molecular devices, and more information is expected to be provided by noise measurements.

In this work we investigate the effects of phonon scattering on the current noise through nanojunctions. Using the extended Keldysh-Green's function formalism we derive an expression for cumulant generating function in the case of weak electron-phonon coupling. We present analytic results for the case of a single broad level and identify, both in the inelastic current and in the noise, physically distinct contributions based on their voltage dependence. We apply our theory to an experimentally relevant set-up [1] and predict the inelastic contribution to current noise in the presence of phonon heating effects.

[1] R. H. M. Smit, Y. Noat, C. Untied, N.D. Lang, M.C. van Hemert, and J.M. van Ruitenbeek, Nature 419, 906 (2002).

TT 21.6 Tue 15:45 HSZ 304

Time-Resolved Counting Statistics for a Quantum Point Contact — •Adam Bednorz[1,2] and Wolfgang Belzig[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Institute of Theoretical Physics, University of Warsaw, Hoza 69, 00-681 Warsaw, Poland

We show that the naive formulation of time-resolved full counting statistics fails for high frequencies and leads to results, which could be interpreted as negative probabilities. We propose to construct a properly time-ordered positive-operator-valued measure, that combines counting statistics with detector backaction parametrized by a characteristic time τ [1]. The standard counting statistics is recovered in long time limit. In high frequency limit, for a weak coupling between the system and detector, the generating functional of counting statistics gains an additional Gaussian white noise component, that saves the positivity of the probability. It agrees with experiments since otherwise at strong coupling the noise measurements would be considerably modified due to the detector backaction. Finally, we also show that with more than one detector these nonclassical correlations can be directly measured.

[1] A. Bednorz and W. Belzig, Phys. Rev. Lett. **101**, 206803 (2008).

TT 21.7 Tue 16:00 HSZ 304

Electron counting statics in transport through double quantum dots — •Clive Emary[1], David Marcos[2], Ramon Aguado[2], and Tobias Brandes[1] — [1]Institut für Theor. Physik, TU Berlin — [2]Departamento de Teoria de la Materia Condensada, CSIC, Madrid

The double quantum dot is an important paradigm of quantum transport, representing a quantum two level system (qubit) connected to leads. We present several new aspects of the transport through a double quantum dot in the Coulomb blockade regime. On the one hand we discuss finite-frequency full counting statistics of the transport electrons and investigate the visibility of coherent effects at finite temperatures and bias; on the other, we study the effects of higher-order electron tunneling process usually neglected in standard treatments.

TT 22: Correlated Electrons: Quantum-Critical Phenomena 2

Time: Wednesday 9:30–13:00 Location: HSZ 03

Invited Talk TT 22.1 Wed 9:30 HSZ 03

Thermal expansion and magnetostriction close to quantum criticality — •Markus Garst — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Str. 77, 50937 Köln

Quantum phase transitions occur in materials at zero temperature upon tuning an external parameter, e.g., magnetic field to an instability of the ground state. A coupling of the quantum critical fluctuations to the lattice degrees of freedom can be exploited to probe quantum criticality at finite temperatures. We discuss the resulting anomalous signatures in thermal expansion, magnetostriction and the Grüneisen parameter, which provide a valuable tool not only to detect but also to classify a quantum phase transition. A smoking gun for the existence of such a transition is, e.g., the divergence of the Grüneisen parameter with an exponent characteristic for its universality class. We also explain that a negative thermal expansion naturally accompanies such transitions, and that its sign changes indicate the entropy distribution in the phase diagram. As examples, we discuss (a) quantum critical metamagnetism, a concept introduced for the bilayer ruthenate $Sr_3Ru_2O_7$, and (b) the critical properties of the spin-ladder compound $(C_5H_{12}N)_2CuBr_4$, that exhibits a diverging thermal expansion.

