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Title II: Quantum-Dot Spintronics

Abstract:

Well-defined and -controllable nanostructures such as quantum dots are ideal model systems to investigate the interplay of Coulomb interaction, nonequilibrium, and collective order such as ferromagnetism. For quantum dots with large single-level spacing only a few, ultimatively one, orbital level participates in transport. This opens the possibility to employ quantum dots for a controlled manipulation of a few quantum degrees of freedom, whose dynamics can be detected via transport measurements.

We study theoretically electronic transport through interacting quantum dots coupled to ferromagnetic leads. To account for Coulomb interaction, nonequilibrium and collective order on a single footing, we employ a diagrammatic real-time approach that allows for a systematic classification and evaluation of the contributing transport processes.

In the presence of ferromagnetic leads with, in general, non-collinear magnetization directions, an applied bias voltage leads to a finite spin polarization of the quantum dot level. The dynamics of the accumulated quantum-dot spin can be manipulated by gate and transport voltages. It is, furthermore, influenced by external magnetic fields as well as by an effective exchange field that arises due to the interplay of spin polarization in the leads and strong Coulomb interaction in the quantum dot.