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Analysis of electron tunneling events with the hidden Markov model[1] MATTHEW HOUSE, HONG WEN JIANG, University of California, Los Angeles — The charge fluctuations of a quantum dot in a semiconductor heterostructure can be observed using a charge sensor which observes electrons transiting on and off of the quantum dot in real time. As electrons tunnel onto and off of the quantum dot, the conductance of the charge sensor shows stochastic transitions between two levels in a pattern that is commonly referred to as a random telegraph signal. Information about the quantized states of electrons on the quantum dot can be inferred from measurements of the charge sensor conductance. We have applied the hidden Markov model (HMM) formalism to the problem of extracting information about quantum dot states and transition rates from charge sensor data. HMM theory provides a mathematical approach for inferring the details of a stochastic process from indirect observations. We discuss how this applies to the analysis of charge sensor data in quantum dot experiments. We apply HMMs to simulated and experimental data, and demonstrate its usefulness in extracting the electron transition rates. Data analysis by HMM is much more robust against noise than previous approaches, and has the potential to infer whether tunneling events correspond to the ground state or to excited states of the quantum dot, information which is not directly observable by the charge sensor.

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