HL 11: Focus Session: Single Particle Sources for Electronic Devices I (Joint session of HL and TT, organized by HL)

Organizers: Rolf Haug (Universität Hannover) and Janine Splettstößer (Chalmers University)

Time: Monday 11:30–13:00 Location: H10

Invited Talk HL 11.1 Mon 11:30 H10

A clean single electron source using voltage pulses generating levitons. — •Christian Glattli — Nanoelectronics Group, Service de Physique de l'État Condensé CEA-Saclay, 91191 Gif-sur-Yvette, France

A simple approach to realize an on-demand electron soource is to apply a voltage pulse on a contact of the conductor such that the resulting current pulse injects a single charge in the conductor. At first sight, the idea seems too naive to produce something useful. However it appears that this procedure perfectly works [1]. More surprisingly it contains a rich physics: the generation of a new kind of excitation carrying a single particle: a leviton. The method was theoretically considered 20 years ago by L. Levitov and collaborators [2] who found that a voltage pulse with Lorentzian shape produces a minimal excitation, i.e. such that the number of excitations generated is not larger than the number of injected charges.

In this talk, I will present the recent experimental generation of levitons. I will also show electron quantum optics applications, reporting a two-leviton quantum interference experiment, the electrical analog of the Hong Ou Mandel experiment with photons which reveal perfect electron coherence. Finally using electron quantum tomography [3] an almost complete picture of the Leviton wave-function can be experimentally given.

[1] J. Dubois et al, Nature 502, 659-663 (2013).
[2] Levitov et al., J. Math. Phys. 37, 4845*4856 (1996).
[3] T. Jullien et al., Nature 514, 603*607 (2014)

HL 11.2 Mon 12:00 H10

Feedback Control of Waiting Times — •Tobias Brandes — TU Berlin, Institut für Theoretische Physik

Feedback control is known as a versatile tool for controlling quantum transport. So far most approaches deal with a control of stationary quantities (such as charge and heat currents). In this talk I will address the direct control of a temporal correlation function, the waiting time distribution, under feedback conditions. Within a simple transport model, I try to analyse possible connections to the thermodynamics of information and (with C. Emary) to optimal control theory.

HL 11.3 Mon 12:15 H10

Squeezing of shot noise using feedback controlled single-electron tunneling — •Timo Wagner[1], Johannes C. Bayer[1], Eddy P. Rugeramigabo[1], Philipp Strasberg[2], Tobias Brandes[2], and Rolf J. Haug[1] — [1]Institut für Festkörperphysik, Leibniz Universität, D-30167 Hannover, Germany — [2]Institut für Theoretische Physik, TU Berlin, D-10623 Berlin, Germany

Quantum feedback control has been studied intensively in quantum optics for a variety of different mechanism and systems [1]. Here we demonstrate the squeezing of shot noise in a quantum dot (QD) using an exclusively electronic feedback loop. Therefore the single-electron counting statistics [2, 3] is monitored in real-time with a coupled quantum point contact (QPC) and the deviation from a target rate is fed back periodically to speed up or slow down the process. With increasing feedback response we observe a stronger squeezing and faster freezing of the charge current fluctuations. The measurements confirm previous theoretical predictions [4] and show that the feedback loop is very robust even under stronger experimental restrictions. Our technique is analog to the generation of squeezed light with in-loop photodetection in quantum optics [1, 5].

[1] H. M. Wiseman, *Quantum Measurment and Control*, Cambridge University Press, Cambridge (2009)
[2] S. Gustavson, et al., Surf. Sci. Rep. 64, 191 (2009)
[3] N. Ubbelohde, et al., Nature. Com. 3, 612 (2012)
[4] T. Brandes, Phys. Rev. Lett. 105, 06060 (2010)
[5] S. Machida, Y. Yamamoto, Opt. Commun. 57, 290 (1986)

Invited Talk HL 11.4 Mon 12:30 H10

(De)coherence of single electron wavepackets in quantum Hall edge channels — •Erwann Bocquillon[1,2], Arthur Marguerite[2], Vincent Freulon[2], Jean-Marc Berroir[2], Bernard Plaçais[2], Antonella Cavanna[3], Yong Jin[3], and Gwendal Fève[2] — [1]Physikalisches Institut (EP3), Universität Würzburg, Würzburg, Germany — [2]Laboratoire Pierre Aigrain, Ecole Normale Supérieure, Paris, France — [3]Laboratoire de Photonique et Nanostructures, Marcoussis, France

The ballistic propagation of electronic waves along the quantum Hall edge channels of a two dimensional electron gas bears strong analogies with photon optics. Ballistic and one-dimensional propagation are provided by the chiral quantum Hall edge states and electronic beam splitters can be implemented using quantum point contacts. These analogies have inspired a whole set of experiments and provide an efficient tool to understand electronic propagation in quantum conductors.

In this talk, I will present how one can implement electron quantum optics experiments down to a single charge resolution using an on-demand single electron emitter. In particular, we generate two indistinguishable quasiparticles that we characterize via their interference on a beamsplitter in an electronic analogue of the Hong-Ou-Mandel experiment. The visibility of two-particle interferences reveals decoherence effects due to interactions with the environment, and especially with other co-propagating edge channels. These implementations of electron quantum optics experiments pave the way to more complex ones, such as the tomography of a single electron.