Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Quantum Computation and Quantum Measurement with Mesoscopic Superconducting Structures

By

Qiang Deng

Systems of mesoscopic Josephson junctions are at present among the leading candidates for development of practical qubits for quantum information devices. Although different qubit structures have been realized with Josephson junctions, their common feature is the design that is optimized to overcoming the problem of decoherence by the low-frequency noise that exists in all solid-state structures. In the presented dissertation research, we proposed and studied an alternative approach of direct suppression of noise by a feedback loop based on the low-frequency quantum measurements. The minimal noise induced in the qubit by such a feedback loop was calculated under the conditions of continuous quantum-limited measurements. Another obstacle facing the quantum Josephson junction circuits is the information transfer between the circuit elements. We studied the quantum dynamics of dual-rail arrays of NSQUIDs characterized by a negative inductance between its arms, which hold promise for quantum information transfer. The scaling and decoherence properties of these arrays were analyzed. Information transfer along NSQUID arrays can also be used to implement, adiabatic quantum computation (AQC), an alternative to the gate-model approach to quantum computation that is expected to be more stable against the decoherence. Here we suggested fidelity of the ground state as the quantitative measure of the ultimate effect of decoherence on AQC. We showed that decoherence-induced deformation of the ground state of an AQC algorithm is characterized by the same noise correlators as those that determine the decoherence time in the gate-model approach. Results for fidelity of a 16-qubit array at finite temperatures were obtained numerically.

Date: July 15, 2013
Time: 2:00 pm
Place: B-131

Program: Physics
Dissertation Advisor: Dmitri Averin