Abstract:
Defects provide potentials for quantum particles (electrons and holes) in crystals. In high purity crystals, the quantum-confined particles can behave similarly to atoms, enabling atomic-like physics in the solid state. In this seminar, I present results on two fundamental defects ubiquitous in semiconductors, the stacking fault and the substitutional donor. In both experiments, the high-purity of the semiconductor results in exceptionally sharp excitonic optical transitions that can be utilized to determine the fundamental properties of the defect-bound carriers.

In the first experiment, we show that stacking faults (SF) provide the most homogeneous 2D potential for excitons yet reported. The narrow transitions enable us to observe a magnetic non-reciprocity effect in which the energy of the excitonic emission depends on the sign of the magnetic field. This effect, due to conservation of the exciton two-dimensional momentum, provides evidence that excitons are mobile in this novel potential and enables a measurement of the giant SF exciton dipole moment (~10 nm). The large dipole moment combined with the high optical homogeneity demonstrates potential for stacking faults as a novel platform to study coherent phenomena in interacting excitonic gases.

If time permits, I will present recent results on spin lifetimes for electrons bound to substitutional donors. We measure the longitudinal relaxation (T1) in three semiconductors, GaAs, InP, and CdTe. Unexpectedly, the maximum observed T1 is similar in all materials (~1 ms) and the relaxation time is inversely proportional to B3. I will discuss the surprising implications of this result in terms of known spin-relaxation mechanisms in direct band gap semiconductors.

1T. Karin et al., “Fundamental properties of 2D excitons bound to single stacking faults in GaAs,” arxiv.org/abs/1601.03991 (2016)

Photo luminescence from excitons bound to stacking faults. Scale bar 10 µm.

Bio:
Kai-Mei Fu received her A.B. in Physics from Princeton University in 2000 and her M.S. and Ph.D. in Applied Physics from Stanford University in 2003 and 2007, respectively. She worked as a research associate at HP Labs, Palo Alto from 2007-2011 before joining the faculty at the University of Washington with a joint position in Physics and Electrical Engineering. Her research focuses on understanding and engineering the quantum properties of point defects in crystals for quantum information and sensing applications. She is the recipient of the NSF CAREER Award, the Cottrell Scholar Award, and the UW College of Engineering Junior Faculty Award.

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