Yale Institute for Nanoscience and Quantum Engineering

Friday- December 6, 2013

12:00 to 1:00 p.m.

Becton Seminar Room

Light lunch will be served at 11:45 a.m.

Rebecca Milot

Department of Chemistry, Yale University

"Using Terahertz Spectroscopy to Study Systems with Solar Energy Applications"

Bioinspired solar water oxidation systems are being developed in the context of renewable alternatives to fossil fuels. One possible design incorporates thin-film dye-sensitized nanoparticle photoanodes to capture and convert visible light to charge carriers. Because the operation of these systems requires rapid and efficient charge separation and storage, time-resolved terahertz spectroscopy (TRTS), an optical pump/THz probe technique, is ideally suited for studying them due to its femtosecond time resolution and high sensitivity to the conductivity of nanoparticulate semiconductors. Using TRTS, the efficiency and dynamics of electron injection from a series of *tris*-pentafluorophenyl porphyrin sensitizers into TiO_2 and SnO_2 nanoparticles was investigated. Electron injection from the dyes to TiO_2 was only observed when the energy level of the dye excited state was higher than that of the conduction band. When injection was possible, it was completed within 500 fs after photoexcitation. With SnO_2, electron injection was slower, and the rate depended strongly on the identity of the metal ion coordinated to the center of the porphyrin ring. Additionally, the injection kinetics were multiexponential, which suggests that electron injection occurs from multiple excited states of the porphyrin molecule.

Brian Vlastakis

Department of Applied Physics, Yale University

"Encoding quantum information in 100-photon Schrödinger cat states"

In many implementations, the superposition of a two-level system, or qubit, has been the basic element towards realizing a quantum computer. Alternatively, we explore encoding quantum information in a superposition of coherent states. Unlike two-level systems, coherent states mimic the classical, macroscopic behavior of an oscillator. These coherent state superpositions are known as cat states due to their resemblance to the thought experiment by Schrödinger which illustrates the counterintuitive nature of the superposition principle when applied to everyday, macroscopic objects. Here, we map an arbitrary state of a superconducting transmon qubit to a cat state in a cavity resonator. We create cat states as large as 111 photons and extend this protocol to create superpositions of up to four coherent states. These superposition states could have a wide array of applications which include redundant encoding for quantum error correction as well as increased phase sensitivity for precision quantum measurement.

HOST: Paul Fleury