CAMS

Center for Applied Mathematics and Statistics

ANNUAL REPORT
2018 – 2019

July 1, 2018 – June 30, 2019

NJIT
New Jersey Institute of Technology

TABLE OF CONTENTS

I. FROM THE DIRECTOR

The Center for Applied Mathematics and Statistics (CAMS) is entering its 33nd year as a vehicle for research in applied mathematics and statistics at NJIT. CAMS supports faculty research by organizing colloquia, seminars and conferences and by facilitating group and interdisciplinary research proposals. We take particular pride in the undergraduate research that is supported by CAMS. NJIT Provost Fadi Deek has encouraged increased efforts at undergraduate research university wide, and CAMS and the Department of Mathematical Sciences are happy to take a leading role in this endeavor. CAMS combined with faculty from the Department of Computer Science and researchers in industry to obtain a six year NSF 'EXTREEMS' grant, which began in September 2013 and is now in its sixth and final summer of engaging undergraduates in research. The grant has enabled us to significantly enhance the exposure of undergraduate mathematical science students to topics in computational and data-enabled science and engineering.

Some of the other highlights and significant achievements of this past year include:

- Six new funded projects, including grants by the National Science Foundation and the National Institute of Health.

- The oversight of an additional thirty four continuing grants, from various agencies. CAMS receives substantial funding for graduate student and faculty research from sources such as the National Science Foundation, the Office of Naval Research, the Air Force Office of Scientific Research, NASA, DARPA, American Chemical Society, and other state and local agencies such as the NJ Meadowlands Commission and private industry.

- Hosting of the 16th Frontiers in Applied and Computational Mathematics (FACM) conference. The conference this year was carried out jointly with the 11th Northeast Complex Fluids and Soft Matter Workshop (NCS11). This event was attended by more than 120 participants, and focused on the topic of mathematical challenges in the applications involving particles in fluids, broadly taken. The presentations included discussions of novel topology-based methods, computations, as well as experimental advances, providing truly interdisciplinary setting.

As always, the accomplishments of CAMS have been built with the support and dedication of many individuals. We are grateful to Fadi Deek, Provost and Senior Vice President of Academic Affairs, Jonathan Luke, Department of Mathematical Sciences Chair, and Atam Dhawan, Senior Vice President for Research, for encouraging CAMS through their strong support of scientific research. Finally, we thank President Joel Bloom, who has been a constant source of support for CAMS and its mission. We look forward to continued fruitful interactions with these individuals in the upcoming year, as well as to significant contribution of CAMS to the newly formulated 2020 Vision: A Strategic Plan for NJIT.

Lou Kondic, Director • Cyrill Muratov, Associate Director

II. MISSION STATEMENT

The Center for Applied Mathematics and Statistics (CAMS) is an interdisciplinary research center dedicated to supporting applied research in the mathematical sciences at NJIT. CAMS was established in 1986 to promote research in the mathematical sciences at the New Jersey Institute of Technology. Members of the Department of Mathematical Sciences naturally form the core of CAMS membership, but the importance of mathematics for science and technology has made CAMS an interdisciplinary organization.

CAMS brings researchers from academia, industry, and government to NJIT by organizing interdisciplinary workshops and by bringing together researchers with common goals whose strengths are complementary. CAMS activities also include support for the submission of research proposals, which is done through dissemination of information, organization of group projects, collegial advice and assistance with application documents. Graduate student research is encouraged through the CAMS Summer Research Program and support for students to attend conferences. CAMS sponsors an annual conference, "Frontiers in Applied and Computational Mathematics," which has become a leading forum for the presentation of new research in applied mathematics and the sciences.

In the future, CAMS hopes and expects to maintain its high standards of professionalism and scholarship and plans to extend its activities to include fostering more research by undergraduate students and developing long-term relationships with industry.

Department of Mathematical Sciences
Advisory Board 2018 - 2019

Dr. John S. Abbott	Corning Incorporated
Dr. James Cai	Roche Innovation Center New York
Dr. Ned J. Corron	U.S. Army AMCOM
Mr. Erik Gordon	Trillium Trading, LLC
Dr. Richard Silberglitt	Rand Corporation

III. MEMBERS AND VISITORS

Department of Mathematical Sciences

Afkhami, Shahriar
Ahluwalia, Daljit S.
Askham, Travis
Bechtold, John
Blackmore, Denis
Booty, Michael
Bose, Amitabha
Boubendir, Yassine
Bukiet, Bruce
Bunker, Daniel
Choi, Wooyoung
Cummings, Linda
Deek, Fadi
Dhar, Sunil
Diekman, Casey
Fang, Yixin
Frederick, Christina
Golowasch, Jorge
Goodman, Roy
Guo, Wenge
Hamfeldt, Brittany
Horntrop, David
Jiang, Shidong
Johnson, Kenneth
Kappraff, Jay
Kondic, Lou
Loh, Ji Meng
Luke, Jonathan
Lushi, Enkeleida
Matveev, Victor
MacLaurin, James
Michalopoulou, Zoi-Heleni
Milojevic, Petronije
Muratov, Cyrill
Nadim, Farzan
Oza, Anand
Petropoulos, Peter
Russell, Gareth
Shirokoff, David
Siegel, Michael
Subramanian, Sundarraman
Sverdlove, Ronald
Turc, Catalin
Wang, Antai
Young, Yuan-Nan

Department of Civil and Environmental Engineering: Meegoda, Jay
Department of Mechanical & Industrial Engineering: Marras, Simone
Rosato, Anthony
Federated Department of Biological Sciences: Holzapfel, Claus (Rutgers University)
Rotstein, Horacio

CAMS External Faculty Members

Booth, Victoria	University of Michigan, Ann Arbor
Diez, Javier	University Nacional del Centro, Tandil, Argentina
Erneux, Thomas	Université Libre de Bruxelles, Belgium
Huang, Huaxiong	York University, Toronto, Canada
Moore, Richard	SIAM, Philadelphia
Papageorgiou, Demetrios	Imperial College, London
Tao, Louis	Peking University, China
Vanden-Broeck, Jean-Marc	University College London
Wylie, Jonathan	City University of Hong Kong

IV. COLLOQUIA AND SEMINARS

Applied Mathematics Colloquium/ Department of Mathematical Sciences Colloquium

September 7, **Arezoo Ardekani**, Purdue University
Transport of Motile Microorganisms and their Interactions with Surrounding Fluids

September 14, **Thilo Simon**, NJIT
A Nonlocal Isoperimetric Problem with Dipolar Repulsion

September 21, **Sanjoy Mahajan**, Olin College
Street-Fighting Mathematics for Better Teaching and Thinking

September 28, **Saverio Spagnolie**, University of Wisconsin - Madison
Deformable Bodies in Anisotropic Fluids

October 5, **Amitabha Bose**, NJIT
Towards an Understanding of How We Generate and Keep a Musical Beat

October 12, **Satish Kumar**, University of Minnesota
Dynamic Wetting Failure and Air Entrainment in Coating Flows

October 19, **Andrea Bertozzi**, UCLA
Swarming by Nature and by Design

October 26, **Charles Doering**, University of Michigan
Optimal Bounds and Extremal Trajectories for Time Averages in Nonlinear Dynamical Systems

November 2, **Esra Buyuktahtakin**, NJIT
A New Multi-Stage Stochastic Programming Model and Cutting Planes for the Optimal Surveillance and Control of Emerald Ash Borer in Cities

November 9, **Bjorn Engquist**, University of Texas
Fast Solvers for Frequency Domain Wave Propagation

November 16, **Casey Diekman**, NJIT
Using One-Dimensional Maps to Understand Circadian Oscillators and Jet Lag

November 30, **Thomas Wanner**, George Mason University
Bifurcation Diagram Verification for the Diblock Copolymer Model

December 7, **Abhyudai Singh**, University of Delaware
Systems Biology in Single Cells: A Tale of Two Viruses

January 25, **Leonid Rubchinksky**, Indiana University Purdue University Indianapolis (IUPUI)
Dynamics of Intermittent Neural Synchronization: Observations, Mechanisms, and Functions

February 1, **Russel Caflisch**, NYU Courant
Accelerated Simulation for Plasma Kinetics

February 8, **Gillan Queisser**, Temple University
Cross-Scale Modeling and Simulation of Biochemical and Electrical Signals in Neurons and Networks

February 15, **Benedetto Piccoli**, Rutgers University - Camden
Lagrangian and Sparse Control for Multi-Agents Dynamics and Traffic

February 22, **Lydia Bourouiba**, MIT
Unsteady Fluid Fragmentation

March 1, **Jeff Moehlis**, UCSB
Controlling Populations of Neural Oscillators

March 8, **Govind Menon**, Brown/IAS
Random Conformal Maps with Branching

March 15, **Judith R. Miller**, Georgetown University
Spatial Population Dynamics with Adaptation to a Heterogeneous Environment

March 29, **Daniel Harris**, Brown University
Forces on Capillary Disks

April 5, **Jörn Dunkel**, MIT
Wrinkles, Spaghetti & Knots

April 12, **Tepper Gill**, Howard University
A Little Physics, Can Lead to a Lot of Mathematics and Vis-Versa

April 26, **Francesco Maggi**, University of Texas
Almost Minimal and Almost Constant Mean Curvature Surfaces in Surface Tension Driven Phenomena

May 3, **Tore Magnus Arnesen Taklo**, NJIT
Resonance Between Surface and Internal Gravity Waves

Applied Statistics Seminar

September 20, **Yuexiao Dong**, Temple University
Model-Free Variable Selection with Matrix-Valued Predictors

September 27, **Samiran Ghosh**, Wayne State University
Non-Inferiority Trial Design with Placebo as Third Arm: What Should One Test for and Why does it Matter!

October 4, **Jingchen Liu**, Columbia University

A Fused Latent and Graphical Model

October 25, **Ruobin Gong**, Rutgers University
Modeling Uncertainty with Sets of Probabilities

November 1, **Zijian Guo**, Rutgers University
Semi-supervised Inference for Explained Variance in High-dimensional Linear Regression and Its Applications

November 15, **Ying Hung**, Rutgers University
Computer Experiments with Binary Time Series and Applications to Cell Biology: Modeling, Estimation and Calibration

November 29, **T.S.G. Peiris**, University of Moratuwa
Identification of Factors Related to Student's Anxiety in Learning Statistics

April 3, **Joshua Loftus**, Stern School of Business, New York University
Conditional Inference after Model Selection for Significance and Goodness of Fit Tests

April 25, **Qingfeng Liu**, Department of Economics, Otaru University of Commerce, Japan
Model Averaging Estimation for Nonlinear Regression Models

Mathematical Biology Seminar

September 18, **Pedro Vilanova**, NJIT Department of Mathematical Sciences
Information-based Variational Model Reduction of High-dimensional Reaction Networks

October 2, **Naomi Oppenheimer**, Flatiron Institute
Membrane Hydrodynamics - Passive Reactants and Active Proteins

October 16, **Adam Ponzi**, NJIT Department of Mathematical Sciences
Striatal Network Dynamics in Huntington's Disease

October 23, **Paula de Oliveira**, University of Coimbra
Recent Advances in Controlled Drug Delivery: the Roles of Mathematical Modeling

November 13, **Carlotta Mummolo**, NJIT Department of Biolmedical Engineering
Balance and Locomotion of Legged Systems Through Contact Interactions

November 20, **Mariano Marcano**, University of Puerto Rico
Modeling Hormone Regulation of Renal Flows

December 4, **David Tourigny**, Columbia University
Energetic Substrate Availability Regulates Synchronous Activity in an Excitatory Neural Network

December 11, **Kristen Severi**, NJIT Department of Biological Sciences
Locomotor Control in the Larval Zebrafish

January 29, **David Albers**, Columbia University
Data Assimilation Approaches Using Clinical Data to Forecast and Phenotype Glucose Dynamics

February 19, **Nir Krakauer**, CUNY/CCNY
Health Indicators with the New Anthropometrics

February 26, **Alessio Franci**, National Autonomous University of Mexico
Control Principles of Neuronal Excitability

March 26, **Simon Garnier**, NJIT Biological Sciences,
We the Swarm: Lessons in Problem-Solving from Tiny Brains and Neuron-Less Creatures

April 2, **Jean-Pierre Etchegaray**, Federated Department of Biological Sciences at Rutgers-Newark
Interplay Between Epigenetics and Transcription Regulate Embryonic Stem Cell Function

April 16, **Kristin Tessmar-Raible**, Universität Wien
Timing with Sun and Moon

May 16, **Birendra Nath Mallick**, School of Life Sciences, Jawaharlal Nehru University, New Dehli, India
Pros and Cons of Mathematical Model of Neural Network to Explain REM Sleep Regulation and Associated Patho-Physiology

Fluid Mechanics and Waves Seminars

October 15, **Mahadevan Ganesh**, Colorado School of Mines
An Efficient Bayesian Electromagnetism Algorithm

October 22, **Adam O'Brien**, University of Toronto
Immersed Boundary Simulations of Objects at Fluid-Fluid Interfaces

October 29, **Vincent Martinez**, Department of Mathematics & Statistics, CUNY-Hunter College
Asymptotic Coupling in Hydrodynamic Equations and Applications to Data Assimilation

November 5, **Ihsan Topaloglu**, Department of Mathematics & Applied Mathematics, Virginia Commonwealth University
Slow Diffusion Limit of Aggregation-Diffusion Energies and Their Gradient Flows

November 26, **Tonatiuh Sanchez-Vizuet**, Courant Institute of Mathematical Sciences
An Adaptive HDG Solver for Dirichlet Boundary Value Problems in Curved Domains: An Application to Plasma Equilibrium

December 3, **Quentin Brosseau**, New York University
The Dynamics of Asymmetric Microswimmers

February 11, **Joel Newbolt**, Department of Physics, New York University
Flow-Mediated Collective Dynamics in Flapping Swimmers

March 4, **Lee Ricketson**, Lawrence Livermore National Laboratory, Center for Applied Scientific Computing
Sparse Grid Techniques for Particle-in-Cell Simulation of Kinetic Plasma Dynamics

March 11, **Sebastian Furthauer**, Flatiron Institute
Moving Molecules to Living Matter: The Physics of the Cytoskeleton

March 25, **Antonio Perazzo**, Princeton University
Harnessing Flow-Microstructure Interactions to Design Soft Matter

April 15, **Lina Baroudi**, Manhattan College
Computational Study of the Early-Time Coalescence Dynamics of Two Liquid Drops

May 13, **Luis A. Pugnaloni**, Universidad Nacional de La Pampa
Granular Matter in Oil and Gas Production

V. PUBLICATIONS, PRESENTATIONS, AND REPORTS

A. PUBLICATIONS

JOURNAL PUBLICATIONS

Shahriar Afkhami

Thin Viscoelastic Dewetting Films of Jeffreys Type Subject to Gravity and Substrate Interactions (with V. Barra and L. Kondic), *European Physics Journal E*, Vol. 42, pp. 12, March 2019.

Breakup of Finite-Size Liquid Filaments: Transition from No-Breakup to Breakup Including Substrate Effects (with A. Dziedzic, M. Nakrani, B. Ezra, and M. Syed), *European Physics Journal E*, Vol. 42, pp. 18, March 2019.

