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Detection of spin states in a quantum dot by random telegraph signal analysis with the hidden Markov model MATTHEW HOUSE, HONG-WEN JIANG, University of California, Los Angeles, MING XIAO, GUOPING GUO, HAIOU LI, GANG CAO, TAO TU, GUANGCAN GUO, Key Laboratory of Quantum Information, Chinese Academy of Sciences, Univeristy of Science and Technology of China — A lateral GaAs quantum dot with an adjacent quantum point contact charge sensor was tuned so that its chemical potential is close to the Fermi level of an adjacent electron reservoir. In this configuration electrons tunnel back and forth between the quantum dot and the reservoir due to thermal fluctuations, characteristic switching known as a random telegraph signal (RTS). The charge state of the quantum dot is directly observable, but spin and orbital state information is not. Such extra states may reveal themselves in the statistics of the timing of tunneling events. We present a statistical analysis approach based on the Hidden Markov Model (HMM) for extracting information about the internal structure of the quantum dot from RTS data, particularly focusing on determining the electronic spin state. We demonstrate on simulated and experimental data that this technique can detect electron spin states and measure their tunneling rates individually when the energy level difference is less than or comparable to the thermal energy scale. This opens a new regime for studying quantum dot spin physics because other experiments require a Zeeman energy difference greater than the thermal energy in order to distinguish the spin states.

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