

# Prof. Patanjali Kambhampati

*McGill University*

*“Excitons in Semiconductor Quantum Dots: Design principles for lasers, optical switches and LEDs”*



## Materials Seminar

UW Madison Department of Chemistry

The semiconductor quantum dot is one of the canonical systems in nanoscience. Whereas the nanometer size of these materials is obvious, the richer and more meaningful issue is the presence of quantum confinement effects conferred by virtue of size. One may qualitatively describe quantum dot electronic structure like the textbook particle in a sphere. However, this simple picture misses the vast majority of the processes which ultimately control the functionality of the quantum dot. Our goal is to obtain a detailed picture of the rich inner workings of the quantum dot. We recently introduced a mixed time/frequency domain ultrafast spectroscopic approach which we denote *State-Resolved Exciton Dynamics*. We have applied this approach to both resolving long standing controversies as well as revealing new processes, including:

- 1) Hot exciton relaxation dynamics: *radiationless transitions on the nanoscale*
- 2) Optical gain: *recovering predictions from theory and revealing new physics*
- 3) Electronic structure of multiexcitons: *a platform for ultrafast all-optical logic*
- 4) Understanding the surface of quantum dots: *a path towards quantum dot LEDs*

Our newer work extends these efforts based upon our new developments in fully automated coherent 2D electronic spectroscopy, featuring complete polarization shaping of femtosecond pulses. With this approach, we are able to produce the first demonstration of ultrafast all-optical switching in quantum dots as a first step towards optical logic.

Thursday  
April 18  
12:15 pm  
1315  
Chemistry