Transition in a Numerical Model of Contact Line Dynamics and Forced Dewetting, *Journal of Computational Physics*, Vol. 374, August 2018.

Numerical Simulations of Nearly Incompressible Viscoelastic Membranes (with V. Barra and S. Chester), *Computers & Fluids*, Vol. 175, pp. 36-47, August 2018.

Simulations of Microlayer Formation in Nucleate Boiling, *International Journal of Heat and Mass Transfer*, Vol. 127, July 2018.

Interaction of a Pair of Ferrofluid Drops in a Rotating Magnetic Field (with M. Qiu and J. Feng), *Journal of Fluid Mechanics*, Vol. 846, pp. 121-142, July 2018.

Denis L. Blackmore

New Fractional Nonlinear Integrable Hamiltonian Systems (with O. Hentosh, B. Kyshakevych, and A. Prykarpatski), *Applied Mathematics Letters*, Vol. 88, pp. 41-49, January 2019.

Generalized Lie-Algebraic Structures Related to Integrable Dispersionless Dynamical Systems and Their Application (with O. Hentosh, Y. Prykarpatsky, and A. Prykarpatski), *Journal of Mathematical Science and Modelling*, Vol. 1, pp. 105-130, October 2018.

Reduced Pre-Lie Algebraic Structures, the Weak and Weakly Deformed Balinsky-Novikov Type Symmetry Algebras and Related Hamiltonian Operators (with O. Artemovych, A. Balinsky, and A. Prykarpatski), *Symmetry*, Vol. 10, pp. 601, November 2018.

A Novel Integrability Analysis of a Generalized Riemann Type Hydrodynamic Hierarchy (with A. Samoilenko, Y. Prykarpatsky, and A. Prykarpatski), *Miskolc Math. Notes*, Vol. 27, October 2018.

Michael R. Booty

Simulation of Surfactant-Mediated Tipstreaming in a Flow-Focusing Geometry (with J. K. Wrobel, M. S. Siegel, and Q. Wang), *Physical Review Fluids*, Vol. 3, pp. 43859, November 2018.

Amitabha K. Bose

A Neuromechanistic Model for Rhythmic Beat Generation (with A. Byrne and J. Rinzel), *PLOS Computational Biology*, Vol. 15, pp. e1006450, May 2019.

Short-Term Synaptic Dynamics Control the Activity Phase of Neurons in an Oscillatory Network (with D. Martinez, H. Anwar, D. M. Bucher, and F. Nadim), *eLife*, Vol 8, pp. e46911, June 2019.

Wooyoung Choi

On Resonant Interactions of Gravity-Capillary Waves without Energy Exchange (with M. Chabane), *Studies in Applied Mathematics*, Vol. 142, pp. 528-550, April 2019.

Linda J. Cummings

Surface, Interface, and Temperature Effects on the Phase Separation and Nanoparticle Self Assembly of Bi-Metallic Ni0.5Ag0.5: A Molecular Dynamics Study (with R. Allaire, A. Dhakane, R. Emery, P. Ganesh, P. Rack, L. Kondic, and M. Fuentes-Cabrera), *Nanomaterials*, Vol. 9, pp. 1040, June 2019.

Computing Dynamics of Thin Films via Large Scale GPU-Based Simulations (with L. Kondic and M. Lam), *Journal of Computational Physics X*, Vol. 2, pp. 100001, December 2018.

Membrane Filtration with Complex Branching Pore Morphology (with P. Sanaei), *Physical Review Fluids*, Vol. 3(9), pp. 94305, September 2018.

Casey O. Diekman

Cika Modulates the Effect of Kaia on the Period of the Circadian Oscillation in Kaic Phosphorylation (with M. Kaur, A. Ng, P. Kim, and Y. I. Kim), *Journal of Biological Rhythms*, Vol. 34, pp. 218-223, February 2019.

Neuronal Oscillations on an Ultra-Slow Timescale: Daily Rhythms in Electrical Activity and Gene Expression in the Mammalian Master Circadian Clockwork (with M. D.C. Bell), *European Journal of Neuroscience*, Vol. 48, pp. 2696-2717, October 2018.

Data Assimilation Methods for Neuronal State and Parameter Estimation (with M. J Moye), *Journal of Mathematical Neuroscience*, Vol. 8, pp. 13881, August 2018.

Christina A. Frederick

Image Reconstruction in Quantitative PAT with the Simplified P2 Approximation (with K. Ren and S. Vallelian), *SIAM J. Imaging Sci*, Vol. 11, pp. 2847-2876, December 2018.

An L2-Stability Estimate for Periodic Nonuniform Sampling in Higher Dimensions, *Linear Algebra and its Applications*, Vol. 555, pp. 361-372, October 2018.

Roy H. Goodman

NLS Bifurcations on the Bowtie Combinatorial Graph and the Dumbbell Metric Graph, *Discrete and Continuous Dynamical Systems*, Vol. 39, pp. 2203-2233, April 2019.

Wenge Guo

Control of Directional Errors in Fixed Sequence Multiple Testing (with A. Grandhi and J. Romano), *Statistica Sinica*, Vol. 29, pp. 1047-1064, April 2019.

Group Sequential BH and Its Adaptive Versions Controlling the FDR (with S. Sarkar, A. Chen, and L. He), *Journal of Statistical Planning and Inference*, Vol. 199, pp. 219-235, March 2019.

Brittany D. Hamfeldt

Convergence Framework for the Second Boundary Value Problem for the Monge-Ampere Equation, *SIAM Journal on Numerical Analysis*, Vol. 57, pp. 43556, April 2019.

Shidong Jiang

Finite-Element Method Solution of Non-Fickian Transport in Porous Media: the CTRW-FEM Package (with R. Ben-Zvi, H. Sher, and B. Berkowitz), *Groundwater*, Vo. 57, pp. 479-484, July 2018.

On Integral Equation Methods for the First Dirichlet Problem of the Biharmonic and Modified Biharmonic Equations in Nonsmooth Domains (with J. Helsing), *SIAM Journal on Scientific Computing*, Vol. 40, pp. A2609-A2630, July 2018.

The Anisotropic Truncated Kernel Method for Convolution with Free-Space Green's Functions (with L. Greengard, S. Jiang, and Y. Zhang), *SIAM Journal on Scientific Computing*, Vol. 40, pp. A3733-A3754, November 2018.

Lou Kondic

Surface, Interface, and Temperature Effects on the Phase Separation and Nanoparticle Self Assembly of Bi-Metallic Ni0.5Ag0.5: A Molecular Dynamics Study (with R. Allaire, A. Dhakane, R. Emery, P. Ganesh, P. Rack, L. J. Cummings, and M. Fuentes-Cabrera), *Nanomaterials*, Vol. 9, pp. 1040, June 2019.

Thin Viscoelastic Dewetting Films of Jeffreys Type Subject to Gravity and Substrate Interactions (with V. Barra and S. Afkhami), *European Physics Journal E*, Vol. 42, pp. 12, March 2019.

Computing Dynamics of Thin Films via Large Scale GPU-Based Simulations (with M. Lam and L. Cummings), *Journal of Computational Physics X*, Vol. 2, pp. 100001, December 2018.

Self-Assembly of a Drop Pattern from a Two-Dimensional Grid of Nanometric Metallic Filaments (with I. Cuellar, P. Ravazzoli, J. Diez, A. Gonzalez, N. Roberts, J. Fowlkes, and P. Rack), *Physical Review E*, Vol. 98, pp. 043101, October 2018.

Energy Dissipation in Sheared Wet Granular Assemblies (with L. Kovalcinova, S. Karmakar, M. Schaber, A.-L. Schuhmacher, M. DiMichiel, M. Brinkmann, and R. Seemann), *Physical Review E*, Vol. 98, pp. 32905, October 2018.

Zoi-Heleni Michalopoulou

Geoacoustic Inversion with Generalized Additive Models (with J. Piccolo and G. Haramuniz), *Journal of the Acoustical Society of America*, Vol. 145, pp. EL463-EL468, June 2019.

Multipath Broadband Localization, Bathymetry, and Sediment Inversion (with P. Gerstoft), *IEEE Journal of Oceanic Engineering*, pp. 43841, January 2019.

Richard O. Moore

Importance Sampling for Thermally Induced Switching and Non-Switching Probabilities in Spin-Torque Magnetic Nanodevices (with Y. Yu and C. Muratov), *IEEE Trans. Magn.*, Vol. 55, pp. 7205011, May 2019.

Cyrill B. Muratov

Importance Sampling for Thermally Induced Switching and Non-Switching Probabilities in Spin-Torque Magnetic Nanodevices (with Y. Yu and R. Moore), *IEEE Trans. Magn.*, Vol. 55, pp. 7205011, May 2019.

Walker Solution for Dzyaloshinskii Domain Wall in Ultrathin Ferromagnetic Films (with V. Slastikov, J. Robbins, and O. Tretiakov), *Phys. Rev. B*, Vol. 99, pp. 100403R, March 2019.

A Universal Thin Film Model for Ginzburg-Landau Energy with Dipolar Interaction, *Calc. Var. PDE*, Vol. 58, pp. 43466, February 2019.

Magnetic Domains in Thin Ferromagnetic Films with Strong Perpendicular Anisotropy (with H. Knuepfer and F. Nolte), *Arch. Rat. Mech. Anal.*, Vol. 232, pp. 727–761, November 2018.

A Multiple Scale Pattern Formation Cascade in Reaction-Diffusion Systems of Activator-Inhibitor Type (with M. Henry, and D. Hilhorst), *Interfaces Free. Bound.*, Vol. 20, pp. 297-336, July 2018.

Farzan Nadim

Distinct Co-Modulation Rules of Synapses and Voltage-Gated Currents Coordinate Interactions of Multiple Neuromodulators. (with X. Li and D. Bucher), *The Journal of Neuroscience : the Official Journal of the Society for Neuroscience*, Vol. 38, pp. 8549-8562, October 2018.

Short-Term Synaptic Dynamics Control the Activity Phase of Neurons in an Oscillatory Network (with D. Martinez, H. Anwar, A. K. Bose, and D. M. Bucher), *eLife*, Vol. 8, pp. e46911, June 2019.

Anand U. Oza

Hydrodynamic Spin States (with R. Rosales and and J. Bush), *Chaos: An Interdisciplinary Journal of Nonlinear Science*, Vol. 28, pp. 096106, September 2018.

Equilibrium Shapes and Their Stability for Liquid Films in Fast Flows (with L. Ganedi, M. Shelley, and L. Ristroph), *Physical Review Letters*, Vol. 121, pp. 94501, August 2018.

Horacio G. Rotstein

Inhibition-Based Relaxation Oscillations Emerge in Resonator Networks (with A. Bel and A. Torresi), *Mathematical Modeling of Natural Phenomena*, Vol. 14, pp. 405, May 2019.

Network Resonance: Impedance Interactions via a Frequency Response Alternating Map (FRAM) (with R. J. Leiser), *SIAM Journal of Applied Dynamical Systems (SIADS)*, Vol. 18, pp. 769-807, April 2019.

Membrane Potential Resonance in Non-Oscillatory Neurons Interacts with Synaptic Connectivity to Produce Network Oscillations (with A. Bel), *Journal of Computational Neuroscience*, Vol. 46, pp. 169-195, March 2019.

Ionic Current Correlations Are Ubiquitous Across Phyla (with T. Tran, C. T. Unal, L. Zaborszky, A. Kirkwood, and J. P. Golowasch), *Scientific Reports*, Vol. 9, pp. 1687, February 2019.

Subthreshold Amplitude and Phase Resonance in Single Neurons: 2D Models, *Encyclopedia of Computational Neuroscience*, December 2018.

Subthreshold Antiresonance and Antiphasonance in Single Neurons: 3D Models, *Encyclopedia of Computational Neuroscience*, December 2018.

Quadratization: from Conductance-Based Models to Caricature Models with Parabolic Nonlinearities (with A. G. R. Turnquist), *Encyclopedia of Computational Neuroscience*, November 2018.

Zuofeng Shang

Distributed Generalized Cross-Validation for Divide-And-Conquer Kernel Ridge Regression and Its Asymptotic Optimality, *Journal of Computational and Graphical Statistics*, Vol. 28, pp. 43466, May 2019.

David G. Shirokoff

Unconditional Stability for Multistep Imex Schemes: Practice (with D. Zhou and B. Seibold), *Journal of Computational Physics*, Vol. 376, pp. 295-321, January 2019.

Michael S. Siegel

Simulation and Validation of Surfactant-Laden Drops in Two-Dimensional Stokes Flow (with S. Palsson and A.-K. Tornberg), *Journal of Computational Physics*, Vol. 386, pp. 218-247, June 2019.

Deformation and Stability of a Viscous Electrolyte Drop in a Uniform Electric Field (with Q. Wang and M. Ma), *Physical Review Fluids*, Vol. 4, pp. 53702, May 2019.

Simulation of Surfactant-Mediated Tipstreaming in a Flow-Focusing Geometry (with J. K. Wrobel, M. R. Booty, and Q. Wang), *Physical Review Fluids*, Vol. 3, pp. 43859, November 2018.

Sundarraman Subramanian

Function-Based Hypothesis Testing in Censored Location-Scale Models, *Lifetime Data Analysis*, Vol. 27, pp. 43435, January 2019.

Catalin C. Turc

Harmonic Density Interpolation Methods for High-Order Evaluation of Laplace Layer Potentials in 2D and 3D, *Journal of Computational Physics*, Vol. 376, pp. 43374, October 2018.

Yuan-Nan Young

A Slightly Deformable Darcy Drop in Linear Flows (with Y. Mori and M. Miksis), *Physical Review Fluids*, Vol. 4, pp. 063601, June 2019.

PROCEEDINGS PUBLICATIONS

Denis L. Blackmore

The Dispersionless Integrable Systems and Related Conformal Structure Generating Equations of Mathematical Physics (with O. Hentosh, Y. Prykarpatsky, and A. Prykarpatski), Easy Chair, No. 624, February 2019.

Wooyoung Choi

Fifth-Order Nonlinear Spectral Model for Surface Gravity Waves: from Pseudo-Spectral to Spectral Formulations, *Workshop on Nonlinear Water Waves*, April 2019.

Casey O. Diekman

Experimental Validation of a Closed-Loop Respiratory Control Model Using Dynamic Clamp (with P. Thomas and C. Wilson), Conf Proc IEEE Eng Med Biol Soc., pp. 5273-5276, July 2018.

Ji Meng Loh

Impact of Mutation Operators on the Ratio of Equivalent Mutants (with A. Mili), International Conference on Intelligent Software Methodologies, Tools and Techniques (SOMET 2018), September 2018.

BOOKS AND BOOK CHAPTERS

Denis L. Blackmore

Pfeifer-Sato Solutions of Buhl's Problem and a Lagrange--d'Alembert Principle for Heavenly Equations (with O. Hentosh, Y. Prykarpatsky and A. Prykarpatski), *Nonlinear systems and their remarkable mathematical structures*, CRC Press, pp. 187 – 222, December 2018.

