TT 1: Tutorial: Quantum Shot Noise

Time: Sunday 14:00–17:00 Location: EW 201

Tutorial TT 1.1 Sun 14:00 EW 201

Introduction to Quantum Shot Noise — •Tobias Brandes — Technische Universität Berlin, Institut für Theoretische Physik, Hardenbergstr. 36, Sekr. E-W 7-1, 10623 Berlin

This tutorial introduces Quantum Shot Noise, starting from a historical perspective of photoelectron counting statistics in quantum optics where many original concepts were developed between the 1950s and the 1980s. I will therefore start with Mandel's semiclassical counting formula that promotes a simple (short time) Fermi-Golden rule calculation to a (long-time) probability distribution. The quest for a quantum version of that formula was characterised by the subtleties of theoretically describing sources, fields, and detectors in a consistent manner. It lead from rather complicated (ordered) operator expressions to the much simpler concept of counting quantum jumps directly 'at the source' in a description with modified Master equations and counting variables. In hindsight, the underlying quantum jump (quantum trajectory) approach can be regarded as a 'by-product' of counting statistics, or vice versa. In its modern version - geared towards ultrasmall, artificial structures like quantum dots - this formalism serves as a versatile tool to theoretically address various noise-related aspects of quantum transport.

Tutorial TT 1.2 Sun 15:00 EW 201

Shot noise and electron counting measurements in low dimensional electron systems — •Frank Hohls — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr. 2, D-30167 Hannover

The noise is the signal! In this presentation I will first give an experimentalists introduction on what we can learn and have learned about low dimensional electron systems by measurements of the current shot noise. Noise can be used as a tool to examine fundamental aspects of a system or to characterize its parameters. In the second part I will show how even more information can be gained in quantum dot systems: we can now eavesdrop on the individual tunnelling events of electrons into and out of such small island with quantized charge. With a time resolved recording of these individual events which compose the current we can set out to characterize the detailed dynamics of the system and compile full counting statistics. I will discuss recent progress and future possibilities of this method.

Tutorial TT 1.3 Sun 16:00 EW 201

Full counting statistics - a new view on quantum transport — •Wolfgang Belzig — Fachbereich Physik, Universität Konstanz, D-78457 Konstanz

We introduce the concept of Full Counting Statistics (FCS) as new paradigm in the field of quantum transport of electrons. We briefly review some aspects of current fluctuations and the correspondingly investigated current-current correlations in mesoscopic physics: suppression of quantum shot noise due to Fermi statistics, universality of noise in diffusive and chaotic conductors and the influence of induced superconducting correlations. The question we try answer using FCS is, what are the underlying fundamental elementary processes leading to the observed noise properties. While this question might look trivial in simple systems (e.g. independent tunneling of single electrons), the answer in more complicated systems is much more intriguing and by no means obvious. Examples are the transport of entangled electrons, fractional charges in edge states or the transport under the influence of time-dependent fields.