

Abstract

Topic of this thesis are electronic properties and transport characteristics of single and double quantum dots. We begin with a discussion of the effects of Coulomb interaction on the eigenspectra of isolated single and double dots. Thereafter, we study consequences of these many-particle effects for the transport characteristics of dots that are coupled to external contacts. In these studies the limit of weak coupling is considered which allows to neglect any back action of the external coupling on the eigenspectrum of the dot structures. In the last part of this thesis we extend our description of quantum transport and describe effects of the external coupling on the eigenspectrum and transport characteristics of a double dot.

In the first part we discuss the excitation spectrum and the transport properties of a single two-dimensional dot with parabolic confinement. Classical and quantum mechanical effects of Coulomb interaction on the charge density excitations are studied for various numbers of electrons confined to the dot. The calculations explain recently measured Raman spectra of self-assembled dots. Thereafter, a blocking mechanism in the nonlinear transport regime is introduced, which completely suppresses the stationary current through the dot. The presented blocking mechanism only occurs if the Coulomb interaction exceeds the single particle level spacing and the blockade can be switched on and off by an external magnetic field.

The second part deals with the consequences of Coulomb interaction on the eigenspectrum and the transport properties of two vertically coupled dots. It is shown that a vertical magnetic field can tune a spontaneous charge polarization in vertical direction of the 3-electron ground state. This strong charge polarization is caused by the different magnetic-field dependence of the intra- and interdot Coulomb interaction and has severe consequences on the serial transport through the double dot. In particular linear transport through the double dot is blocked at the critical magnetic field.

In the last part of the thesis we study again the transport characteristics of a double dot coupled in series to external contacts. Now we consider the regime when the external coupling exceeds the interdot tunneling energy and extend our description of the double dot, by considering also superpositions of eigenstates. In fact we find that these superpositions are relevant since they describe the interplay between the decoherent coupling to the external contacts and the coherent dynamics on the double dot. Analogies to related work in the field of spintronics are pointed out. Furthermore, we find that the external coupling shifts the energy of the dot levels which results in characteristic features in the current-voltage characteristic of the double dot as well as in its stability diagram.