Joint Quantum Seminar

Wednesday, March 20, 4:00 pm
Jefferson 250

Prof. Lieven Vandersypen

Delft University of Technology

"Simulating Fermi-Hubbard physics with quantum dots"

Gate-defined quantum dots have recently emerged as a credible platform for quantum simulation. A quantum dot array naturally emulates the extended Fermi-Hubbard model. The energy scales cover the most relevant parts of the phase diagram, with individually tunable hopping energies well below the on-site interaction energies and at the same time far exceeding the thermal energy. In addition, site-specific potential offsets are individually tunable, further extending the range of physical phenomena that can be explored. Finally, the accessible observables include particle number, spin, spin correlations, addition energies and transport, complementing those of cold atom experiments. As a first illustration, we show the transition from Coulomb blockade to collective Coulomb blockade, the finite-size analogue of the metal to Mott insulator transition [1]. In a second experiment, we present evidence of Nagaoka ferromagnetism in a 2x2 quantum dot plaquette [2]. This is a form of magnetism that has not been observed before, highlighting the potential of quantum dots to provide new insights in Fermi-Hubbard physics. I will close with a brief overview and perspective of our recent work on silicon spin qubits in our group [3-5].

[1] T. Hensgens, T. Fujita, et al, Quantum simulation of a Fermi-Hubbard model using a semiconductor quantum dot array, Nature 548, 70–73 (2017)[2] J.P. Dehollain, et al, in preparation [3] T.F. Watson, et al, A programmable two-qubit quantum processor in silicon, Nature 555, 633-637 (2018) [4] N. Samkharadze, et al, Strong spin-photon coupling in silicon, Science 359, 1123-1127 (2018)

Student Presentation will begin at 4:00
Guest Presentation will begin at 4:30 PM
Refreshments will be provided

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