An Analytical Approach on Mesoscopic Transport Involving with Electron-Electron Interaction

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Abstract: In this paper, we try to present a way in terms of which one can analytically obtain the Hartree self-consistent potential instead of computing it by the numerical iterative procedure as usual, which is convenient for us to describe the current flow through a mesoscopic conductor. In our treatment, we expand the action function $S(x)$ by Planck constant $\hbar$, then the self-consistent potential and the wavefunction can be solved analytically order by order starting from the Poisson equation and quantum Hamilton-Jacobian equation, the differential conductance and quantum capacitance can thus be obtained naturally. In our paper, we show the quantum corrections up to the second order, and the electron-electron interaction is considered only at the Hartree approximation level.

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