Advancing Si-based charge qubits

We are pursuing quantum information applications of Si-based single electron tunneling (SET) devices, using both charge and spin degrees of freedom. In the next few years, we hope to demonstrate: i) coherent manipulation of a single electron in a double quantum dot; ii) investigation of correlation between qubit decoherence and standard microelectronics industry defect measurements; iii) elucidation of interplay between defect existence, defect motion, and qubit decoherence; iv) optimization of coherence.

Quantum information as an application of Si-based (SET) devices is a new application for us that exploits our extensive previous work on SET devices for metrology requiring precise charge counting. In the past year, we have completed a thorough analysis of the energetics of these devices to ensure that the targeted coherent manipulation will be possible, given what we know of the performance of our devices in the non-coherent regime.

A precursor to coherent manipulations in the double quantum dot is the demonstration of charge stability or "honeycomb" diagrams (one shown below) in a double quantum dot. We have recently developed the ability to demonstrate such honeycomb diagrams.

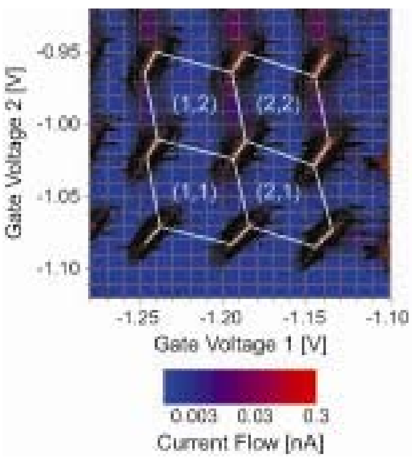

Figure 2.4: Honeycomb diagram: Blue color represents no current flow, red color represents high current flow. White lines are guides to the eye; numbers are examples of numbers of electrons on each dot. Note that by demonstrating this honeycomb diagram, we have demonstrated the ability to control the integer number of electrons on each of the two quantum dots, and to non-coherently transfer electrons between one dot and another.

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