# Influence of spin relaxation and Coulomb correlations on the dynamics of an open quantum dot

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Recent experimental advancement allowed for a time-resolved electron charging of quantum dots by a two-dimensional electron gas (2DEG) [1]. We have simulated the charging dynamics for a better understanding of the role of Coulomb interactions and relaxation processes on the time-dependent occupation probabilities of quantum dots.

The quantum dots are assumed to be initially empty and we calculate the time evolution as the gate voltage is instantly changed to enable electron tunneling from the 2DEG into the quantum dots. The charging of a single quantum dot in the sequential tunneling regime is determined by using a master equation for the occupation probabilities. To incorporate many-body effects, the eigenstates of a finite number of correlated electrons in the quantum dot obtained by the exact diagonalization method are taken into account. The electrons in the quantum dot can interact with phonons and nuclear spins which lead to two types of relaxation processes: 1. an orbital relaxation in the dot, which is instantaneous compared to the tunneling dynamics and 2. a spin relaxation with a time scale that can be in the order of the tunneling times. A detailed analysis of the time dependence reveals the complex interplay between Coulomb correlations and different spin-relaxation mechanisms.

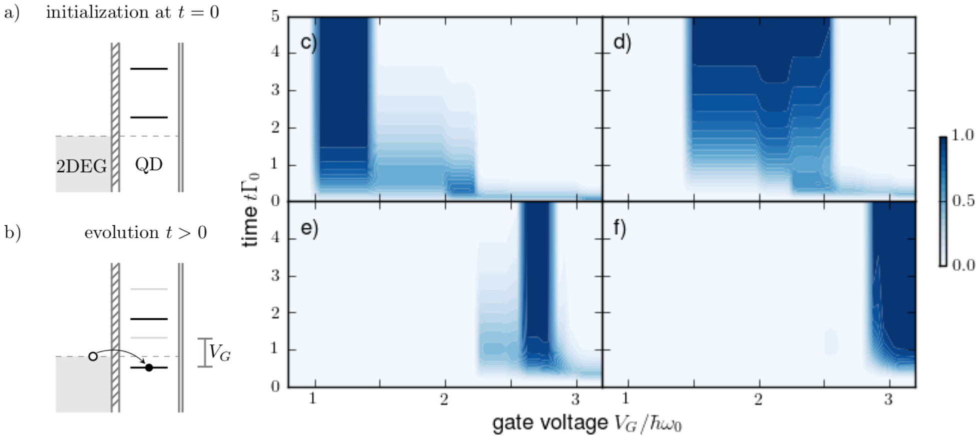


FIG. 1: An initially empty quantum dot coupled to a two-dimensional electron gas (a) is brought out of equilibrium by applying a gate voltage (b). The time-dependent occupation probability for one to four electrons (c-f) depending on the gate voltage reflects the distinct charging times from which the influence of electronic correlations and relaxation can be inferred.

[1] B. Marquardt, M. Geller, B. Baxevanis, D. Pfannkuche, A.D. Wieck, D. Reuter, and A. Lorke, *Nat. Commun.* **2**, 209 (2011)