorder). We review strategies towards mitigating and counteracting the detrimental effects of noise in entanglement transport. In particular, we discuss how different ways of encoding the quantum information can result in noise-prone or noise-robust entanglement transport. We present quantum master equations as a unifying framework to analyze the different noise sources.

FM 52.2 Wed 14:30 1009

Quantum-correlated photons generated by non-local electron transport — •Felicitas Hellbach[1], Wolfgang Belzig[1], Fabian Pauly[2,1], and Gianluca Rastelli[1] — [1]Physik, Universität Konstanz, D-78457 Konstanz — [2]OIST Graduate University, Onna-son, Okinawa 904-0395, Japan

Since the realization of high-quality superconducting microwave cavities, one can envisage the possibility to investigate the coherent interaction of light and matter [1]. We study a parallel double quantum dot device operating as single-electron splitter interferometer, with each dot linearly coupled to a local photon cavity. We explore how quantum correlation and entanglement between the two cavities is generated by the coherent transport of a single electron passing simultaneous through the two different dots. We calculate the covariance of the cavity occupations by use of a diagrammatic perturbative expansion (Keldysh Green's functions) to the fourth order in the dot-cavity interaction strength, taking into account vertex diagrams. In this way, we demonstrate the creation of entanglement by showing that the Cauchy-Schwarz inequality can be violated.

[1] C. Wang et al. Science **352**, 1087-1091 (2016),
A. Stockklauser et. al., Phys. Rev. X **7**, 011030 (2017),
X. Mi et al., Science **355**, 156-158 (2017),
J. J. Viennot et. al., Science **349**, 408-411 (2015).

FM 52.3 Wed 14:45 1009

Enhancing Resonance Energy Transfer by Means of Coherence and Entanglement — •Severin Bang[1], Robert Bennett[1], and Stefan Yoshi Buhmann[1,2] — [1]Institute of Physics, University of Freiburg, Germany — [2]Freiburg Institute for Advanced Studies (FRIAS), Germany

Resonance energy transfer usually refers to a transfer between two partners. In this talk, we explore how the process can be enhanced by replacing a single donor by an entangled donor system coherently sharing excitations. We demonstrate this for the example of donors initially prepared in a superradiant Dicke state.

We describe the process by quantum electrodynamics in terms of dipole moments coupled via an exchange of virtual photons, whose propagation is encoded in Green's tensors [1]. We focus on the possibility of enhancing the energy transfer rate and on its dependence on the spacial configurations of donors and acceptors.

[1] J. L. Hemmerich, R. Bennett, S. Y. Buhmann, Nature Commun. **9**, 2934 (2018).

FM 52.4 Wed 15:00 1009

High-dimensional entanglement in atmospheric turbulence — •Giacomo Sorelli[1], Nina Leonhard[2], Claudia Reinlein[2], Vyacheslav N. Shatokhin[1], and Andreas Buchleitner[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg i. Br. — [2]Fraunhofer Institute for Applied Optics and Precision Engineering, Jena

Discrete high-dimensional quantum states (qudits) offer several advantages over their two dimensional counterpart (qubits). In particular, qudits increase the amount of information encoded into a single carrier. Moreover, in entanglement-based QKD the intervention of an eavesdropper is excluded by the violation of a Bell inequality, which is the more violated the larger the dimensionality of the employed states. Spanning a discrete infinite-dimensional Hilbert space, the orbital angular momentum (OAM) of light can be used to realize such high-dimensional quantum systems. However, its use in free-space QKD is severely limited by phase distortions introduced by random refractive index fluctuations due to atmospheric turbulence.

We discuss the efficiency of adaptive optics (AO) in mitigating turbulence-induced signal and entanglement losses of OAM states, for a vast range of atmospheric conditions. We show that the stronger Bell correlations available in higher dimensions are nullified by their faster turbulence-induced decay. In contrast, AO corrections allow to restore non-locality, and thus the security of entanglement-based quantum communication, even for high-dimensional states in moderate turbulence.