Physical Sciences Seminar

Circuit Quantum Electrodynamics with superconductor-semiconductor hybrid systems

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Host: Georgios Katsaros

Semiconductor qubits rely on the control of charge and spin degrees of freedom of electrons or holes confined in quantum dots (QDs). Typically, semiconductor qubit-qubit coupling is short range, effectively limiting qubit distance to the spatial extent of the wavefunction of the confined particle (a few hundred nanometers). This is a significant constraint towards scaling of the QD-based architectures to realize dense 1D or 2D arrays of QDs.Inspired by techniques originally developed for circuit QED, we recently demonstrated the strong coupling of individual electrons [1,2] confined in GaAs quantum dots to individual microwave photons, making use of the enhanced electric component of the vacuum fluctuations of a resonator with impedance beyond the typical 50 Ohm of standard coplanar waveguides, realized by cascading Josephson junctions. With this hybrid technology, we recently realized a proof of concept experiment, where the coupling between a transmon and a double QD (DQD) is mediated by virtual microwave photon excitations in a high impedance SQUID array resonator, which acts as a quantum bus enabling long-range coupling between dissimilar qubits [3]. Similarly, we achieved coherent coupling between two DQD charge qubits separated by approximately 50 um [4]. In the dispersive regime, we spectroscopically observed qubit-qubit coupling as an avoided-crossing in the energy spectrum of the DQD charge qubits. The methods and techniques developed in this work are transferable to QD devices based on other material systems and can be beneficial for spin based hybrid systems [5].[1] A. Stockklauser*, P. Scarlino*, et al., Phys. Rev. X 7, 011030 (2017).[2] P. Scarlino*, D. J. van Woerkom*, et al., arXiv:1711.01906.[3] P. Scarlino*, D. J. van Woerkom*, et al., arXiv:1806.10039.[4] D. J. van Woerkom*, P. Scarlino*, et al., Phys. Rev. X 8, 041018 (2018).[5] A. Landig*, J. Koski*, et al., Nature 560, 179-184 (2018).

Friday, January 18, 2019 11:00am - 12:00pm

Big Seminar room Ground floor / Office Bldg West (I21.EG.101)

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