# Department of Applied and Computational Mathematics and Statistics Colloquium


## Oleg Igoshin

Department of Bioengineering
Rice University


will give a lecture entitled:

## *Ultrasensitivity and stochasticity in bacterial networks*


## Abstract

Nonlinearities of rate laws describing biochemical reaction kinetics can often result in ultrasensitive switches in which small changes or fluctuations of parameters can lead to a large change in network output. Such switches are important for making robust cell decisions but can be detrimental for networks functioning in homeostasis and desiring noise minimization. In this presentation I'll discuss biological examples illustrating each of these cases. In the first story, with combination of mathematical modeling and bioinformatic data analysis, we show that noise minimization and avoidance of ultrasensitive switches explain operon organization of *E. coli*. We hypothesized that operons alter gene expression noise characteristics, resulting in selection for or against maintaining operons depending on network architecture. Mathematical models for 6 functional classes of network modules showed that 3 classes exhibited decreased noise and 3 exhibited increased noise with same-operon contranscription of interacting proteins. We employed bioinformatic analysis of *E. coli* chromosome to find overrespresentation of noise-minimizing operon organization compared with randomized controls. These results suggest a central role for gene expression noise in selecting for or against maintaining operons in bacterial chromosomes thereby providing an example of how the architecture of post-translational networks affects bacterial evolution. In the second story, with combination of mathematical modeling and single-cell microscopy, we show the existence and origins of ultrasensitivity in the network responsible for cell-fate decision in sporulating *B. subtilis*. We infer that under uncertain conditions cells initiate sporulation but postpone making the sporulation decision in order to average stochastic fluctuations and to achieve robust population response. These results illustrate how unique structure of the sporulation network allows fast and robust population level response despite cellular variability.


**Monday, September 9, 2013**
**4:00 p.m. to 5:00 p.m.**
**127 Hayes-Healy Center**

**Colloquium Tea** **3:30 p.m. to 4:00 p.m.** **154 Hurley Hall**