Roy H. Goodman

Mathematical Analysis of Fractal Kink-Antikink Collisions in the Phi-4 Model, Mathematical Analysis of Fractal Kink-Antikink Collisions in the Phi-4 Model, Springer-Verlag, pp. 75-91, February 2019.

B. PRESENTATIONS

Shahriar Afkhami

June 26, 2019: Basilisk/Gerris Users' Meeting, Sorbonne University, Paris, France
"Breakup of Finite Size Liquid Filaments Including Substrate Effects and Magnetophoretic Interaction of Ferrofluid Droplets,"

Travis L. Askham

March 26, 2019: Computational Methods for Integral Equations (MATH-GA 2840.001), New York University, New York, NY
"Eigenvalues and PDEs" (Guest Lecture in Graduate Seminar)

February 26, 2019: SIAM CSE, SIAM, Spokane, WA
"Fredholm Determinants: a Robust Approach to Computing Stokes Eigenvalues"

Denis L. Blackmore

June 20, 2019: Engineering Mechanics Institute Conference (EMI 2019), Engineering Mechanics Institute, California Institute of Technology, Pasadena, CA

1. "Recent Advances in Modeling, Analysis and Simulation of the Dynamics of Granular and Related Flow Fields"
2. "Stress Propagation in Granular Columns"

May 23, 2019: FACM'19 Conference: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
"PIV Measurement of Flow Induced on a Salt Waterbody by a Freshwater Source"

May 19-23, 2019: SIAM Conference on Applications of Dynamical Systems 19, Snowbird, UT

1. "A Dynamical Systems Based Hierarchy for Shannon, Metric and Topological Entropy"
2. "Analyzing Chaos in Walking Droplet Models"
3. "Complexity and Chaos in Higher Dimensional Lotka--Volterra Dynamics"

March 29, 2019: Mathematics Colloquium, Howard University, Washington, D.C.
"Analysis of Walking Droplet Dynamics: Amazing Complexity"

November, 2018: American Physical Society 71th Annual Division of Fluid Dynamics Meeting, American Physical Society, Atlanta, GA
"PIV Measurement of Flow Induced on a Salt Waterbody by a Freshwater Source"

Amitabha K. Bose

June, 2019: Rhythm Production and Perception Workshop, Travers City, MI
"A Neuromechanistic Model for Keeping a Simple Rhythmic Beat in the Context of Music"

May, 2019: SIAM Conference on Applications of Dynamical Systems, Snowbird, UT
"A Neuromechanistic Model for Keeping a Simple Rhythmic Beat in the Context of Music"

March 12, 2019: Complex Systems Seminar, University of Michigan, Ann Arbor, MI
"Towards a Neural and Mathematical Understanding of How We Generate and Keep a Musical Beat"

March 11, 2019: Quantitative Biology Seminar, University of Michigan, Ann Arbor, MI
"Understanding Entrainment Properties of Circadian Oscillator Models Using a One-Dimensional Map"

September 21, 2018: Mathematics Colloquium, Indiana University-Purdue University at Indianopolis, Indianapolis, ID
"Understanding Entrainment Properties of Circadian Oscillator Models Using a One-Dimensional Map"

July 14-17, 2018: Organization for Computational Neuroscience, OCNS, Seattle, WA

1. "Models for Perceiving and Learning Time Intervals and Rhythms"
2. "Reentrainment of the Circadian Pacemaker during Jet Lag: East-West Asymmetry and the Effects of North-South Travel" (Poster)

Daniel E. Bunker

June 22, 2019: Evolution 2019, Society for the Study of Evolution, Providence, RI
"Urban Plant Evolution: A Case-Study with Capsella Bursa-Pastoris in New York City" (Poster)

May 9, 2019: Federated Department of Biological Sciences Research Day 2019, NJIT Dept Biological Sciences, Newark, NJ
"Plant Evolution and Urbanization: Capsella Bursa-Pastoris Populations along an Urban-Rural Gradient in New York City."

November, 2018: American Physical Society 71st Annual Division of Fluid Dynamics Meeting, American Physical Society, Atlanta, GA
"PIV Measurement of Flow Induced on a Salt Waterbody by a Freshwater Source"

Wooyoung Choi

June 19, 2019: Seminar, Pusan National University, Korea
"Nonlinear Resonant Wave Interactions and Their Applications"
September 5, 2018: Mini-Symposium on Interfacial Waves, European Dynamics Days, Loughborough University, Loughborough, UK
"Asymptotic Models for Coupled Surface and Internal Waves and Their Resonant Interactions"

September 4, 2018: Mini-Symposium on Dispersive Hydrodynamics, European Dynamics Days, Loughborough, UK
"On Resonant Interactions of Gravity-Capillary Waves without Energy Exchange"

Sunil K. Dhar

September 14, 2018: Michigan State Symposium on Mathematical Statistics and Applications, National Science Foundation and Institute of Mathematical Statistics, Breslin Student Events Center, Michigan State University
"In Honor of Hira L. Koul's Scientific Legacy"

Casey O. Diekman

April 29, 2019: Institute for Brain & Neuroscience Research Showcase, NJIT, Newark, NJ
1. "Data Assimilation Methods for Neuronal State and Parameter Estimation" (Poster)
2. "Mathematical Modeling of Cyanobacterial Circadian Oscillations" (Poster)
3. "Overview of Circadian Clock Research Consortium"

February 28, 2019: STEM Faculty Research Presentations, Garden State LSAMP, Essex County College, Newark, NJ
"Mathematical Modeling of Circadian Rhythms in Cancer Therapy"

November 26, 2018: Center for Computational and Applied Mathematics (CCAM) Seminar, Purdue University, West Lafayette, IN
"Mathematical Modeling of Circadian Rhythms: Gene Expression, Membrane Excitability, and Jet Lag"

July 28, 2018: Tutorial Workshop on Parameter Estimation for Biological Models, North Carolina State University, Raleigh, NC
"Data Assimilation Methods for Neuronal State and Parameter Estimation" (Poster)

July 14, 2018: Organization for Computational Neuroscience, OCNS, Seattle, WA
"Reentrainment of the Circadian Pacemaker during Jet Lag: East-West Asymmetry and the Effects of North-South Travel" (Poster)

Christina A. Frederick

May 12, 2019: BIRS: Women In Numerical Methods for PDEs and their Applications, Banff International Research Station, Banff, Canada
"Acoustic seafloor classification using machine learning and FEM simulations"

November, 2018: 176th Meeting of the Acoustical Society of America and 2018 Acoustics Week, Acoustical Society of America, Victoria, BC, Canada
"Acoustic Seafloor Classification Using Machine Learning and Simulation"

Roy H. Goodman

April, 2019: IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, Athens, GA
"NLS Bifurcations on the bowtie combinatorial graph and the dumbbell metric graph"

March, 2019: Applied Math Seminar, Drexel University, Philadelphia, PA
"NLS Bifurcations on the bowtie combinatorial graph and the dumbbell metric graph"

October, 2018: Analysis and PDE Seminar, University of North Carolina, Chapel Hill, NC
"NLS Bifurcations on the bowtie combinatorial graph and the dumbbell metric graph"

October, 2018: Fall Midwest Regional Meeting, American Mathematical Society, Ann Arbor, MI
"NLS Bifurcations on the bowtie combinatorial graph and the dumbbell metric graph"

Wenge Guo

June 1, 2019: 2019 Symposium on Data Science & Statistics, American Statistical Association and Interface Foundation of North America, Bellevue, WA
"Multiple Hypotheses Testing for Discrete Data - `MHTdicsrete' R Package"

December 28, 2018: Data Science Seminar, Mingzu University of China, Beijing, China
"FDR Controlling Procedures for Testing Hierarchically Ordered Hypotheses"

Brittany D. Hamfeldt

September 18, 2018: Monge-Ampere solvers with applications to illumination optics, Eindhoven University of Technology, Eindhoven, Netherlands
"A Viscosity Framework for Solving the Second Boundary Value Problem for the Monge-Ampere Equation"

August 28, 2018: Numerical Analysis Seminar, University of Maryland, University of Maryland
"Convergent Numerical Methods for the Second Boundary Value Problem for the Monge-Ampere Equation"

August 24, 2018: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
"Beam Shaping Using Optimal Transport"

Kenneth A. Horwitz

November 13, 2018: Lunch at ITE Session, ITE, NJIT, Newark, NJ
"Encouraging OER Adoptions: Experiences with the NJIT's Open Textbook Initiative"

Lou Kondic

May 30, 2019: Summer School on Capillarity-driven Flows in Microfluidics, Twente University, Enschede, Netherlands
"Films on Thermally Conductive Substrates I and II"

April 25, 2019: BIRS Workshop on Modeling of Thin Liquid Films - Asymptotic Approach versus Gradient Dynamics, BIRS Center, Banff, Alberta, Canada
"Modeling Liquid Crystal Films on Nanoscale"

March 25, 2019: Lorentz Center Workshop on Granular Matter across scales, Lorentz Center, Leiden, Netherlands
"Quantifying Interaction Networks in Particulate Systems"

February 1, 2019: Seminar, Dept. of Physics, Rutgers University, Newark, NJ
"Modeling Thin Liquid Films: from Liquid Crystals to Liquid Metals"

November 18-20, 2018: 71st Annual Meeting of the American Physical Society Division of Fluid Dynamics, American Physical Society Division of Fluid Dynamics, Atlanta, Georgia

1. "Quantitative Modeling of Growth of Colloid Nuclei" (Poster)
2. "Stability of Fluid Films of Nanoscale Thickness Involving Contact Lines"
3. "Quantitative Modeling of Growth of Colloid Nuclei" (Poster)

November 1, 2018: Seminar, Dept. of Physics, Rutgers University, Piscataway, NJ
"Modeling Thin Liquid Films: from Liquid Crystals to Liquid Metals"

October, 2018: Annual Meeting of American Society for Gravitational and Space Research, American Society for Gravitational and Space Research, Washington, DC
"Growth of Colloid Nuclei"

October 5, 2018: 55th SES Annual Technical Meeting, University Carlos III, Madrid, Spain
1. "Force Networks and Stick-Slip Dynamics"
2. "Loss of Memory and Correlation in Dense Sheared Particulate Systems"

October 1, 2018: Seminar, Department of Physics, University of Navarra, Pamplona, Spain
"Percolation and Persistence of Compressed Granular Matter"

August 1, 2018: Seminar, Department of Mathematics, University of Buenos Aires, Buenos Aires, Argentina
"Percolation and Persistence of Compressed Granular Matter"

Ji Meng Loh

September 29, 2018: Workshop on Point Process Models, Texas A&M, IAMCS, STATMOS, NISS, College Station, TX
"Weighted PSVM for Inhomogeneous Spatial Point Processes"

James N. MacLaurin

October 5, 2018: AMS Delaware Section Meeting, University of Delaware, Newark, DE
"Phase Reduction of Biochemical Oscillations"

August 10, 2018: FACM, NJIT, Newark, NJ
"Stochastic Traveling Waves in Neuroscience"

Victor V. Matveev

June 28, 2019: Department of Information Engineering Seminar, University of Padova, Italy
"Accuracy of Mass-Action vs. Stochastic Modeling of Ca2+-Dependent Vesicle Release"

June 25, 2019: International Conference for Mathematical Neuroscience, Copenhagen, Denmark
"Accuracy of Mass-Action vs. Stochastic Modeling of Calcium-Dependent Vesicle Release"

March 4, 2019: 63rd Annual Meeting of the Biophysical Society, Biophysical Society, Baltimore, MD
"Pade Approximation of Single-Channel Ca2+ Nanodomains in the Presence of Cooperative Ca2+ Buffers" (Poster)

July 15, 2018: Annual Meeting of the Organization for Computational Neuroscience, Seattle, WA
"Mass-Action vs Stochastic Simulations of Ca2+ Dependent Vesicle Release Latency" (Poster)

Zoi-Heleni Michalopoulou

May, 2019: Meeting of the Acoustical Society of America, Acoustical Society of America, Louisville, KY
"Bayesian Inference for Water Column and Sediment Inversion in Ocean Acoustics"

February 28, 2019: SIAM Conference on Computational Science and Engineering, SIAM, Spokane, WA
"Shallow Water Inversion with Sequential Filtering and Linearization"

November, 2018: Meeting of the Acoustical Society of America, Victoria, BC, Canada
1. "Acoustic Seafloor Classification Using Machine Learning and Simulations of Helmholtz Equations"
2. "Sequential Filtering and Linearization for Inversion in the Seabed Characterization Experiment"

Richard O. Moore

August 15, 2018: Mathematics Seminar, Departamento de Matematica, Universidad Nacional de San Martin, Buenos Aires, Argentina
"Rare Event Techniques in Stochastic Nonlinear Wave Equations"

Cyrill B. Muratov

May, 2019: 12th International Symposium on Hysteresis Modeling and Micromagnetics, University of Crete, Heraklion, Greece
"Multidomain States in Ultrathin Ferromagnetic Films with Strong Perpendicular Magnetic Anisotropy"

April, 2019: AMS Sectional Meeting, Special Session on Modeling and Qualitative Study of PDEs from Materials Science and Geometry, NSF, Hartford, CT
"Analysis of Novel Domain Wall Types in Ferromagnetic Nanostructures"

March, 2019: Workshop on Mathematical Models for Pattern Formation, Carnegie Mellon University, Pittsburgh, PA
"The Mathematics of Charged Drops"

January, 2019: Workshop on Optimal Design of Complex Materials, Isaac Newton Institute, Cambridge, UK
1. "Analysis of Novel Domain Wall Types in Ferromagnetic Nanostructures"
2. "The Mathematics of Charged Drops"

November, 2018: Analysis, Logic and Physics Seminar, Richmond, VA
"The Mathematics of Charged Liquid Drops"

September, 2018: PDE seminar, University of Pisa, Pisa, Italy
"Analysis of Novel Domain Wall Types in Ferromagnetic Nanostructures"

Padma Natarajan

February 26, 2019: Lunch at ITE Session, ITE, NJIT, Newark, NJ
"Grading and Assessment Tools for Instructional Technology Toolbox"

November 13, 2018: Lunch at ITE Session, ITE, NJIT, Newark, NJ

"Encouraging OER Adoptions: Experiences with the NJIT's Open Textbook Initiative"

Anand U. Oza

June 21, 2019: Soft Materials Coffee Hour, Department of Chemical Engineering, Princeton University, Princeton, NJ
"Coarse-Grained Models for Interacting Flapping Swimmers"

June 13, 2019: Mathematical Fluids, Materials, and Biology, National Science Foundation, University of Michigan, Ann Arbor, MI
"Coarse-Grained Models for Interacting Flapping Swimmers"

June 11, 2019: NJIT Graduate Student Seminar, NJIT Department of Mathematical Sciences, Newark, NJ
"Wave-Particle Interaction in Active Systems"

June 10, 2019: REU Mathematical Sciences Bootcamp, Mathematical Biosciences Institute, Ohio State University, Columbus, OH
"Memory in Physical and Biological Systems"

May 19, 2019: SIAM Conference on Applications of Dynamical Systems, Snowbird, UT
"Dynamical Models for Interacting Flapping Swimmers"

March 6, 2019: American Physical Society March Meeting, Boston, MA
"Equilibrium Shapes and Their Stability for Liquid Films in Fast Flows"

