Quantum measurement and control of a Maxwell demon in double quantum dots

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In scenarios coined Maxwell's demon, information on microscopic degrees of freedom is used to seemingly violate the second law of thermodynamics. This has been studied in the classical as well as the quantum domain. Here we study an implementation of Maxwell's demon that can operate in both domains [1,2]. In particular, we investigate information-to-work conversion over the quantum-to-classical transition. The system is analyzed within a recently developed Quantum Fokker-Planck master equation framework for continuous measurement and feedback control [2]. The demon measures the charge state of a double quantum dot, and uses this information to guide electrons against a voltage bias by tuning the on-site energies of the dots. Coherent tunneling between the dots allows for the buildup of quantum coherence in the system. Under strong measurements, the coherence is suppressed, and the system is well-described by a classical model. As the measurement strength is further increased, the Zeno effect prohibits interdot tunneling. A Zeno-like effect is also observed for weak measurements, where measurement errors lead to fluctuations in the on-site energies, dephasing the system.

The presenter acknowledges support from the Swedish Research Council, Grant No. 2018-03921 and FQXi Grant Number: FQXi-IAF19-07 from the Foundational Questions Institute Fund, a donor advised fund of Silicon Valley Community Foundation

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