

**DEPARTMENT OF PHYSICS AND ASTRONOMY**  
**CONDENSED MATTER SEMINAR/SPINTRONICS/PURDUE**  
**QUANTUM CENTER**

**Wednesday May 2, 2018**

**2:00 PM, Room 242 Physics**

**Refreshments 1:45 PM Room 242 Physics**



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**Resonator Dressed State Control Using  
Broadband Two-Level Defect Inversion**

Laboratory for Physical Sciences, University of Maryland, College Park

Superconducting quantum circuits, composed of superconductor and amorphous dielectric, is a promising way to realize quantum computation. At very low-temperatures ( $<1$  K), all amorphous solids contain low-energy excitations which is attributed to the motion of group of atoms between two potential wells separated by a tunnel barrier. These are called two-level system (TLS) defects. TLSs are known to cause performance limiting decoherence in qubits and noise in superconducting photon detectors.

We have achieved a broadband TLS inversion in the GHz regime, as monitored by a quantum-regime superconducting resonator. The TLS inversion is caused and controlled by application of a strong pump field and a swept electric bias field. The dressed resonator responds to the TLS inversion through changes in its resonance frequency and internal loss. For the lowest bias rates, inverted TLSs are confined in a narrow band near the pump frequency due to relaxation processes. In this regime the frequency and internal loss tangent are nearly unchanged. With increasing bias rates, a large fraction of TLSs are inverted and distributed in energy below the resonance frequency. This causes large change of resonance frequency and loss up to some maximum value. For even larger bias rates, the probability of TLS inversion is lower when interacting with the pump field due a larger probability of Landau-Zener tunneling. As a result, the shifts in resonance frequency and loss lower from their respective maximum values. Numerical simulations of (complex) permittivity change agree with experimental results. This is a promising way to improve relaxation and coherence times of superconducting qubit.