HL 11: Transport: mainly Theory

Time: Monday 12:00–13:15 Location: POT 51

HL 11.1 Mon 12:00 POT 51

Two-dimensional correlation spectroscopy as new tool in noise spectroscopy — •Sebastian Starosielec, Jörg Rudolph, and Daniel Hägele — AG Spektroskopie der kondensierten Materie, Ruhr-Universität Bochum

The measurement of fluctuations, e.g. spin fluctuations via Spin Noise Spectroscopy reveals intrinsic properties of physical systems even in thermal equilibrium. However, the frequency-resolved power spectra do not represent all the system's dynamical properties. For example, an inhomogeneously broadened spectral feature cannot be distinguished from a purely homogeneously broadened signal by the usually measured noise power spectrum. In 2010, Liu et.al. showed in a theoretical example that the homogeneous linewidth of a single spin in a semiconductor quantum dot can be determined from third-order correlations of the measured time-dependent Faraday-signal even in the presence of inhomogeneous broadening [1].

We have implemented a spectrum analyzer for two-dimensional correlation spectroscopy measuring $S^{\mathrm{corr}}(\omega,\omega') = \langle I_\omega I_{\omega'}\rangle - \langle I_\omega\rangle\langle I_{\omega'}\rangle$ up to 90 MHz, with I_ω being the frequency dependent intensity of the time dependent signal [2]. S^{corr} allows to distinguish between the homogenous and inhomogenous broadening. We discuss a broad range of application for S^{corr} including the detection of critical dynamics at second order phase transitions and the detection of coherent signals on a large background of noise.

[1] R.B. Liu et al., New J. Phys. 12, 013018 (2010)
[2] S. Starosielec et al., Rev.Sci.Instrum. 81, (to appear Dec. 2010).

HL 11.2 Mon 12:15 POT 51

Direction Dependence of Spin Relaxation in Confined 2D Systems — •Paul Wenk[1] and Stefan Kettemann[1,2] — [1]School of Engineering and Science, Jacobs University Bremen, Bremen 28759 — [2]Asia Pacific Center for Theoretical Physics and Division of Advanced Materials Science Pohang University of Science and Technology (POSTECH) San31, Hyoja-dong, Nam-gu, Pohang 790-784, South Korea

Spin dynamics in semiconductors have been studied for decades, but still the prime condition for building spintronic devices, namely the understanding of spin relaxation, is not satisfactorily fulfilled. In this talk we present the dependence of spin relaxation on the direction of the quantum wire under Rashba and Dresselhaus (linear and cubic) spin orbit coupling. Comprising the dimensional reduction of the wire in the diffusive regime, the lowest spin relaxation and dephasing rates for (001) and (110) systems are found. The analysis of spin relaxation reduction is then extended to non-diffusive wires and we show that, in contrast to the theory of dimensional crossover from weak localization to weak antilocalization in diffusive wires (PRL98.176808, PRB81.125309), the relaxation due to cubic Dresselhaus spin orbit coupling is reduced and the linear part shifted with the number of transverse channels.

HL 11.3 Mon 12:30 POT 51

Anomalous Cherenkov spin-orbit sound — •Sergey Smirnov — Institut für Theoretische Physik, Universität Regensburg

The Cherenkov effect is a well known phenomenon in the electrodynamics of fast charged particles passing through transparent media. If the particle is faster than the light in a given medium, the medium emits a forward light cone. This beautiful phenomenon has an acoustic counterpart where the role of photons is played by phonons and the role of the speed of light is played by the sound velocity. In this case the medium emits a forward sound cone. Here, we show that in a system with spin-orbit interactions in addition to this normal Cherenkov sound there appears an anomalous Cherenkov sound with forward and backward sound propagation [1]. Furthermore, we demonstrate that the transition from the normal to anomalous Cherenkov sound happens in a singular way at the Cherenkov cone angle. The detection of this acoustic singularities therefore represents an alternative experimental tool for the measurement of the spin-orbit coupling strength.

[1] S. Smirnov, arXiv:1010.4002 (2010)

HL 11.4 Mon 12:45 POT 51

Stochastic resonance in nanoelectronic devices — •Fabian Hartmann[1], David Hartmann[1], Peter Kowalzik[1], Alfred Forchel[1], Luca Gammaitoni[2], and Lukas Worschech[1] — [1]Technische Physik, Physikalisches Institut, Universität Würzburg and Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Am Hubland, D-97074 Würzburg, Germany — [2]NiPS Laboratory, Dipartimento di Fisica, Universita di Perugia, I-06123 Perugia, Italy, and Istituto Nazionale di Fisica Nucleare, Sezione di Perugia, I-06123 Perugia, Italy

Noise degrades the performance of any device. This simple statement is not true if principle associated with Stochastic Resonance (SR) comes into play. Here the output exhibits a maximum signal-to-noise ratio (SNR) for noise floors unequal to zero. The authors have fabricated submicron-sized nanoelectronic devices and tested the noise activated response in these bistable devices under weak periodic modulation. We demonstrate that the weak periodic input can be synchronized with an optimum amount of noise and thus the operation condition of SR is fulfilled.

HL 11.5 Mon 13:00 POT 51

Random-telegraph-signal noises due to defects in ballistic nanotube transistors — •Neng-Ping Wang[1] and Stefan Heinze[2] — [1]Physics Department, Ningbo University, Fenghua Road 818, Ningbo 315211, P.R. China — [2]Institute of Theoretical Physics and Astrophysics, Christian-Albrechts-Universitaet zu Kiel, Leibnizstr. 15, D-24098 Kiel, Germany

Recently, there has been remarkable progress in carbon nanotube field-effect transistors (CNFETs). High performance and even ballistic transport have been demonstrated, and there is increasing focus on integrating such transistors into operational device circuits. However, all materials exhibit some low-frequency electrical noise which appears as 1/f noise and random telegraph signals (RTSs). The low-frequency noise increases inversely with the system size, so it is important to understand microscopic aspect of RTS noise in nanotubes.

Here we report calculations of the RTS noises due to single trapped charges in CNFETs using the non-equilibrium Greens function method in a tight-binding approximation. We find that the RTS noise amplitude depends on the nanotube-direction position of the charge. When a trapped charge is farther from the source (or drain) lead and closer to the middle of the channel, the RTS noise in the turn-on regime increases, while the RTS noise in the ”on” regime decreases. We calculate the electron potential along nanotube and explain such dependence of the RTS noise. We examine also how the RTS noise depends on both the thickness and dielectric constant of the gate dielectric, suggesting routes to reduce electrical noise.