Electron transport through double quantum dots with interdot Coulomb repulsion

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We consider electron tunnelling through double quantum dots (DQD) attached to external leads. Systems of quantum dots coupled in series and in parallel configuration are investigated. Tunnelling coupling between the two dots in series is described by $V$ and it is treated as a tunable parameter. A single dot in the system is described by the one-level Anderson Hamiltonian with infinite intradot Coulomb repulsion. Accordingly, only a single state on each dot can be expected and the double occupancy of each dot can be ignored. The interdot Coulomb interaction is taken into account and it is described via Hubbard-like term. Strong and weak correlation regimes are studied. Tunneling rates between the dots and reservoirs are assumed to be weak, so the Kondo effect is not observed in the system.

The non-equilibrium Green function (GF) formalism is introduced to describe electron transport in the non-linear regime. The retarded $G^r$ and advanced $G^a$ GFs are calculated within the framework of the Hartree-Fock approximation with use of the equation of motion method. For a DQD system GFs are represented by 2 x 2 matrices. In the present approach diagonal and non-diagonal terms are taken into account and are calculated in a self-consistent way. Note, that for steady-state transport one does not need to find an appropriate formula for lesser GF $G^<$ itself (see Ref. [1]). Occupation numbers and electric current can be expressed by $\int G^<(\varepsilon) d\varepsilon$ and retarded (advanced) GF only. This approach allows us to omit any additional approximation involved in calculations of $G^<$. Density of states (DOS), number of electrons, I-V characteristics as well as differential conductance are calculated and discussed in detail. For the system with two quantum dots in series electric current shows an asymmetry with respect to the applied voltage [2]. This asymmetry strongly depends on relative level spacing in the dots and hoping rate.