TT 22.2 Wed 10:00 HSZ 03

Low-temperature thermal expansion of $Nb_{1-y}Fe_{2+y}$ — •Stefan Lausberg[1], Manuel Brando[1], Rafik Ballou[2], F Malte Grosche[3], and Frank Steglich[1] — [1]Max-Planck-Institut für Chemische Physik fester Stoffe Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Laboratoire Louis Néel, CNRS, B.P. 166, 38042 Grenoble Cedex 9, France — [3]Cavendish Laboratory, Cambridge CB30HE, United Kingdom

The hexagonal C14 Laves phase system $Nb_{1-y}Fe_{2+y}$ exhibits a magnetically ordered ground state, the nature of which strongly depends on the concentration y. Stoichiometric $NbFe_2$ shows low-temperature ($T_N = 10$ K) spin-density-wave (SDW) order, while slight Fe-excess induces low-moment ferromagnetism (FM). A quantum critical point (QCP) is expected on the Nb-rich side at $y \sim -0.015$, where signatures of logarithmic Fermi-liquid breakdown have been reported [1]. The presence of a QCP can be thermodynamically tested by measuring the thermal expansion coefficient $\alpha(T)$: In metals close to a QCP, a divergence of the Grüneisen ratio $\Gamma = \alpha/c_p$ has been proposed, since α is more singular than c_p, while in metals with a Fermi-liquid ground state, α/T and c_p/T are constant. We report measurements of α for different single crystals with y close to the QCP. Surprisingly, we find an extremely large α coefficient, similar to that of heavy-fermion materials [2], and it increases with decreasing temperature. The behavior of the resulting Γ parameter will be discussed.

[1] M. Brando et al., PRL **101**, 026401 (2008).
[2] R. Küchler et al., Physica B **378-380**, 36 (2006).

TT 22.3 Wed 10:15 HSZ 03

Probing the quantum critical behavior of $CeCoIn_5$ via thermal expansion measurements — •Sebastian Zaum[1,2], Kai Grube[1], Roland Schäfer[1], Eric D. Bauer[3], Christoph Meingast[1], and Hilbert v. Löhneysen[1,2] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe, Germany — [2]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe, Germany — [3]Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA

The heavy-fermion compound $CeCoIn_5$ is an unconventional superconductor. Its tetragonal crystal structure leads to anisotropic superconducting properties with an upper critical field of $B_{c2} = 5$ T and 11.8 T along the a- and c-axes, respectively. At its upper critical field $B_{c2} \parallel c$, $CeCoIn_5$ reveals a quantum critical point with pronounced deviations from Fermi-liquid behavior. We have measured the thermal expansion α_i ($i = a, c$) and magnetostriction λ_i longitudinal and transverse to the magnetic field. As expected, α_i/T changes its sign at B_{c2} and diverges with decreasing temperature. The effect of the quantum critical behavior on α_a, however, is qualitatively different from that on α_c. While α_c shows at $T = 0.3$ K a crossover to a weaker divergence, α_a does not change its singular behavior down to the lowest measured temperature of 50 mK.

TT 22.4 Wed 10:30 HSZ 03

Divergence of the Magnetic Grüneisen Ratio at the Field-Induced Quantum Critical Point in $YbRh_2Si_2$ — Yoshi Tokiwa[1,2], Teodora Radu[1], •Philipp Gegenwart[2], Christoph Geibel[1], and Frank Steglich[1] — [1]Max-Planck Institute for Chemical Physics of Solids, D-01187 Dresden — [2]I. Physik. Institut, Georg-August Universität Göttingen, Friedrich-Hund Platz 1, 37077 Göttingen

We study quantum criticality in the heavy-fermion metal $YbRh_2Si_2$ by means of the low-temperature magnetization and specific heat[1]. The magnetic Grueneisen ratio $\Gamma_{mag} = -(dM/dT)/C$ is derived, which is found to diverge in the approach of the field-induced quantum critical point. The data are compared with theoretical predictions for quantum criticality in heavy-fermion metals.

[1] T. Tokiwa et al., arXiv:0809.3705v2.

TT 22.5 Wed 10:45 HSZ 03