November 18, 2018: American Physical Society Division of Fluid Dynamics Meeting, Atlanta, GA
"Equilibrium Shapes and Their Stability for Liquid Films in Fast Flows"

November 16, 2018: Applied Math Seminar, Courant Institute of Mathematical Sciences, New York University, New York, NY
"Coarse-Grained Models for Interacting Flapping Swimmers"

October 31, 2018: NJIT Mechanical and Industrial Engineering Seminar, NJIT Department of Mechanical and Industrial Engineering, NJIT, Newark, NJ
"Course-Grained Models for Interacting Flapping Swimmers"

September 29, 2018: American Mathematical Society Fall Eastern Sectional Meeting, American Mathematical Society, University of Delaware, Newark, DE
"Traveling Waves in a Continuum Model of 1D Schools"

July 23, 2018: Hydrodynamic Quantum Analogues VIII, Brown University, Providence, RI
"Interacting Walkers and Spin States"

Horacio G. Rotstein

April 29, 2019: Institute for Brain & Neuroscience Research Showcase, NJIT, Newark, NJ
"Mathematical Modeling of Cyanobacterial Circadian Oscillations" (Poster)

April 11, 2019: Colloquium, Fields/Krembil via a KCN/CMM, Toronto, ON, Canada
"Inhibition-Based Theta Resonance in a Hippocampal Network"

February 25, 2019: Computational Neuroscience & Neuronal Oscillations Journal Club, NJIT, Newark, NJ
"Feedback Processes across Levels of Organization in Neuronal Systems"

February 22, 2019: Applied Mathematics Colloquium, University of Arizona, Tucson, AZ,
"Resonance-Based Mechanisms of Generation of Oscillations in Networks of Non-Oscillatory Neurons"

November 3-7, 2018: Annual Meeting of the Society for Neuroscience, San Diego, CA

1. "Modification of Ion Channel Gene Expression Regulates the Expression of Multiple Ionic Currents" (Poster)
2. "Distinct Mechanisms Underlie Electrical Coupling Resonance and Membrane Potential Resonance" (Poster)

September 26, 2018: Bernstein Conference on Computational Neuroscience, Workshop on 'Resonance in neurons and neural networks: theoretical and experimental approaches', Bernstein Network, Berlin, Germany
"From Subthreshold Neuronal Resonance to Network Resonance"

September 18, 2018: Reunion de la Union Matematica ArgentinaUMA, La Plata, Buenos Aires, Argentina
"Resonant Nodes Generate Oscillations in Networks with Graded Connectivity"

September 5, 2018: Cognitive Computational Neuroscience Conference, Philadelphia, PA
"A Dynamical Systems Model of Intrinsic and Evoked Activity, Variability and Functional Connectivity"

August 14, 2018: Departement of Mathematics, UNS and INMABB, CONICET, Argentina,
"Resonance-Based Mechanisms of Generation of Oscillations in Networks of Non-Oscillatory Neurons"

August 8, 2018: Intituto del Calculo, FCEN, UBA-CONICET, Argentina,
"Resonance-Based Mechanisms of Generation of Oscillations in Networks of Non-Oscillatory Neurons"

July 24, 2018: Neurobiology of Cognition Gordon Conference / Neural Circuits Supporting Cognitive Function, Newry, ME
"A Dynamical Systems Model of Intrinsic and Evoked Activity, Variability and Functional Connectivity" (Poster)

David G. Shirokoff

March 13, 2019: Recent Advances in Pure and Applied Statistics, Tulane University, New Orleans LA
"Conic Programming for a Variational Inequality Arising in Self-Assembly"

February 28, 2019: SIAM Conference on Computational Science and Engineering, Spokane, WA
"Devising Unconditionally Stable Multistep IMEX Schemes That Avoid Stiff Nonlinear Implicit Terms"

January 23, 2019: WONAPDE 2019: Sixth Chilean Workshop on Numerical Analysis of Partial Differential Equations, Concepcion, Chile
"Unconditional Stability for Multistep IMEX Schemes"

October 16, 2018: Afonso Bandeira group meeting, Courant Institute, New York University, New York, NY

"Convex Relaxations for Variational Problems Arising from Models of Self-Assembly"

October 2, 2018: Lunch @ ITE series, NJIT, Newark, NJ
"The History of Calculus: Integrating Historical Content into Modern Curricula"

September 28, 2018: Princeton Day of Optimization, Princeton, NJ
"Convex Relaxations for Variational Problems Arising from Self-Assembly" (Poster)

July 13, 2018: International Conference on Spectral and High Order Methods, London, England
"Overcoming Order Reduction via Weak Stage Order"

July 11, 2018: SIAM Conference on Mathematical Aspects of Material Science, Portland, OR
"Conic Programming of a Variational Problem Arising from the Large Deviations Limit of the Boltzmann Distribution"

July 10, 2018: SIAM Annual Meeting, Portland, OR
"Efficient Solvers for Some Conic Variational Problems"

Michael S. Siegel

February 28, 2019: SIAM Conference on Computational Science and Engineering, Spokane, WA
"Numerical Simulations of Two-Phase Flow of Electrolyte Drops"

November 8, 2018: Colloquium, Center for Nonlinear Analysis, Carnegie Mellon University, Pittsburgh, PA
"Accurate and Efficient Boundary Integral Computations for Interfacial Flow with Surfactant"

July 29, 2018: Numerical Analysis of Coupled and Multi-Physics Problems with Dynamic Interfaces, CMO, BIRS, NSF and NRC Canada, Oaxaca
"Accurate and Efficient Boundary Integral Computations for Interfacial Flow with Surfactant"

Yuan-Nan Young

July 9, 2018: SIAM Conference on Mathematical Aspects of Material Science, SIAM, Portland, OR
"Long-Range Interaction Mediated Dynamics of a System of Active Janus Particles: an Integral Equation Approach"

VI. EXTERNAL ACTIVITIES AND AWARDS

A. FACULTY ACTIVIES AND AWARDS

Shahriar Afkhami

Associate Editor, Journal of Engineering Mathematics, January 2016 - Current

Member, Pi Mu Epsilon Honorary Society, November 2010 - Current

Member, Society for Industrial and Applied Mathematics, September 2009 - Current

Member, European Mechanics Society, January 2006 - Current

Member, American Physical Scociety, January 2005 - Current

Travis L. Askham

Member, Society for Industrial and Applied Mathematics, January 2011 - Current

Manish Bhattacharjee

Member, Calcutta Statistical Association, Current

Denis Blackmore

Associate Editor, Mechanics Research Communications, 2007 - Current

Editorial Board, Universal Journal of Physics and Application, 2015 - Current

Editorial Board, Atlantis/Springer Advanced Book Series: Studies in Mathematical Physics: Theory and Applications, 2011 - Current

Editorial Board, Journal of Nonlinear Mathematical Physics, 2010 - Current

Editorial Board, Differential Equations and Applications, 2008 - Current

Editorial Board, Regular and Chaotic Dynamics, 2006 - Current

Editorial Board, Mathematical Bulletin of the Shevchenko Scientific Society, 2005 - Current

Member, Society for Industrial and Applied Mathematics, Current

Member, American Mathematical Society, Current

Member, Mathematical Association of America, Current

Member, International Association of Mathematical Physics, Current

Member, Gesellschaft für Agewandte Mathematik und Mechanik, Current

Member, Pi Mu Epsilon, Current

Member, Sigma Xi, Current

Michael R. Booty

Member, American Institute of Chemical Engineers, August 2017 - Current

Member, American Institute of Aeronautics and Astronautics, Current

Member, American Physical Society, Current

Member, Society for Industrial and Applied Mathematics, Current

Member, The Combustion Institute, Current

Bruce G. Bukiet

Backpage Problem Editor, Association of Math Teachers of New Jersey, 2007 - Current

Member, National Council of Teachers of Mathematics, 2005 - Current

Member, Institute for Operations Research and Management Science, 2004 - Current

Member, Association of Math Teachers of New Jersey, 1999 - Current

Member, Mathematical Association of America, 1990 - Current

Member, Center for Applied Mathematics and Statistics, 1989 - Current

Member, American Physical Society, 1988 - Current

Member, Society for Industrial and Applied Mathematics, 1984 - Current

Member, Sigma Xi, 1980 - Current

Daniel E. Bunker

Member, American Association for the Advancement of Science, January 2016 - Current

Graduate Faculty, Rutgers - New Brunswick; Ecology and Evolution Graduate Program, April 2009 – Current

Linda J. Cummings

Member, American Physical Society, September 2014 - Current

Associate Editor of *IMA Journal of Applied Mathematics*, Institute of Mathematics and its Applications, London, July 2011 - Current

Member, Biophysical Society, January 2010 - Current

Casey O. Diekman

Member, Society for Applied and Industrial Mathematics, July 2014 - Current

Member, Society for Mathematical Biology, July 2014 - Current

Member, Society for Neuroscience, July 2014 - Current

Roy H. Goodman

Long Term Visitor, New York University Tandon School of Engineering, September 2018 - Current

Member, American Mathematical Society, Current

Wenge Guo

Member, International Indian Statistical Association, 2011 - Current

Member, International Chinese Statistical Association, 2010 - Current

Member, Institute of Mathematical Statistics, 2006 - Current

Member, American Statistical Association, 2005 - Current

Brittany D. Hamfeldt

Member, Society for Industrial and Applied Mathematics, 2014 - Current

Member, Association for Women in Mathematics, 2013 - Current

David J. Horntrop

Member, American Mathematical Society, June 1988 - Current

Member, Society for Industrial and Applied Mathematics, June 1988 - Current

Kenneth A. Horwitz

Member, Association of Math Teachers of New Jersey, February 2018 - Current

Member, Association for Supervision and Curriculum Development, September 2013 - Current

Member, National Council of Teachers of Mathematics, September 2013 - Current

Shidong Jiang

Member, Society for Industrial and Applied Mathematics, October 2012 - Current

Member, American Mathematical Society, January 1999 - Current

Jay M. Kappraff

President of NJIT chapter, Sigma Xi, September 2007 - Current

Member of the Editorial Board of ISIS Symmetry Journal, ISIS Symmetry, September 2003 - Current

Member, Mathematics association of America, Current

Lou Kondic

Member, European Mechanics Society, September 2005 - Current

Member, Society for Industrial and Applied Mathematics, September 2000 - Current

Fellow, American Physical Society, September 1994 - Current

Ji Meng Loh

Member, International Chinese Statistical Association, November 2012 - Current

Member, Institute of Mathematical Statistics, October 2009 - Current

Jonathan H. Luke

Member, Society for Applied and Industrial Mathematics, 1986 - Current

Member, American Mathematical Society, 1981 - Current

Member, American Physical Society, 1980 – Current

Simone Marras

Associate Editor, *Quarterly Journal of the Royal Meteorological Society*, 2018 - Current

Topical Editor, Geoscientific Model Development, Copernicus EGU, 2014 - Current

Victor V. Matveev

Member, Society for Industrial and Applied Mathematics, October 2014 - Current

Member, American Association for the Advancement of Science, January 2011 - Current

Member, Society for Mathematical Biology, August 2004 - Current

Member, Biophysical Society, September 2003 - Current

Member, Society for Neuroscience, September 1996 - Current

Richard O. Moore

Member, American Mathematical Society, January 2004 - Current

Member, Optical Society of America, February 1999 - Current

Member, Society for Industrial and Applied Mathematics, January 1999 - Current

Cyrill B. Muratov

Member, Materials Research Society, November 2018 - Current

Member, Society for Industrial and Applied Mathematics, January 2000 - Current

Farzan Nadim

Member, American Physiological Society, September 2005 - Current

Member, Society for Industrial and Applied Mathematics, September 1999 - Current

Member, Society for Neuroscience, September 1994 - Current

Padma Natarajan

Member, American Statistical Association, October 2017 - Current

Anand U. Oza

Member, American Physical Society, October 2012 - Current

Member, Society for Industrial and Applied Mathematics, December 2009 - Current

Roy A. Plastock

Member, Mathematical Association of America, Current

Horacio G. Rotstein

Member, Organization for Computational Neuroscience, May 2011 - Current

Member, American Mathematical Society, January 2001 - Current

Member, Society for Industrial and Applied Mathematics, January 2001 - Current

Member, Society for Mathematical Biology, January 2001 - Current

Member, Society for Neuroscience, January 2001 - Current

David G. Shirokoff

Member, Society for Industrial and Applied Mathematics, January 2015 - Current

Sundarraman Subramanian

Member, American Statistical Association, Current

Member, Institute of Mathematical Statistics, Current

Life Member, International Indian Statistical Association, Current

Antai Wang

Member, American Statistical Association, August 1999 - Current

B. FACM 2019 CONFERENCE: FRONTIERS IN APPLIED AND COMPUTATIONAL MATHEMATICS

The sixteenth conference on Frontiers in Applied and Computational Mathematics, under the abbreviated title FACM 2019, was held at the New Jersey Institute of Technology on May 23 - 24. This year conference was organized jointly with the 11th Northeast Complex Fluids and Soft Matter Workshops (NCS11). The conference was supported jointly by the National Science Foundation Programs in Mathematical Sciences within the Division of Mathematical and Physical Sciences and by the Program in Particulate and Multiphase Processes within the Division of Chemical, Bioengineering, Environmental and Transport Systems (CBET) grant No. DMS 1903321. We thank NSF for their support that has allowed us to organize an impactful event!

FACM 2019/NCS11 focused on the topic of mathematical challenges in the applications involving particles in fluids, broadly taken. Due to joint organization with NCS11, there was a significant participation of junior scientists from the Northeast, including participants from engineering and other applied disciplines, leading to a truly interdisciplinary environment. The conference focused on recent progress in mathematical methods used for modeling and simulating problems where particles in fluids were involved, including discussion of novel topological methods, computations, and recently developed models used for describing these complex systems. The conference had a total of 126 participants and included 4 plenary speakers, 28 invited presentations, 42 poster presentations, as well as a very successful session focusing on Career Advice for Junior Researchers.

