SFB/TRR 21 - Colloquium

18. November 2011, Ulm

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Feedback Control of Quantum Transport

Monitoring quantum systems during their time evolution usually introduces extra noise, but it also provides information that can be used to control the system dynamics. In this talk, I will discuss three models for closed-loop control of charge qubit states and of quantum transport through nanoscale structures. The first model is a scheme where a time-dependent signal is used to continuously adjust tunnel rates or energy levels. An error charge determines whether to speed up or slow down the transport process – a form of feedback that is analogous to the centrifugal governor used, e.g., in thermo-mechanic machines like the steam engine. It generates a new kind of full counting statistics (FCS) where all the cumulants except the first are frozen in at large times. The second model is based on an instantaneous modification of quantum jumps by feedback loops that upgrade the FCS counting fields to super-operators in the underlying quantum master equation. A charge qubit is coupled to a detector (single electron dot and quantum point contact) . A feedback loop conditioned upon the detector signal can then be used to prepare pure, stationary qubit states. The third model applies the Wiseman-Milburn scheme to single electron transport through a double quantum dot. With an appropriate choice of feedback parameters, the FCS signal collapses to that of a single level dot and again pure stationary qubit states can be generated.

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