



# DEPARTMENT OF MATHEMATICAL SCIENCES

Week of November 26 - 30, 2018

## SIAM Speaker Series

**Bob LaBarre**

United Technologies Research Center

**Industrial Mathematics: An oxymoron or more than you know?**

Refreshments will be served.

**Monday, November 26, 2018  
6:00PM–7:00PM  
Stratton Hall 304**

## Discrete Mathematics Seminar

**Bill Martin**

WPI

**Title: The story of  $(T,M,S)$ -nets**

ABSTRACT: Quasi-Monte Carlo methods are used for numerical integration, simulation, and optimization. In contrast to the true Monte Carlo approach, where points are chosen at random, a quasi-Monte Carlo method employs deterministic point sets which are distributed “uniformly” with respect to some pre-specified statistics. These requirements often have combinatorial meaning. Such is the case with  $(T,M,S)$ -nets.

This talk focuses on the combinatorics and how I got involved in the subject. Beginning with the definition and small examples, we review the Schmid-Lawrence Theorem which connects  $(T,M,S)$ -nets to orthogonal arrays and error-correcting codes. In the 1990s, a puzzle arose as to whether these strange codes have meaningful duals. Doug Stinson and I answered this question and, bringing in the theory of association schemes, introduced the linear programming bound for  $(T,M,S)$ -nets, which proved to be quite powerful. The story involves an interesting assortment of researchers in a wonderful mix of geographic locations. So the slides emphasize this social aspect of the tale.

**Tuesday, November 27, 2018  
3:00PM–3:50PM  
Stratton Hall 203**

## Analysis and PDE Seminar Series

**Patricia Alfonso-Ruiz**

University of Connecticut

**Title: Diffusion processes on generalized diamond fractals**

ABSTRACT: In this talk we introduce (in some sense natural) diffusion processes on a parametric family of fractals called generalized diamond fractals. These spaces arise as scaling limits of diamond hierarchical lattices, which are studied in the physics literature in relation to random polymers, Ising and Potts models among others.

In the case of constant parameters, the self-similarity of the space can be exploited to obtain a canonical Dirichlet form and a diffusion process. This approach was taken in earlier investigations due to Hambly and Kumagai to study the properties of the diffusion process and its associated heat kernel. Alternatively, a diamond fractal can also be regarded as an inverse limit of metric measure graphs. This approach allows to construct a canonical diffusion process for more general parameters through a procedure proposed by Barlow and Evans. In addition, it turns out that it is possible to give a rather explicit expression of the associated heat kernel, which is in particular uniformly continuous and admits an analytic continuation.

**Thursday, November 29, 2018  
12:00PM–1:00PM  
Salisbury Labs 104**

## Seminar on Numerical Methods

**Calina Copos**

Courant Institute

**Title: Modeling the cell cytoplasm rheology in confined environments**

ABSTRACT: Microfluidic devices have found numerous applications in biology and medicine because of their ability to efficiently control and replicate microenvironments. Cell migration through microfluidic channels has gained interest as an experimental method for one-dimensional, directed migration and has been applied to study red blood cell flow, differentiation of cancer cells, and the role of interstitial flow in tumor cell migration. In such confined microenvironments, the rheology of the cytoplasm becomes an important factor in determining the escape time across the channel. With this goal in mind, we consider a poroelastic immersed boundary method in which a fluid permeates a porous, elastic structure of negligible volume fraction, and extend this method to include stress relaxation of a moving, deforming material. Finally, we use this modeling framework to study the passage of a cell through a microfluidic channel. In this confined experimental setup, we demonstrate that the rheology of the cell cytoplasm is important for capturing the transit time through a narrow channel in the presence of a pressure drop in the extracellular fluid.

**Thursday, November 29, 2018  
11:00AM–11:50AM  
Stratton Hall 203**

## **Colloquium**

**Anastasios Matzavinos**

**Brown University**

**Title: Mesoscopic modeling of polymer transport in an array of entropic barriers**

ABSTRACT: In this talk, we discuss dissipative particle dynamics (DPD) simulations of biological polymers (e.g., DNA molecules) dispersed by a pressure-driven fluid flow across a periodic array of entropic barriers. We compare our simulations with nanofluidic experiments, which show polymers transitioning between various types of behaviors as pressure increases, and discuss physical insights afforded by the ability of the DPD method to model flows at the nanoscale. We also consider anomalous diffusion phenomena that emerge in both experiment and simulation, and illustrate similarities between this system and Brownian motion in a tilted periodic potential. Finally, we formulate and analyze a continuous-time Markov process modeling the motion of the polymer across the entropic barriers. Our main result is a functional central limit theorem for the position of the polymer with an explicit formula for the effective diffusion coefficient in terms of the parameters of the model. A law of large numbers for the asymptotic velocity and large deviation estimates are also obtained.

**Friday, November 30, 2018  
11:00AM - 12:00PM  
Stratton Hall**