Abstract:
Silicon nanowires have many unusual material properties that make them uniquely suited for many applications. For isolated defect states in wide-band materials can behave as a solid-state analog of a trapped ion. A prime example is the nitrogen-vacancy (NV) center in diamond, which is a source of single photons, a high-quality spin qubit, and an interface between light and solid-state quantum states. Despite the great success of NV centers, there remain practical challenges associated with the optical properties of the defect and notably, the properties of the host crystal. Growth and doping control of high-quality single-crystal diamond is challenging, and there is no well-established heteroepitaxy. Moreover, solid-state quantum researchers are limited by the properties of NV centers, with few alternative “quantum defects.” This is in contrast to the situation with trapped atoms where researchers have a periodic table from which to select atoms with desirable properties for a particular application. These factors have motivated research groups worldwide to explore semiconductor materials other than diamond as the host for quantum defects, both to expand the defect “periodic table” and because of the advantages that conventional semiconductor materials offer for integration, fabrication, functionality, and growth. I will describe our efforts to understand the recently discovered single defects in ZnO that exhibit bright (>50 kcounts/s) single photon emission when excited by sub-bandgap-energy light. We use variable temperature confocal fluorescence microscopy to characterize the optical properties of these defects, one at a time. Using group theoretical considerations, we establish that these ZnO defects have orbital singlet ground and excited states, which is the first step towards revealing the structure and electronic states of single photon sources in ZnO.