

Why is Time-Varying Control Necessary for Signal Processing with Locally-Connected Quantum-Dot Arrays?

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Extended Abstract

New nanodevices which encode information into the geometrical charge distribution of artificial (or natural) molecules have been proposed [1-5]. Functional units are composed by exploiting the electrostatic coupling between neighboring devices. In these unit, processing takes place by reshaping the electron density of the molecules [6, 7], and not by switching electron currents. It has been proposed and demonstrated that high speed, extremely low loss logic gates (e.g. inverters, majority gates) can be realized.

It will be shown that Coulomb-coupled time-invariant or stationary artificial molecules behave like nonlinear locally passive systems for small-signal excitations, thus multiple equilibria cannot be achieved by integrating them [8-10]. Without multiple equilibrium write-hold-read memories, and thus signal processors, cannot be realized.

However, the signal transfer-function of strongly nonlinear molecules can be varied in time by adiabatic control, called clock control. It will be shown that strongly nonlinear time-varying molecules can transform the necessary amount of clock-energy into the flow of signals, thereby enabling the network of molecules to perform multiple equilibria. It is envisaged that, by a proper integration of clock-controlled artificial molecules, universal digital signal processors can be built.

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