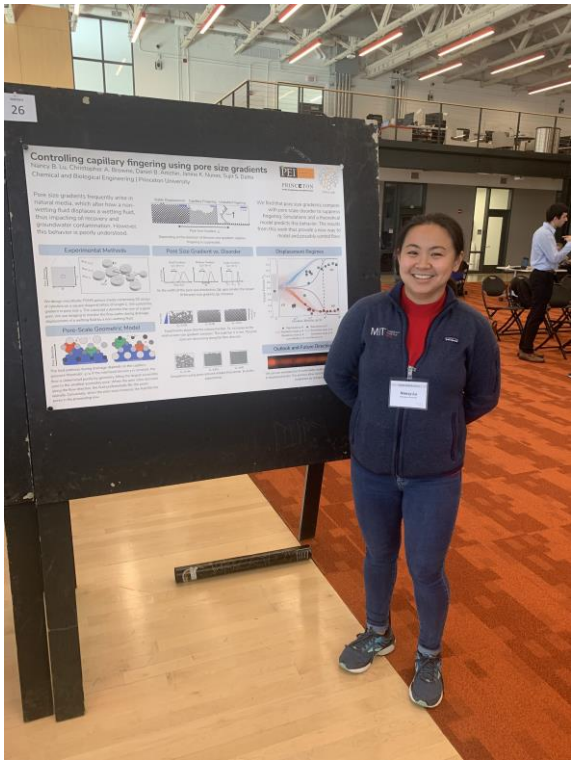
The plenary speakers and titles of their talks were as follows:

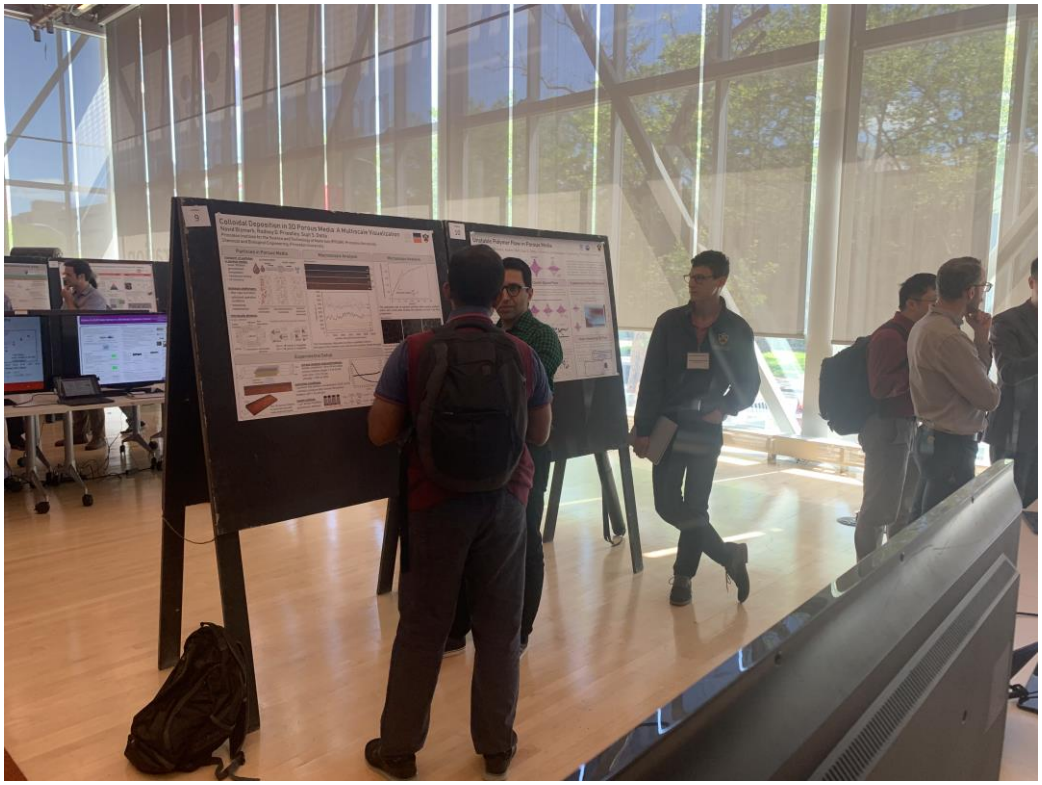
- Igor Aronson, Pennsylvania State University, "Engineering Spatial-Temporal Organization of Bacterial Suspensions"
- John Brady, California Institute of Technology, "The Dynamics of Active Colloids"
- Michael Shearer, North Carolina State University, "Continuum Equations of Granular Flow"
- Kathleen Stebe, University of Pennsylvania, "Embedded Energy Landscapes in Soft Matter to Direct Colloid Motion''

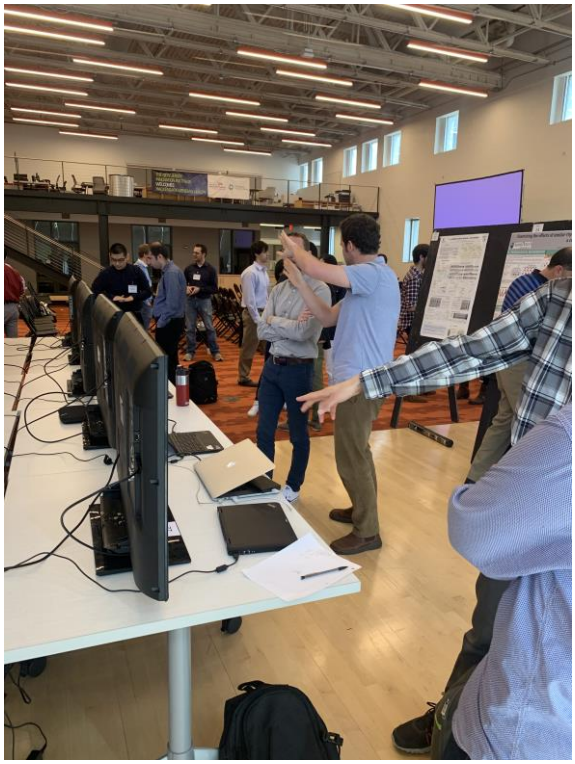
The organizing committee for this year's conference was: Denis Blackmore, Michael Booty, Shawn Chester, Linda Cummings, Lou Kondic (Chair), Jonathan Luke, Enkeleida Lushi, Anand Oza, Anthony Rosato, Michael Siegel, Pushpendra Singh, and Yuan-Nan Young.

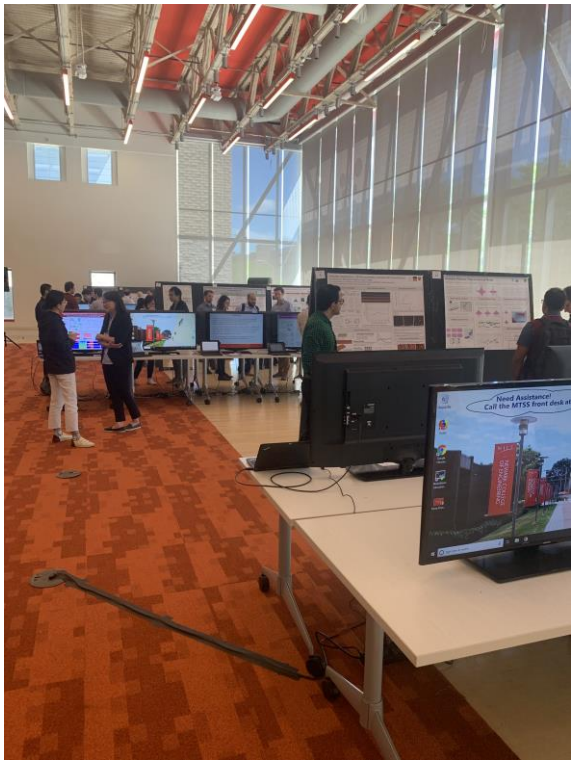
Photos from FACM 2019

Group Photo from FACM 2019 (above) and Photos from the Poster Session (below)




Colloidal Deposition in 3D Porous Media: A Multiscale Visualization




Need Assistance!
Call the MTSS front desk at

VII. FUNDED RESEARCH

A. EXTERNALLY FUNDED RESEARCH

CONTINUING FUNDED PROJECTS

Efficient High Frequency Integral Equations and Iterative Methods
National Science Foundation: August 1, 2017 - July 31, 2020
Yassine Boubendir

NSF INCLUDES DDLP: Leadership and iSTEAM for Females in Elementary school (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM
National Science Foundation: April 1, 2018 - March 31, 2020
Bruce Bukiet

Colaborative Research: Nonlinear Interactions between Surface and Internal Gravity Waves in the Ocean
National Science Foundation: September 15, 2016 - August 31, 2019
Wooyoung Choi

Modeling Steep Surface Waves Evolving Under Wind Forcing and Energy Dissipation Due to Wave Breaking
National Science Foundation: September 1, 2015 - August 31, 2018
Wooyoung Choi

GOALI: Predicting Performance & Fouling of Membrane Filters
National Science Foundation: September 15, 2016 - August 31, 2020
Linda Cummings (PI), Lou Kondic (Co-PI)

Collaborative Research: Expanding Links with Industry through Collaborative Research and Education in Applied Mathematics
National Science Foundation: April 1, 2013 - March 31, 2019
Linda Cummings (PI), Richard Moore (Co-PI)

Multisensory Integration by Circadian Clocks
US ARMY: October 1, 2016 – May 31, 2019
Casey Diekman

CAREER: Neuronal Data Assimilation Tools and Models for Understanding Circadian Rhythms
National Science Foundation: July 1, 2016 - June 30, 2021
Casey Diekman

Numerical Methods for Multiscale Inverse Problems and Applications to Sonar Imaging
National Science Foundation: September 1, 2017 - August 31, 2020
Christina Frederick

Meshfree Finite Difference Methods for Nonlinear Elliptic Equations
National Science Foundation: September 1, 2016 - August 31, 2020
Brittany Hamfeldt

Numerical Methods for Optimal Transportation
Simons Foundation: September 1, 2016 - August 31, 2021
Brittany Hamfeldt

Collaborative Research: Efficient High-Order Algorithms for Nonequilibrium Microflows over the Entire Range of Knudsen Number
National Science Foundation: July 1, 2017 - June 30, 2020
Shidong Jiang

Collaborative Research: Efficient High-Order Parallel Algorithms for Large-Scale Photonics Simulation
National Science Foundation: August 15, 2014 - July 31, 2018
Shidong Jiang

NASA Shared Services Center (NSSC): Structure Evolution During Phase Separation in Colloids Under Microgravity
NASA: August 16, 2016 - August 15, 2018
Lou Kondic (PI), Boris Khusid (NCE, Co-PI)

Quantifying Complex Spatio Temporal Systems
DARPA: August 1, 2016 - July 31, 2018
Lou Kondic

Collaborative Research: Computations, Modeling and Experiments of Self and Directed Assembly for Nanoscale Liquid Metal Systems
National Science Foundation: July 1, 2016 – June 30, 2020
Lou Kondic (PI), Shahriar Afkhami (Co-PI)

Collaborative Research: Computational and Data-Enabled Science and Engineering
National Science Foundation: September 15, 2015 – August 31, 2019
Lou Kondic

Collaborative agreement with Meadowlands Environmental Research Institute - Benthic Project
Rutgers University: January 1, 2018 – September 30, 2019
Ji Meng Loh

Cell Calcium Dynamics
National Science Foundation: July 1, 2015 – June 30, 2019
Victor Matveev

Geoacoustic Inversion in Shallow Water
US NAVY ONR: March 1, 2018 - February 28, 2021
Zoi-Heleni Michalopoulou

Shallow Water Inversion with Optimization and Direct Methods
Office of Naval Research: April 1, 2016 - September 30, 2019
Zoi-Heleni Michalopoulou

Magnetization Dynamics at Nanoscale
National Science Foundation: July 1, 2016 - June 30, 2019
Cyrill Muratov

US-Israel Research Proposal: Network Resonance: Spiking Mechanisms and Behavioral Implications
National Science Foundation: September 15, 2016 - August 31, 2020
Horacio Rotstein

Collaborative Research: Overcoming Order Reduction and Stability Restrictions in High-Order Time-Stepping
National Science Foundation: August 1, 2017 – July 31, 2020
David Shirokoff

Penalty Methods and Computational Material Science
Simons Foundation: September 1, 2015 - August 31, 2020
David Shirokoff

Numerical Methods and Analysis for Induced-Charge Electrokinetic Flow with Deformable Interface
National Science Foundation: August 1, 2014 – January 31, 2019
Michael Siegel (PI), Michael Booty and Yuan-Nan Young (Co-PIs)

STTR PH II/Innovative Physics-based Modeling Tool for Application to Passive Radio Frequency Identification System on Rotorcraft
US Dept. of Navy: January 4, 2017 – June 30, 2019
Catalin Turc

Efficient Solutions of Wave Propagation Problems in Multi-Layered, Multiple Scattering Media
National Science Foundation: September 1, 2016 - August 31, 2020
Catalin Turc

Collaborative Research: Theoretical, Computational and Experimental Investigations on the Interaction Between a Lipid Bilayer Memebraneand a Solid Substrate or Particle
National Science Foundation: September 1, 2016 - August 31, 2019
Yuan-Nan Young

CONTINUING FUNDED TRAINING PROGRAMS

EXTREEMS-QED: Research and Training in Computational and Data-Enabled Science and Engineering for Undergraduates in the Mathematical Sciences at NJIT
National Science Foundation: September 1, 2013 - August 31, 2020
Michael Siegel, David Horntrop, Ji Meng Loh, Zoi-Heleni Michalopoulou, and Marvin Nakayama

PROJECTS FUNDED DURING THE PRESENT ACADEMIC/FISCAL YEAR

The Study of Hele-Shaw Viscoelastic Two-Phase Flows
American Chemical Society: January 1, 2019 – August 31, 2021
Shahriar Afkhami

Recent Advances in Numerical Wave Propagation
National Science Foundation: August 1, 2018 - July 31, 2019
Yassine Boubendir

Liquid Crystal Films Across Scales: Dewetting & Dielectrowetting
National Science Foundation: September 1, 2018 - August 31, 2021
Linda Cummings (PI), Lou Kondic (Co-PI)

Dynamical Systems Modeling of the Basal Ganglia
IBM: September 26, 2018 - December 28, 2018
Casey Diekman

CAREER: Generated Jacobian Equations in Geometric Optics and Optimal Transport
National Science Foundation: July 1, 2018 - June 30, 2023
Brittany Hamfeldt

Stick-Slip Dynamics and Failure in Granular Materials
Army Research Office: July 15, 2018 – July 14, 2020
Lou Kondic

Conference on Frontiers in Applied and Computational Mathematics
National Science Foundation: May 1, 2019 – April 30, 2020
Lou Kondic (PI), Denis Blackmore (Co-PI), Linda Cummings (Co-PI), Michael Siegel (Co-PI)

Scalable Inference of quantile Regression for Large-Scale Health Care Data
National Institutes of Health: May 15, 2019 – April 30, 2022
Ji Meng Loh

Wave-Coupled Active Matter
Simons Foundation: September 1, 2018 - August 31, 2023
Anand Oza

B. PROPOSED RESEARCH

PROJECTS PROPOSED DURING PRESENT FISCAL YEAR

Amitabha K. Bose

Collaborative Research: CRCNS US-German Research Proposal: How Does the Brain Learn the Pattern and Beat of Rhythmic Sound?
National Science Foundation, November 2018

Bruce G. Bukiet

Leadership and iSTEAM for Females in Elementary School (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM
National Science Foundation, May 2019

Linda J. Cummings

Collaborative Research: Workshop and Camp Focusing on Industrial Mathematics
National Science Foundation, December 2018

Casey O. Diekman

INTERN: NSF-Funded Graduate Student Internship at IBM
National Science Foundation, December 2018

Simons Investigators in the MMLS for Dr. Casey O. Diekman
The Simons Foundation, November 2018

Using the Circadian Rhythm of Tumor Cells to Pinpoint Delivery of PARP Inhibition and Radiotherapy
US NIH, October 2018

Mathematical Modeling of Circadian Timekeeping
The Simons Foundation, September 2018

