FM 62: Poster: Open and Complex Quantum Systems

Time: Wednesday 16:30–18:30 Location: Tents

FM 62.1 Wed 16:30 Tents

Study of the role of system-environment correlations in quantum open system dynamics — •Rodrigo Gómez and Heinz-Peter Breuer — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, D-79104 Freiburg, Germany

In open quantum system dynamics, the system can experience decoherence and/or dissipation due to its interaction with the environment, but it can also get correlated and entangled with the environment in complex ways. We studied the role of system-environment correlations in open quantum system dynamics by taking two approaches: (1) Analyzing the case of an exactly solvable atom-field model, studying the dynamics of the correlations in relation to the parameters describing the open system, such as the spectral density of the environment, decay rate, detuning, etc. Distinguishing the cases when the system behaves Markovian and Non-Markovian; (2) Studying the general change of mutual information in open system dynamics.

We show with the first approach (1) that the system-environment correlations seem to be present during the open system dynamics, and that we can reach maximal degree of system-environment correlations even for Markovian dynamics. With the second approach (2), we highlight some entropic relations between the change of mutual information and the open system dynamics.

FM 62.2 Wed 16:30 Tents

Irreversibility and entropy production in open quantum systems — •Nico Krause and Heinz-Peter Breuer — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany

On the basis of various random matrix models we investigate the degree of irreversibility of the dynamics of open quantum systems. Starting from the exact expression for the irreversible entropy production in terms of relative entropy, our central goal is the derivation of suitable approximate expressions which only refer to open system degrees of freedom. The result allows an efficient determination of the entropy production of quantum thermodynamic processes using information theoretical concepts.

FM 62.3 Wed 16:30 Tents

Exact approach to quantum non-Markovianity in the Caldeira-Leggett model — •Simon Einsiedler, Andreas Ketterer, and Heinz-Peter Breuer — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany

Employing the exact analytical solution of the Caldeira-Leggett model, a paradigmatic model for an open quantum system, we study the non-Markovian quantum dynamics for arbitrary couplings, temperatures and frequency cutoffs. Non-Markovianity is quantified using both the Bures metric (fidelity) and the relative entropy as distance measures for quantum states. This approach enables us to study quantum memory effects in the whole range from weak to strong dissipation.

FM 62.4 Wed 16:30 Tents

Entanglement bounds and entanglement protection with generalized Gaussian non-Markovian unravelings — •Nina Megier[1,2,3], Walter T. Strunz[1], Carlos Viviescas[4], and Kimmo Luoma[1] — [1]Institut für Theoretische Physik, Technische Universität Dresden, Dresden, Germany — [2]Dipartimento di Fisica "Aldo Pontremoli", Università degli Studi di Milano, Milan, Italy — [3]Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Milan, Italy — [4]Universidad Nacional de Colombia, Bogota D.C., Colombia

Generalized Gaussian non-Markovian unravelings are useful tool to describe the dynamics of the open quantum system, where the trajectories fulfill the generalized stochastic Schrödinger equation [1-3]. Here we show a derivation of the evolution equation from the microscopic description of the total system [4]. Our characterization of the dynamics generalizes the standard approach [5], as the complex noise driving the evolution has both a Hermitian correlation and a non-Hermitian correlation. The additional degrees of freedom of our description (resulting from the non-zero non-Hermitian correlation) can be used for quantum informational tasks. We discuss such applications as improving entanglement bounds and environment-assisted entanglement protection.

[1] - L. Diósi, L. Ferialdi, PRL 113, 200403 (2014), [2] - A.A. Budini, PRA 92, 052101 (2015), [3] - L. Ferialdi, PRL 116, 120402 (2016), [4] - N. Megier, W. T. Strunz, C. Viviescas, K. Luoma, PRL 120, 150402 (2018), [5] - W.T. Strunz, L. Diósi, N. Gisin, PRL 82, 1801 (1999)

FM 62.5 Wed 16:30 Tents

Many-particle interference to test Born's rule: Theory and two-particle experiment — •Marc-Oliver Pleinert[1,2], Eric Lutz[3], and Joachim von Zanthier[1,2] — [1]Institut für Optik, Information und Photonik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen, Germany — [2]Erlangen Graduate School in Advanced Optical Technologies (SAOT), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91052 Erlangen, Germany — [3]Institute for Theoretical Physics I, University of Stuttgart, D-70550 Stuttgart, Germany

Born's rule, one of the cornerstones of quantum mechanics, relates detection probabilities to the modulus square of the wave function. Single-particle interference is accordingly limited to pairs of quantum paths and higher-order interferences are prohibited. Deviations from Born's law have been quantified via the Sorkin parameter which is proportional to the third-order term. We here extend this formalism to many-particle interferences and find that they exhibit a much richer structure. We demonstrate, in particular, that all interference terms of order (2M+1) and greater vanish for M particles. We introduce a family of many-particle Sorkin parameters, which are exponentially more sensitive to deviations from Born's rule than their single-particle counterpart, and present first results of the Sorkin parameter within two-particle correlations.

FM 62.6 Wed 16:30 Tents

Fisher information of single-photon emitters and thermal light sources in the far field without an imaging system — •Manuel Bojer[1], Anton Classen[1,2], and Joachim von Zanthier[1] — [1]Institut für Optik, Information und Photonik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen, Germany — [2]Institute for Quantum Science and Engineering Texas A&M University, College Station, TX 77843, USA

Rayleigh's criterion states that two light sources are unresolvable close to each other if their images, blurred by diffraction, overlap significantly. However, via quantum estimation theory it could be shown that even for small distances there should be in principle information about the source separation available. We here explicitly calculate the quantum Fisher information for two single-photon emitters emitting photons into the far field without an imaging system. We show that for distinguishable photons emitted by two sources of equal intensity the available information as a function of their separation is constant. We also introduce an optimal measurement basis, namely new orthogonalized spherical harmonics, in order to extract the information. Additionally for two thermal light sources we calculate the Fisher information of various measurement schemes including multi-photon measurements and compare them to the quantum Fisher information.