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Ultra-sensitive charge amplifiers approaching the quantum limit

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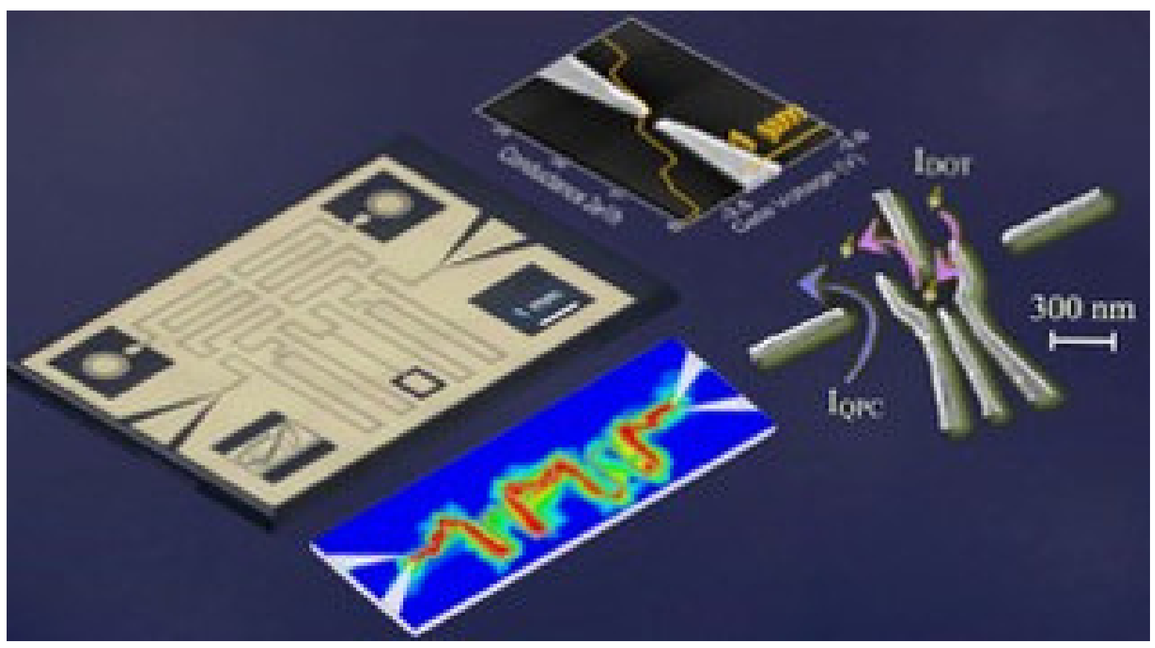
Abstract:

An in-depth understanding of the electrical properties of mesoscopic systems requires direct insight into various quantum phenomena such as electron-electron correlations, dephasing and decoherence, quantum oscillations, single-electron charging, excitation and de-excitation process. Most of these phenomena are short-time-scaled, fragile and, sensitive to environmental decoherences. Conventional transport studies have limited reach in these studies as it probes the time-averaged behavior of the system. A complete understanding of these phenomena requires time-resolved single-charge sensing as opposed to conventional transport studies. Quantum point contacts (QPC) and the superconducting single electron transistors (S-SET) are ultrasensitive charge amplifiers exploited for single-electron detection in solid state circuits. Ease of fabrication, operation and integration with other gated devices on two-dimensional electron systems give the QPC an edge over the S-SETs. QPC based amplifiers are also considered as the readout devices for solid-state spin qubits. In this talk, an overview of charge sensing techniques using QPC charge amplifiers, and also attaining sub-nanosecond time-scale charge amplification by coupling QPC amplifiers to superconducting planar microwave resonators will be presented. I will also present results on the noise characteristics and the device shot-noise limited charge detection in these devices.



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