Dynamical Systems Modeling of the Basal Ganglia
IBM, September 2018

Wenge Guo

Collaborative Research: New Methods for Large Scale Multiple Testing and Inference
National Science Foundation, August 2018

Lou Kondic

Frontiers in Applied and Computational Mathematics 2019

National Science Foundation, October 2018

Computational Topology in Materials Science: From Particulate Matter to Thin Fluid Films
The Simons Foundation, September 2018

Ji Meng Loh

Linked Spatial Point Process Analysis of Mobility Data for Modelling Urban Dynamics
National Science Foundation, January 2019

Spatial Temporal Point Analysis of Large Multi-Year Inhomogeneous NYC Stop-and-Frisk Data
National Science Foundation, August 2018

Enkeleida Lushi

Modeling and Simulations of Problems in Active Matter
The Simons Foundation, February 2019

James N. MacLaurin

Stochastic Modeling of the Primate Visual Cortex
National Science Foundation, November 2018

Simons Investigators in the MMLS for Dr. James N. Maclaurin
The Simons Foundation, November 2018

Coarse-Graining of Neural Networks
National Science Foundation, September 2018

Zoi-Heleni Michalopoulou

Geoacoustic Inversion in Shallow Water - Analytic and Optimization Methods
Office of Naval Research, June 2019

Ocean Acoustics and Signal Processing Algorithms for Geoacoustic Inversion
Office of Naval Research, February 2019

Richard O. Moore

Collaborative Research: Optimized Control, Inference, and Assimilation in Experimental Flow Fields
National Science Foundation, November 2018

Fellowship for Dr. Richard Moore
The Simons Foundation, October 2018

Cyrill B. Muratov

Coherent Structures in Nanomagnetism

National Science Foundation, November 2018

Anand U. Oza

Phase Transitions in Colloid-Polymer Mixtures in Microgravity
NASA, December 2018

Coarse-Grained Models for Hydrodynamically Interacting Schools and Flocks
National Science Foundation, November 2018

Collaborative Research: a Generalized Pilot-Wave Theory
National Science Foundation, November 2018

Collaborative Research: Active Surfers on a Vibrating Bath -- Self-Propulsion and Collective Motion
National Science Foundation, November 2018

Fellowship Application for Dr. Anand Oza
A.P. Sloan Foundation, September 2018

David G. Shirokoff

CAREER: Understanding and Guiding Self-Assembly with Numerical Solvers for Nonconvex Variational Problems
National Science Foundation, July 2018

Michael S. Siegel

Flows about Grooved Superhydrophobic Surfaces
US- Israel Binational Science Foundation, November 2018

Numerical Methods and Analysis of Interfacial Flow with Ionic Fluids and Surfactant
National Science Foundation, November 2018

Sundarraman Subramanian

Estimation and Model Checks for Single-Index Location-Scale and Quantile Regression Models
National Science Foundation, December 2018

Catalin C. Turc

Optimized Schwartz Methods for Wave Propagation Problems in Complex Media
National Science Foundation, November 2018

Antai Wang

Statistical Analysis of Dependent Censored Data Using Copula Models
National Science Foundation, December 2018

Yuan-Nan Young

Collaborative Research: Mathematical Modeling and Coarse-Grained Simulations of Amphiphilic Self-Assembly and Fusion and Fission of Amphiphilic Bilayers
National Science Foundation, November 2018

Mathematical Modeling of Extracellular Matrix (ECM) and Its Roles in Biophysical Processes in Cells and Tissues
National Science Foundation, September 2018

VIII. COMMITTEE REPORTS AND ANNUAL LABORATORY REPORT

A. COMPUTER FACILITIES

Computing Equipment

High quality facilities supporting numerical computation are essential for the Department of Mathematical Sciences (DMS) and the Center for Applied Mathematics and Statistics (CAMS) at NJIT to fulfill their educational and research missions. Thus DMS and CAMS, with the help of SCREMS, CSUMS, UBM, and MRI grants from NSF, together with the generous support of NJIT, have maintained the CAMS Math Computation Laboratory (CMCL) for the research needs of their members since 1989.

Computational support provided by CMCL for the proposers consists of the workstations and desktop PC's that are networked and available to investigators in their offices, plus other more major, shared facilities of the CMCL (see Table 1).

Table 1: Main CAMS Math Computation Laboratory facility, Stheno cluster

Model	Cores	Processor & speed/GPU & max flops	Storage / RAM
Intel multi-core	392	Intel Xeon, 2.2 to 2.53 GHz	9872 GB
Nvidia multi-GPU	15,320	NVIDIA Tesla K20(m), 1.17 Tflops	32 GB

The DMS has expanded its "Stheno" cluster in stages since its first server became operational in 2011. The cluster is intended to be used to test, debug, and run message-passing interface (MPI) codes. It now has 32 nodes and 392 cores, 3,840 GB of RAM, and 9,872 GB of local disk storage. Two servers of the cluster contain GPU's, which now total 6, with a total of 32 GB of GPU RAM. The GPU's are currently CUDA capable and are intended for general purpose computation on GPU-accelerated computing nodes.

The DMS also has its "Gorgon" cluster, which has been expanded sequentially since it became operational in 2010. This cluster is intended for jobs that require large memory, and for parallel computations that use the OpenMP application programming interface. It is now a 32 core system, with AMD Opteron 6134 processors running at 2.3 GHz, and a total of 64 GB of shared memory.

All computational facilities are maintained by the Academic and Research Computing Systems (ARCS) group, headed by its director, David Perel.

Recognizing the need to support the scientific and engineering computing that is essential to research efforts across the campus, NJIT provides all faculty, postdocs, and graduate students access to centralized computing servers for research purposes. These recently received a significant upgrade as part of a substantial donation by Linode, which is a Linux-based cloud hosting company based in New Jersey. The NJIT cluster, "Kong", now has a total of 348 nodes, 3,128 CPU's, 27,008 GB of RAM, and a disk storage of 342,770 GB. Processors are all AMD Opteron or Intel Xeon models, with speeds from 2.2 GHz to 2.8 GHz. It also features total of 18 GPU's (NVIDIA Tesla K20X and NVIDIA Tesla P100), amounting to 60,928 GPU cores and 248 GB of RAM. Stheno and Kong nominally aggregate of approximately 55 TFLOPS computing power.

Office

The DMS assigns an individual office to faculty and postdoctoral associates, and assigns common offices with networked computers and other equipment to graduate students. In addition, a conference room and the CAMS Reading Room are available for formal and informal research meetings. Academic visitors are welcome and are assigned the same facilities.

Other

CAMS: The DMS is the base of the Center for Applied Mathematics and Statistics (CAMS) to which all investigators belong. CAMS supports research in the mathematical sciences at NJIT by preparing a CAMS Annual Report, a series of CAMS Technical Reports (available in electronic form at the CAMS website http://math.njit.edu/research/index.php). CAMS maintains a weekly colloquium on Applied Mathematics and Statistics, and in most weeks there is a seminar in each of mathematical biology, fluid mechanics and waves, and statistics. DMS and CAMS also sponsor a major conference on "Frontiers in Applied and Computational Mathematics," which has been held annually at NJIT since 2004.

B. STATISTICAL CONSULTING LABORATORY REPORT

July 2018 – June 2019

The Statistical Consulting Lab serves the NJIT community and external organizations and aims to offer high quality statistical consulting for the purposes of promoting research, collaboration and statistical education.

We provide statistical consulting service to hospitals. Client: Dr. Douaa Khalil, Saint Joseph's hospital. Description: The primary objective for this study is to analyze whether there are relationships between different external factors (WBC, LOS, LOF and F/P) with serious bacterial infection (SBI) or not. Consultant: Antai Wang. A report of the results of fever related Factors Analysis was presented to the client.

We provided statistical consulting for a biomedical lab in Rutgers University during October, 2018. The lab's research interests include bacterial stress response and developing new antimicrobials. Client: Xilin Zhao, PhD, Rutgers University Biomedical Lab in Rutgers University Description: This consulting service includes two parts. The first part is to help to calculate the number of mice required for one experiment in a grant application. For this experiment, a certain measurement of both the control and experimental group will be compared, based on the preliminary data provide, to calculate the appropriate group size to get a power of 85%. The second part is to help to build an Excel template for them to perform the sample t-test or one-way ANOVA. One common kind of statistical tests they perform is to compare the response of bacterial to several different drugs or to compare the response of bacterial of several different genotype to same drug. We built an Excel template for which they can input the experimental data and get the statistical test result from this template. Consultant: Ph.D. student Gan Luan guided by Sunil K. Dhar. A report of the results and Excel template were presented to the client.

We provided research help to medical professionals who are using mathematics for data analysis. Client: Professor Glenn Mark Atlas, MD, Department of Anesthesiology, Rutgers New Jersey Medical School. Description: Read several journal articles on sumundu transformation and its development. Consultant: Sunil K. Dhar. Provided Dr. Atlas rigorous mathematical improvements as part of reviews of several research documents in which sumundu transformations were being used or developed.

We provided research collaboration for possible grant applications. Client: Assistant Professor Saikat Pal from Department of Biomedical Engineering. Description: discussed preparation of a DoD preproposal to study biomarkers for risk of long-bone fractures among Spinal Cord Injury patients. Consultant: Ji Meng Loh. Preproposal discussion on research ideas was shared.

IX. CURRENT AND COLLABORATIVE RESEARCH

A. RESEARCH AREAS IN CAMS

Mathematical Biology

Researchers in CAMS working on problems related to Mathematical Biology: Booth, Bose, Bunker, Diekman, Golowasch, Holzapfel, Nadim, Maclaurin, Matveev, Rotstein, Russell, and Young.

Mathematical Biology broadly refers to the branch of mathematics that is devoted to the theoretical study of biological processes and the development of novel mathematical tools to understand these processes. Recently, there has been quite a bit of emphasis on the intersection of mathematics with developmental biology, neurophysiology, systems biology and genomics. Moreover, mathematicians are applying their modeling and analytical skills to the study of various diseases, such as diabetes, Parkinson's disease, schizophrenia, multiple sclerosis, Alzheimer's disease, and HIV-AIDS. The kinds of mathematics needed to describe and address problems in these areas of Mathematical Biology are quite vast and include dynamical systems, partial differential equations, fluid dynamics, mechanics, parameter estimation, and statistics, to name only a few. Researchers in Mathematical Biology at NJIT have strong interdisciplinary research programs that involve, in most cases active collaborations with experimentalists at the NJIT and Rutgers campuses, and other universities both in the US and abroad.

A primary focus of the Mathematical Biology group is in experimental, computational, and mathematical neuroscience. The experimental research in neuroscience within CAMS is headed up by Jorge Golowasch and Farzan Nadim. Both researchers run labs in which they conduct experiments on various aspects of the crustacean stomatogastric nervous system. Various aspects of Computational and Mathematical neuroscience are being studied by Victor Matveev, Horacio G. Rotstein, Casey Diekman and Amitabha Bose. Matveev uses analytical and computational techniques to study intracellular calcium signals controlling synaptic neurotransmitter release, endocrine hormone release and other physiological processes. He is particularly interested in the dynamics of calcium diffusion and buffering underlying changes in synaptic transmission strength termed synaptic plasticity. Rotstein is interested in understanding the mechanisms of generation of neuronal rhythmic oscillations in various areas of the brain (e.g., hippocampus, entorhinal cortex, neocortex, prefrontal cortex, striatum, olfactory bulb) and how this results from the cooperative activity of the dynamic and biophysical properties of the participating neurons, the synaptic connectivity and the network topology. A primary focus of this research is the study of the effects that single cell and network resonances (emergent properties resulting from the interaction between neurons/networks and oscillatory inputs) affect the generation of network oscillations. Diekman creates multiscale models of the circadian (~24-hour) clock to understand the interaction of membrane excitability and daily rhythms in gene expression and behavior. He is also developing data assimilation techniques for parameterizing conductance-based models, and new methods for analyzing how circadian oscillators entrain to environmental cycles. Bose is interested in developing mathematical techniques to understand the role of short-term synaptic plasticity in producing multi-stable periodic solutions within neuronal networks. He is also interested in developing models that involve central pattern generating networks.

Another focus of CAMS members is in the area of computational and applied ecology. Dan Bunker is interested in how natural ecosystems cope with the ever increasing stresses placed on them by the forces of global change. Claus Holzapfel is interested in the creation of novel communities that consist of species that never occurred

together, but are now being created through fast paced human impact. Gareth Russell studies complex ecological systems, including predictive models of wading bird species in the Everglades National Park.

In the area of biological fluid-structure interactions, Young has focused on the biomechanics of primary cilium, a cellular antenna that bends under a fluid flow around the cell. Young has also investigated the force from lipid (FFL) paradigm by constructing a continuum model for the activation of a non-selective mechanosensitive channel reconstituted in a vesicle under fluid stress.

Fluid Dynamics

Researchers in CAMS working on problems related to Fluid Dynamics: Afkhami, Bechtold, Booty, Bukiet, Choi, Cummings, Diez, Huang, Jiang, Kondic, Luke, Lushi, Marras, Oza, Papageorgiou, Petropoulos, Rosato, Shirokoff, Siegel, Vanden-Broeck, Wang, Wylie, and Young.

There are fourteen faculty members within the Department of Mathematical Sciences (DMS) and Center for Applied Mathematics and Statistics (CAMS) whose research is in fluid dynamics or the closely related area of combustion. This group of fluid dynamics scientists is one of the largest contained within a department of mathematics in the United States.

Fluid dynamics is concerned with the motion of fluids and gases. Many beautiful and striking phenomena occur in fluid flows. Familiar examples include the giant vortices shed by airplane wings, the persistent red spot of Jupiter, and the formation of crystalline patterns in solidifying fluids (i.e., snowflakes).

The basic equations of inviscid fluid dynamics have been known for over 250 years and viscous flow equations were derived over 180 years ago. They are nonlinear partial differential equations and are simply written. However, analyzing the solutions to these equations is extremely challenging. Mathematicians have played a leading role in the development of analytical, asymptotic and numerical methods for solving the equations of fluid dynamics. Mathematical techniques originally developed to study fluid phenomena have found wide application in other areas of science and engineering. Examples include asymptotic methods, the inverse scattering transform, numerical methods such as boundary integral methods and level set methods, and theoretical techniques to study the qualitative nature of solutions to nonlinear differential equations. Mathematical research in fluid dynamics continues to drive broad advances in mathematical methods, numerical methods and mathematical analysis.

The fluid dynamics group in the Department of Mathematical Sciences at NJIT has an active research program covering interfacial fluid dynamics (Afkhami, Booty, Cummings, Huang, Kondic, Papageorgiou, Siegel, and Vanden-Broeck), thin films (Cummings, Diez, and Kondic), electrohydrodynamics (Papageorgiou, Petropoulos, and Vanden-Broeck), hydrodynamic stability theory (Papageorgiou), sedimentation (Luke), granular flow (Kondic and Rosato) and combustion (Bechtold, Booty, and Bukiet). A particular focus for several of the faculty members (Afkhami, Booty, Choi, Cummings, Huang, Kondic, Papageorgiou, Siegel, Vanden-Broeck, Wang, Wylie, and Young) is the study of free and moving boundary problems. These are particularly challenging problems in that partial differential equations have to be solved in a region which is not known in advance, but must be determined as part of the solution. A famous example is the Stefan problem for melting ice or freezing water, but also the dynamics of bubbles, jets, shock waves, flames, tumor growth, crack propagation and contact problems all can be classified under this heading. CAMS fluid dynamics researchers are also pursuing applications of their work in Biology and Nanotechnology.

