LA-SiGMA

Louisiana Alliance for Simulation-Guided Materials Applications

Spring Seminar Series
3:30pm - 4:30pm, Wednesday February 13, 2013
Tilton Hall 305, Tulane University

Two-Level System Material Defects in Superconducting Qubit Dielectrics

by

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Superconducting qubits have steadily improved their coherence time for over a decade such that quantum information algorithms are now implemented with an integrated circuit. However, material defects at the requisite millikelvin temperatures, often referred to as two-level systems (TLS), interact with the microwave photon fields and continue to limit the coherence of qubits. These TLS also limit the performance of astronomy photon detectors, which are made with superconducting circuits. In this talk, I will focus on TLS which are electrically and resonantly coupled to the microwave fields, and are particularly troublesome for these devices. Unfortunately the microscopic model of these low temperature defects is often unknown, but I will argue that a particular Hydrogen-based defect recently identified by ab-initio calculations in alumina is the likely TLS defect. In addition, I will show how data from resonators allows one to quantify the influence of the TLS using the loss tangent. Next I will show how non-equilibrium data on TLS can be taken with a new device called a microwave bridge resonator. Coupled with new theoretical work, these measurements increase our understanding of TLS out of equilibrium, and allow the practical extraction of the TLS dipole moment.

Dr. Kevin D. Osborn received his doctorate in physics from the University of Illinois at Urbana-Champaign in 2001, with a thesis on the critical fluctuations of the superfluid density in high-temperature superconducting films. He then started postdoctoral research at the National Institute of Standards and Technology in Boulder, Colorado and measured individual InGaAs quantum dots using Al single-electron transistors. In 2004 he received a National Research Council postdoctoral associate award which allowed him to perform studies at NIST on decoherence mechanisms in superconducting phase qubits. In 2007 Dr. Osborn transitioned to the Laboratory for Physical Sciences in College Park, Maryland, to set up a new research group as a US government physicist. His group currently studies decoherence mechanisms in superconducting qubits, with an emphasis on condensed matter phenomena related to two-level systems.