TT 36: Fluctuations, Noise and Quantum Coherence

Time: Wednesday 9:30–10:30 Location: H7

TT 36.1 Wed 9:30 H7

Factorial cumulants of charge fluctuations: correlations vs. spin relaxation — •Philipp Stegmann[1], Annika Kurzmann[1,2], Jens Kerski[1], Rüdiger Schott[3], Arne Ludwig[3], Andreas Wiek[3], Axel Lorke[1], Martin Geller[1], and Jürgen König[1] — [1]Faculty of Physics and CENIDE, University of Duisburg-Essen, Lotharstr. 1, 47057 Duisburg, Germany — [2]Solid State Physics Laboratory, ETH Zurich, 8093 Zurich, Switzerland — [3]Chair for Applied Solid State Physics, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum, Germany

We use factorial cumulants to study the charge fluctuations between a single self-assembled quantum dot and a charge reservoir [1]. Measurements are performed by means of a new optical technique allowing to resolve higher-order cumulants up to 25th order. The factorial cumulants, in contrast to ordinary ones, are most suited to reveal correlations between the tunneling events of electrons [2,3]. Moreover, they turn out to be less demanding on the time resolution of the charge detector. We are able to quantify accurately how spin-relaxation destroys correlations.

[1] A. Kurzmann, P. Stegmann, J. Kerski, R. Schott, A. Ludwig, A. D. Wieck, J. König, A. Lorke, and M. Geller, Optical detection of single electron transport dynamics, submitted.
[2] P. Stegmann and J. König, Phys. Rev. B **92**, 155413 (2015).
[3] E. Kleinherbers, P. Stegmann, and J. König, New J. Phys. **20**, 073023 (2018).

TT 36.2 Wed 9:45 H7

Higher order moments, cumulants, and spectra of continuous quantum measurements — •Fabian Schefczik and Daniel Hägele — AG Spektroskopie der kondensierten Materie, Ruhr-Universität Bochum, Deutschland

We provide general quantum expressions for the multi-time moments $\langle z(t_n)\cdots z(t_1)\rangle$, cumulants, and spectra of the detector output $z(t)$ of a continuous quantum measurement with applications in spin noise spectroscopy and transport theory [1]. The expressions are correct in all orders of the measurement strength, i.e. they cover both the case of spin noise experiments where Gaussian background noise dominates and of transport measurements that usually exhibit quantum jump behavior (telegraph noise). The expressions follow from a rigorous treatment of the so-called stochastic master equation in terms of Ito-calculus. The quantum expressions for the cumulants can be formulated in a way to appear as compact as those for the mult-time moments. We shortly discuss a connection of higher order moments to the celebrated full counting statistics of transport theory.

[1] Daniel Hägele and Fabian Schefczik, Phys. Rev. B 98, 205143 (2018)

TT 36.3 Wed 10:00 H7

Revealing attractive electron-electron interaction in a quantum dot by full counting statistics — •Eric Kleinherbers, Philipp Stegmann, and Jürgen König — Theoretische Physik, Universität Duisburg-Essen and CENIDE, Lotharstr. 1, 47048 Duisburg

Recent experiments [1,2] have presented evidence for electron pairing in a quantum dot beyond the superconducting regime. An electron-electron attraction can effectively arise due to the surrounding solid state environment (e.g. coupling to bosonic modes as polarons, excitons or plasmons) and can be phenomenologically described by the negative-U Anderson model.

In my talk, I will discuss that an attractive interaction, compared to a repulsive one, does generate pronounced correlations in sequential electron transport [3]. In particular, these correlations are revealed by a sign change of higher-order current correlators (generalized factorial cumulants) which can be obtained from the full counting statistics of electron transfer. Remarkably, those correlations are robust against a fast spin relaxation and, most importantly, are detectable even when typical experimental limitations of a charge detector are considered.

[1] G. Cheng et al., Nature **521**, 196 (2015)
[2] G. Prawiroatmodjo et al., Nat. Commun. **8**, 395 (2017)
[3] E. Kleinherbers, P. Stegmann, and J. König, New J. Phys. **20**, 073023 (2018)

TT 36.4 Wed 10:15 H7

Optimal synchronization deep in the quantum regime: resource and fundamental limit — •Martin Koppenhöfer and Alexandre Roulet — Department of Physics, University of Basel, Basel, Switzerland

In this talk, we present an analytical framework to study the synchronization of a quantum self-sustained oscillator to an external signal. Our unified description allows us to identify the resource on which quantum synchronization relies, and to compare quantitatively the synchronization behavior of different limit cycles and signals. We focus on the most elementary quantum system that is able to host a self-sustained oscillation, namely a single spin 1. Despite the spin having no classical analogue, we first show that it can realize the van der Pol limit cycle deep in the quantum regime, which allows us to provide an analytical understanding of recently reported numerical results. Moving on to the equatorial limit cycle, we then reveal the existence of interference-based quantum synchronization blockade and extend the classical Arnold tongue to a snake-like forked tongue. Finally, we derive the maximum synchronization that can be achieved in the spin-1 system, and construct a limit cycle that reaches this fundamental limit asymptotically.