



UNIVERSITY OF MINNESOTA  
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# Department of Chemistry

## Special Seminar

4 p.m. Thursday, September 5, 2013 • 117/119 Smith Hall



Associate Professor

### Patanjali Kambhampati

Department of Chemistry  
McGill University

#### *Excitons in Semiconductor Quantum Dots: Design Principles for Lasers, Optical Switches, and LEDs*

Research focuses on ultrafast processes occurring in quantum dots.  
Website: <http://kambhampati-group.mcgill.ca/>

#### Abstract

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.

For more information, please visit: <http://kambhampati-group.mcgill.ca/> and recent review articles:

- 1) "Unraveling the structure and dynamics of excitons in semiconductor quantum dots", *Acc. Chem. Res.*, **44**, 1 (2011).
- 2) "Hot Exciton Relaxation Dynamics in Semiconductor Quantum dots: Radiationless Transitions on the Nanoscale", *J. Phys. Chem. C*, **115**, 22809 (2011).
- 3) "Multiexcitons in semiconductor nanocrystals: A platform for optoelectronics at high carrier concentration", *J. Phys. Chem. Lett.*, **3**, 1182 (2012).

Host: Associate Professor David Blank