Wave Propagation

Researchers in CAMS working on problems related to Wave Propagation: Ahluwalia, Askham, Booty, Boubendir, Choi, Erneux, Frederick, Goodman, Jiang, Marras, Michalopoulou, Moore, Petropoulos, and Turc.

The analysis of wave propagation has a long and storied tradition in the history of applied mathematics, and the exploration of wave behavior has been a source of countless problems that have changed our understanding of acoustics, hydrodynamics, electromagnetics, optics, and even matter itself. These studies also have led to the development of powerful new mathematical and computational techniques, which have on occasion revolutionized entire fields of study. Several members of the CAMS faculty have research interests in the area of wave propagation; the following is a brief overview of the field and of their particular interests.

One field that has been affected very profoundly by the relatively new science of nonlinear waves is optical communications. Richard Moore is currently using perturbation theory and statistical techniques to develop efficient ways to characterize the effect of perturbations on solitons used for optical communications. Roy Goodman uses Hamiltonian mechanics and asymptotic methods to explore how light can be slowed, delayed, or "trapped"' by engineering defects in nonlinear periodic structures.

The treatment of transient electromagnetic signals such as those arising in signal analysis, spectroscopic applications, and the nondestructive testing of structures requires sophisticated numerical techniques that are stable, fast, and accurate, and that have reasonable memory requirements. Peter Petropoulos is conducting research on a variety of approaches that address these restrictions, including high-order finite difference schemes, boundary integral methods, and perfectly matched layers. Shidong Jiang investigates nonreflecting boundary conditions and scattering problems for acoustic and electromagnetic waves by open surfaces. He employs fast algorithms, including the fast multipole method, iterative solvers, and integral equation formulation of boundary value problems for such problems and for related large-scale problems in physics and engineering. Yassine Boubendir and Catalin Turc develop multi-scale and efficient methods, including domain decomposition methods, for the study of wave scattering.

Even in cases where deterministic wave propagation is relatively well understood, the related inverse problem is far more challenging. The identification of certain characteristics of a source of acoustic waves, such as its location and intensity, is of obvious use in national defense, in environmental studies, in seismology, etc. Zoi-Heleni Michalopoulou has developed a localization-deconvolution approach based on Gibbs sampling that explores the space of allowable configurations with improved speed and accuracy over conventional approaches.

Finally, the propagation of waves through materials is often influenced by parameters that depend on the waves in a way that requires fundamentally different physics. The microwave heating of ceramics or the passage of optical fields through photorefractive crystals, for instance, couples hyperbolic equations to parabolic equations governing the evolution of thermal profiles and chemical species. Gregory Kriegsmann and Richard Moore had investigated asymptotic and numerical methods to treat such coupled hyperbolic-parabolic systems.

Dynamical Systems

Researchers in CAMS working on problems related to Dynamical Systems: Blackmore, Bose, Golowasch, Jiang, Kappraff, Matveev, Moore, Nadim, Oza, Papageorgiou, Rotstein, Siegel, Tao, and Young.

Today's research in the theory and applications of dynamical systems all have their roots in the work of early innovators in differential equations and mathematical modeling.

A major revolution in dynamical systems research took place during the late nineteenth and early twentieth century characterized by innovations in the study of integrability such as those of Kovalevskaya, and culminating in the ground-breaking work of Poincare on nonintegrable Hamiltonian systems. Poincare brought a new infusion of topological methods to dynamical systems research that has illuminated and served as a source of inspiration for virtually all subsequent investigations. In the process, he introduced a new perspective on nonlinearity and complex motion that predated chaos theory. This new topological trend continued and was greatly advanced by such notables as Birkhoff, Kolmogorov, Arnold, and Moser.

Then in the 1960's, the face of dynamical systems research was dramatically altered by Smale and others with the introduction of a variety of techniques from differential topology that provided amazing new insights into the nature of chaotic dynamics. At about the same time, a dramatic advance in research on infinite-dimensional Hamiltonian systems was occurring as a result of several extraordinary discoveries concerning integrability, solitons, and the inverse scattering transform made by the likes of Gardner, Greene, Kruskal, Lax, and our own Robert Miura. These remarkable breakthroughs established the foundations of what has come to be known as the modern theory of dynamical systems, and catalyzed an explosion of applied and fundamental research in nonlinear dynamics.

Dynamical systems research in CAMS has a decidedly applied focus, and is extremely active in a wide and diverse range of areas including mathematical biology, fluid dynamics, wave propagation, computational topology, nonlinear optics, and quantum field theory and its applications to such things as quantum computing. There are a significant number of researchers who employ techniques from nonlinear dynamics in their work, and a smaller but sizeable core group whose interests are centered around dynamical systems and their applications. This includes Denis Blackmore, who applies nonlinear dynamics to study the motion of vortices and vortex filaments in fluids and particles in granular flows, the chaotic evolution of biological populations, the computational topological nature of certain geometric objects, and quantum computing. He also does fundamental research in bifurcation theory, chaos theory, and algebraic and differential integrability analysis of infinite-dimensional Hamiltonian dynamical systems. Dynamical systems methods applied to nonlinear waves and optics is the focus of Roy Goodman's research. A key ingredient in his work is the development of methods for obtaining insights from finite-dimensional reductions of infinite-dimensional systems such as the nonlinear Schrodinger equation.

Numerical Methods

Researchers in CAMS working on problems related to Numerical Methods: Afkhami, Askham, Boubendir, Bukiet, Choi, Frederick, Goodman, Hamfeldt, Horntrop, Jiang, Kondic, Luke, Marras, Matveev, Michalopoulou, Moore, Muratov, Papageorgiou, Petropoulos, Rosato, Shirokoff, Siegel, Tao, Turc, and Young.

Given the rapidly increasing computing power and capacity in recent decades, the use of computation as a means of scientific inquiry has also greatly increased and now is ubiquitous in most areas of applied mathematics. CAMS researchers are actively involved in all aspects of this scientific revolution from the development of new, more efficient and accurate numerical algorithms to the creation of computational packages for use by researchers throughout the world. The computational work of CAMS researchers is supported by state of the art facilities including numerous workstations and a 134 processor cluster.

Virtually every CAMS member uses computation in some aspect of their research. Some of the specific computational tools that are being used and developed by CAMS researchers are described below. Boundary integral methods are being used to study moving interfaces in materials science and fluid dynamics. Computational solutions of nonlinear partial differential equations are used in studies of the formation of finite-time singularities in aerodynamic and interfacial problems. A wide variety of finite difference methods for ordinary and partial differential equations, often in conjunction with iterative solvers and conjugate gradient methods, are used in studies of advection-diffusion problems, wave propagation, blood circulation, the visual cortex, as well as synaptic function and intracellular spatio-temporal calcium dynamics. Level set methods are used to study interfaces in materials. Novel techniques for differential difference equations are also used to better understand materials. Convergence of fast multipole methods is analyzed and these methods are used to study wave propagation. Novel techniques to remove spurious reflections of waves at computational boundaries are being developed. Signal detection and estimation techniques rely upon global optimization techniques used and developed by CAMS researchers. Finite element methods are used to study mechanical systems; the hybrid immersed boundary/immersed interface method is being developed and refined in order to high order accuracy and efficiency near interfaces.

Stochastic computation also receives a great deal of attention by CAMS researchers. Monte Carlo methods based upon the principles of statistical mechanics are used in studies of granular materials. Efficient and consistent coarse-grain algorithms are designed to simulate the dynamics of DNA molecules and lipid bilayer membranes in viscous flows. Monte Carlo simulation is used to study molecular biology and bioinformatics.

Stochastic models of sedimentation are being developed and refined through a combination of analysis and simulation. Markov Chain Monte Carlo methods are used in studies in statistics and biostatistics. Simulations taking advantage of variance reduction techniques are being used to study the effects of stochastic perturbations on solitons. New computational techniques for stochastic partial differential equations based upon spectral methods are being developed and applied to multiscale models of surface processes.

Statistics

Researchers in CAMS working on problems in Applied Probability and Statistics: Dhar, Fang, Guo, Loh, Subramanian, and Wang.

Applied Probability and Statistics/Biostatistics is concerned with the study of processes in which uncertainty plays a significant role. In today's data driven environment, the utility and need for modeling and statistical analysis of uncertainty is assuming increasing importance in virtually every field of human interest. Typical examples are in the comparative study of DNA databases, evaluation of drug safety and effectiveness, design and analysis of modern communication protocols, stochastic models in finance, study of aging and performance analysis of components and complex systems.

While Applied Probability and Statistics/Biostatistics are driven by the need to solve applied problems, their progress and development comes from basic research and from their applications to solve specific problems arising in practice. This interplay of basic and applied research has benefited both. Real life applied problems have often posed new theoretical challenges which had to be solved by developing new methods (e.g., survival analysis and clinical trials). Conversely, theoretical ideas and methods which were developed in a specific applied context were later seen to be of much broader applicability (e.g., nonparametric aging ideas which owe their origins to research in stochastic modeling of reliability of physical systems were later seen as useful constructs in many other areas such as in the study of queuing systems, stochastic scheduling, branching processes as well as in modeling economic inequality). Biostatistics, an increasingly important area of statistics, focuses on developing new statistical methods, as well as applying existing techniques, to interpret data about the medical and life sciences. The importance of biostatistics stems from its wide use in the pharmaceutical and health-care industries, and in medical schools, e.g. in the area of cell biology and molecular medicine empirical survival distributions of mice in both placebo and treatment groups are typically compared to look for significant difference in new chemical treatments when compared with placebo.

The Statistical Consulting Laboratory (SCL), which operates under the umbrella of CAMS, provides data analysis and statistical modeling consulting services to the University community, as well as to external clients. Consulting on statistical and biostatistics problems channeled through the SCL, are provided by statistics faculty. The current coordinator of the SCL is Ji Meng Loh.

The current research interests of the Statistics faculty are in the following broad and overlapping areas: applied probability models (Dhar), bioinformatics and computational biology (Fang, Guo), bootstrap methods (Subramanian), censored time-to-event data analysis (Dhar and Subramanian), computational statistics (Fang, Guo and Subramanian), discrete multivariate distribution/reliability models and inverse sampling (Dhar), distribution theory and statistical inference (Dhar and Subramanian), empirical processes (Dhar, Subramanian), high dimensional inference (Fang, Guo, Loh, and Wang), machine learning and data mining (Fang), minimum distance estimation (Dhar), multiple imputations methods (Subramanian), multiple testing (Guo), semiparametric estimation and inference (Dhar and Subramanian), spatial statistics and spatial point patterns (Loh), statistical issues in clinical trials (Guo and Dhar), and statistical theory of reliability and survival analysis (Dhar, Subramanian, and Loh).

Several CAMS members have active research programs in Biostatistics. This includes the application of non- and semi-parametric statistical inference and computational methods, such as the bootstrap, in biostatistics.

B. RESEARCH DESCRIPTIONS

Shahriar Afkhami

Shahriar Afkhami's research focuses on computational and mathematical modeling of real-life engineering phenomena including biomedical systems, polymers and plastics, microfluidics, and nanomaterials. His current research thrusts include studies of existence of solutions, flow stability, asymptotic behavior, and singularities of complex flow problems. Currently, he is working on 3D computations of drop dynamics and breakup in polymer processing, microfluidics, and electrowetting. Motivated by biomedical and pharmaceutical applications, Shahriar Afkhami has been studying the dynamics of magnetic particles in a blood flow for drug delivery applications. His current materials related projects involve directed assembly of metallic nanostructures.

Daljit S. Ahluwalia

The research of Daljit S. Ahluwalia is in the field of applied mathematics, mainly in the areas of asymptotics and wave propagation. Using analytic and asymptotic methods, he has addressed a wide range of phenomena including scattering, diffraction, reflection, guided waves, dispersion and shock waves. Applications of this work include ocean acoustics, water waves, electromagnetics, and elastic waves.

Travis Askham

Travis Askham's primary research interests are in the field of scientific computing, with a focus on fast algorithms for the numerical solution of partial differential equations (PDEs). In particular, he has developed novel integral equation representations for the clamped plate problem in mechanics and for computing the eigenvalues and eigenfunctions of the Stokes operator. Further, he has developed fast algorithms for solving the linear systems that arise from integral equation representations of PDEs, including a fast multipole-type method for the modified Stokes equations. In other work, he has developed sparse-regression algorithms and exponential fitting algorithms for applications in the data-driven discovery of governing equations for physical systems.

John Bechtold

The research of John K. Bechtold has focused on the modeling and analysis of physical problems, primarily in the area of theoretical combustion. His studies cover a wide range of topics in both premixed and nonpremixed combustion, including stability, ignition, extinction, and complex flame/flow interactions. His current projects include the development of new generalized models of near-stoichiometric flames, stability of expanding and converging flames, and radiation-driven flows in microgravity.

Denis Blackmore

Dynamical systems (nonlinear dynamics) theory is a rich amalgam of techniques from algebra, analysis, chaos theory, differential equations, differential geometry, differential topology, fractals, geometry, singularity theory, and topology, and has important applications in every branch of science and engineering. Denis Blackmore's research is primarily in the theory and applications of dynamical systems and closely related fields. He has studied a plethora of applications in such areas as acoustics, automated assembly, biological populations, computer aided geometric design, fluid mechanics, granular flows, plant growth (phyllotaxis), relativistic and quantum physics, and rough surface analysis. His theoretical work includes fundamental results on solution properties and integrability of differential equations, and analysis of hypersurface singularities. His current projects include

particle dynamics, pilot-wave dynamics, strange chaotic attractors, exotic bifurcation theory, integrability of infinite-dimensional dynamical systems (PDEs), mathematical physics and vortex dynamics, and competing species dynamics

Victoria Booth

Victoria Booth is interested in applying mathematical modeling techniques to further our understanding of the brain. Her research focuses on different spatial and temporal scales of brain function, from single neuron spiking, to activity of large-scale spiking neuron networks, to networks of interacting neuronal populations. The consistent theme of her research is to utilize mathematical modeling to understand the physiological mechanisms generating experimentally observed neural activity, thus providing the neuroscience community with quantitative support of experimental hypotheses and a rigorous theoretical framework for exploring and developing experimentally-testable predictions. Mathematically, understanding the mechanisms generating specific model behaviors requires complete analysis of stable and unstable solutions to the nonlinear ordinary differential equations of the model system. For this analysis, she utilizes numerical simulations and analysis techniques from dynamical systems, singular perturbation theory and bifurcation theory.

Currently, her research activities are primarily concentrated in two major directions: construction and analysis of mathematical models of the sleep-wake regulatory network and investigation of the interactions of single neuron properties and network structure on spatio-temporal activity patterns in large-scale spiking neuron network models.

Michael Booty

Michael Booty's research interests are in mathematical modeling and analysis, by approximate or exact analytical techniques or by numerical methods. Much of his work is motivated by applications in fluid mechanics, including heat transfer, chemical, and electromagnetic effects. His studies on combustion have focused on time-dependent and multidimensional dynamics of reaction waves in mixed and multiphase systems, prototype reaction-diffusion models, dynamics of fast reaction waves, and droplet burning. He has studied conditions that minimize pollutant formation in the thermal oxidation of common materials, in collaboration with faculty of the Department of Chemistry and Environmental Science at NJIT. Current research interests include: studies on interfacial flows with surfactants, elastic membranes, and electrostatic fields (with Michael Siegel and Yuan-Nan Young), thermal waves in microwave heating and processing (with Greg Kriegsmann), and in fluid-structure interaction.

Amitabha Bose

The research of Amitabha Bose focuses on development and application of dynamical systems techniques to address problems arising in mathematical and computational neurophysiology. A major focus of his work has been on uncovering the role of synaptic plasticity in neuronal networks. This has led to a better understanding of how multistability of periodic solutions arise within a neuronal network as well as how some networks maintain phase relationships across a range of frequencies. These findings have been applied, for example, to circuits that are involved with REM sleep, to the crustacean pyloric and gastric mill networks, and other central pattern generating networks. More recent studies have focused on circadian rhythms and sustained activity in random graphs. Underlying much of this work is the rigorous analysis of one-dimensional, discontinuous maps that often arise as a result of model reduction.

Yassine Boubendir

Yassine Boubendir's general interests are in the numerical and the mathematical analysis of Partial Differential Equations. More specifically, he is interested in the design, implementation and analysis of numerical algorithms for problems of electromagnetic, acoustic and elastic wave propagation. In recent years, he introduced a new non-overlapping domain decomposition algorithm that combines a boundary element and finite element methods. In addition, he developed an appropriate Krylov subspace method, at high frequency regime, in the context of multiple scattering situations. Currently, his research is devoted to the acceleration of the iterative methods corresponding to these two algorithms.

Daniel Bunker

Global change poses a strong challenge to ecologists, environmental scientists, and conservation biologists: even as our natural and managed ecosystems become more stressed by the forces of global change, humans require that these ecosystems produce both a greater quantity and a greater variety of ecosystem services. for instance, we may expect a forested ecosystem to produce timber, provide clean water, sequester carbon, support wildlife, and provide recreational opportunities, yet at the same time the forest community is being buffeted by climate change, invasive species, and land-use change. In order to ensure that our ecosystems provide the services society demands, we must be able to predict how ecological communities will respond to these global forces, and in turn how changes in community composition will affect ecosystem services. To develop this predictive framework, I employ a mix of observation, experimentation, modeling and synthesis, within a diverse array of biological communities.

Bruce Bukiet

Bruce Bukiet's research concerns mathematical modeling of physical phenomena and issues in improving education, both at the K-12 level and post-secondary. He has studied the dynamics of detonation waves, including curved detonations and detonation models of discrete mixtures and he currently researches questions involving biological systems relating to balance and cancer. In the area of education, he is extensively involved in NJIT’s Collaborative for Leadership, Education and Assessment Research (CLEAR) and its projects involving enhancing digital learning through the Future Ready Schools – New Jersey effort, its online educational resource repository and in research concerning connecting math classes to the real world. Finally, he continues to work on understanding and optimizing aspects of baseball from a mathematical modeling perspective.

Wooyoung Choi

Wooyoung Choi's research interest lies mainly in fluid mechanics and nonlinear waves, in particular, with applications to geophysical flow problems. His recent research focuses on the development of simple but accurate mathematical models to describe various physical processes in the ocean and, in collaboration with physical oceanographers, their validation with field and laboratory measurements. His current research projects include the development of new asymptotic models and efficient numerical methods to study the short-term evolution of nonlinear ocean surface waves with enhanced physical parameterizations of wave breaking and wind forcing, and the dynamics of large amplitude internal waves in density stratified oceans and their surface signatures.

Linda Cummings

Linda Cummings works on a variety of physically-motivated free boundary problems, mostly fluid-dynamical in nature, many of which arise in industrial or biological applications. On the biological side her current work includes studies of fluid flow, nutrient transport and cell growth in tissue engineering applications; flow dynamics and bacterial biofilm formation in prosthetic devices such as urethral catheters and ureteric stents; and dynamics of

lipids in cell membranes. Her current industrially-relevant projects include modeling and analysis of "bistable" nematic liquid crystal display devices; modeling of bubble dynamics in the manufacture of glass fibers; and the flow of thin liquid films (both Newtonian and non-Newtonian). She also works on classical low Reynolds number free boundary flows, such as Stokes flows and Hele-Shaw flows. Her mathematical approaches are wide-ranging, encompassing skills of mathematical modeling, discrete and continuum mechanics, complex analysis, and asymptotic and numerical methods.

Fadi P. Deek

Fadi Deek's primary research interest is in learning systems and collaborative technologies, with applications to software engineering, and in computer science education. His approach to research involves a mixture of theoretical development, software system implementation, controlled experimental evaluation, and ultimately deployment of the systems developed. His interest in learning systems revolves around the development of new technologies that take into consideration the cognitive behavior and needs of end-users. The specific types of learning systems that he is interested in are related to computing which has motivated his work in software engineering. Because both learning and software engineering are highly collaborative activities, he has also become interested in understanding how collaboration works, ranging from the dynamics of collaborative groups to the technologies required for computer-supported work. His original interest in learning systems was sparked by a long standing interest in computer science education which continues to engage him. These underlying interests in learning systems and collaboration are the unifying theme for his publications, dissertation advisement, system development and professional involvement. Most of this research has been supported by grants where he has been the principal or co-PI.

Sunil K. Dhar

The research focus of Sunil Dhar has been on model building and inference. His ongoing research involves proving existence, computing and developing robust and efficient minimum distance estimators such as L2-distance type, under the following models: linear, AR [k], the additive effects outliers, and the two-sample location model. He also developed functional least squares estimators under the additive effects outliers model. An optimization technique for the general class of sums of absolute multivariate linear functionals has been developed by him. He extended the negative multinomial distribution; this new model has many applications. His ongoing research in multivariate lifetime reliability models involves deriving new multivariate geometric and generalized discrete analogs of Freund's models, with demonstrated applications. Other discrete models developed by him are in the area of models of order k. He has wide and varied experience in statistical consulting.

Casey Diekman

Casey Diekman uses a combination of mathematical modeling, numerical simulation, and dynamical systems analysis to gain insight into biological systems. He is currently focused on creating a mathematical framework to understand how dynamic changes in gene expression affect the electrical properties of neurons and ultimately animal behavior. Circadian (~24-hour) rhythms offer one of the clearest examples of the interplay between these different levels of organization, with rhythmic gene expression leading to daily rhythms in neural activity, physiology and behavior. Diekman develops mathematical models of the master circadian clock in the mammalian brain. These models and the mathematical theory associated with them have led to counterintuitive predictions that have since been validated experimentally by his collaborators. The primary goal of his research program in mathematical biology is to uncover mechanisms underlying biological timekeeping, neuronal rhythm generation, and the disruption of rhythmicity associated with certain pathological conditions including sleep disorders, Alzheimer's disease, breathing problems, and ischemic stroke.

Javier Diez

Javier Diez's research focuses on free surface flows and interface phenomena. He is particularly interested in coating flows and the dynamics of the contact line, where the liquid, the solid substrate and the surrounding environment (gas or liquid) intersect. Current projects include using a combination of experimental measurements (usually by means of optical techniques) and numerical simulations of the fluid dynamic equations, with particular emphasis on the inclusion of intermolecular forces to account for hydrodynamical effects in nanoscale phenomena.

Thomas Erneux

The research of Thomas Erneux is mainly concerned with laser dynamical instabilities and their practical use in applications. More recently, he became interested in delay differential equations appearing in different areas of science and engineering. The response of lasers can be described by ordinary, partial, or delay differential equations. He uses a combination of numerical and singular perturbation techniques to investigate their solutions. A large part of his research is motivated by specific collaborations with experimental groups.

Yixin Fang

Yixin Fang's primary research interest is in high-dimensional-data analysis. He is interested in developing efficient supervised-learning and unsupervised-learning methods for analyzing big data. He is also interested in applying existing statistical methods for analyzing complex data from different fields such as genetics, medical studies, and econometrics.

Christina Frederick

The research of Christina Frederick has encompassed multiscale computation and numerical homogenization for inverse problems based on elliptic PDEs, as well as sampling strategies that exploit special microstructures of functions to reduce the computation cost, and retain theoretical optimality in terms of efficiency and stability. Her recent work includes multiscale methods for sonar imaging, as well as robotics and stochastic differential equations.

Jorge Golowasch

The research of Jorge Golowasch focuses mainly on the cellular and network mechanisms of long-term regulation of electrical activity in a simple model neural network, the pyloric network of the stomatogastric ganglion of crustaceans. An undesirable consequence of plasticity is the potential instability of the system. In the nervous system, the activity of neurons and neural networks remains quite stable over very long periods of time. Conductances, however, also express plasticity. How this plasticity contributes to stability, however, is a question largely unexplored. Using both electrophysiological and computational tools, he and his students in the laboratory study mechanisms of neuronal plasticity and homeostasis of the ionic currents that determine the excitability and electric activity of neurons and simple neural networks. He is also interested in how neurons interact to form rhythmic pattern generating networks.

Roy Goodman

Roy Goodman's research focuses, broadly, on nonlinear wave phenomena. The tools he uses consist mainly of asymptotic methods, dynamical systems analysis, and numerical simulation. Physical applications he has studied include storm propagation in the atmosphere at middle latitudes and the interaction of light pulses in telecommunications optical fibers. Recently, he has been investigating the interaction of nonlinear waves with localized changes to the media through which they propagate. This includes the enticing possibility of "light trapping" at specified locations in optical fibers, as well as more abstract studies of classical nonlinear wave equations. Another area of application is the interaction of vortices in Bose-Einstein condensates.

Wenge Guo

Wenge Guo's research interests include large-scale multiple testing, high-dimensional inference, bioinformatics, machine learning, and statistical methods for clinical trials. The new theories and methods he derived are mainly used for controlling the false discovery rate (FDR) and other generalized error rates in large-scale multiple testing. Their main applications are on bioinformatics and computational biology. His current research projects include estimate and control of the FDR under dependence and development of new multiple testing methodologies for different biomedical areas such as microarray data analysis, design and analysis of clinical trials, and high throughput screening assay.

Brittany Hamfeldt

Brittany Hamfeldt's research focuses on the development of numerical methods for solving nonlinear partial differential equations. A particular focus of her work is the solution of fully nonlinear elliptic equations and related applications to optimal mass transportation. She has introduced new formulations of the associated equations, which have led to the first PDE based methods for optimal mass transportation. These methods have enabled the development of new techniques for solving seismic inverse problems and for reshaping beams of light. She has also introduced a new framework for solving a large class of fully nonlinear elliptic equations on unstructured meshes.

Claus Holzapfel

As a community ecologist Claus Holzapfel is fascinated by the intriguing ways of how species interact with each other. Within that topic his research addresses ecological and evolutionary processes and their outcome in plant populations and communities. The leading question is whether communities are more than simple chance assemblies. Perturbed systems - systems that are altered from their pristine state - are ideal study objects to address such a question, since here possible coevolved interactions are likely disrupted. Good examples are plant communities that are invaded by non-native organisms or systems otherwise heavily impacted by human activity (climate change, land-use change).

David J. Horntrop

The research of David J. Horntrop has focused on the development and numerical simulation of stochastic models of physical phenomena for problems ranging from materials science to fluid dynamics. His studies of turbulent diffusion were based on random field models for the advection of passive scalars and involved asymptotics, stochastic analysis, and the creation of novel wavelet-based Monte Carlo numerical schemes for the simulation of random fields. His current studies of materials involve the development and use of mesoscopic models to describe surface processes in order to gain insight on the importance of small scale phenomena on the creation of large scale patterns. He is presently developing and validating new spectral methods for the numerical solution of stochastic partial differential equations for these studies.

Huaxiong Huang

Huaxiong Huang's research interests include Fluid Mechanics, Scientific Computing, Mathematical Modeling and Industrial Mathematics. Recently, he has been working on problems on stress/defects reduction of InSb crystals, ruin probability and asset allocation related to personal finance, multiphase mass and heat transport problems in cloth assemblies, bread baking, and multiphase bubbly flow related to water purification; extensional viscous flow related to optical fiber drawing and pulling of microelectrodes; and finally in biologically related problems such as the spatial buffering and viral membrane fusion.

Shidong Jiang

Shidong Jiang's main research interests lie in the field of numerical analysis and scientific computing with particular emphasis on fast numerical algorithms and integral equation methods for solving initial/boundary value problems for various partial differential equations (PDEs). He has constructed second kind integral equation formulations for various problems including the open surface problems, the fourth order PDEs such as biharmonic and modified biharmonic equations, the unsteady Stokes equations, the dislocation climb in two dimensions, and the electromagnetic mode propagation of optical waveguides. He has also worked on the construction of sum-of-exponentials and sum-of-poles approximations and their applications including nonreflecting boundary condition for the Schrodinger equation, the Havriliak-Negami dielectric model, the Caputo fractional derivative, efficient separated sum-of-exponentials approximation of the heat kernel in arbitrary dimension, and the continuous time random walk transport equation. He is currently working on the efficient algorithms for large-scale photonics simulation.

Lou Kondic

Research of Lou Kondic has concentrated on modeling and numerical simulations of various problems in fluid mechanics and material science, in particular granular materials. His focus is on modeling, asymptotic methods, and scientific computing. The problems arising from fluid mechanics that he has worked on include interfacial flows for Newtonian and complex fluids (liquid crystals in particular), thin film instabilities, contact line dynamics, and pattern formation on the scales ranging from nano to macro. He has also worked in the field of compressible fluid mechanics, in particular bubble dynamics and sonoluminescence. In the field of granular matter, he has developed molecular dynamics/discrete element simulations for two and three dimensional granular systems. These simulations have been used to address granular statics and dynamics in various settings including microgravity environment, dense granular flows, silo discharge, to name a few. Recent focus has been on development of topological methods for describing structure of granular systems on mesoscale. His research is carried out in close collaboration with experimental researchers in the field.

Ji Meng Loh

Ji Meng Loh’s primary research interest is in spatial statistics, in particular the analysis of spatial point patterns. He has developed methods for bootstrap of spatial data, anomaly detection and assessing data quality. Ji Meng has worked on statistical applications in many fields including cosmology, public health, fMRI analysis and telecommunication.

Jonathan H. C. Luke

The research of Jonathan H. C. Luke has focused on the modeling and analysis of physical problems primarily in the areas of low-Reynolds-number fluid dynamics and wave propagation in complex media. His studies in sedimentation theory cover the topics of velocity fluctuations, renormalization, the method of reflections, cluster dynamics, and variational and numerical methods. His studies of electromagnetic waves in highly dispersive media mainly concern energy deposition and numerical methods. His current projects include analysis of the stability of numerical implementations of no-slip boundary conditions for the Navier-Stokes equations in streamfunction-vorticity form, simulation and analysis of energy deposition from electromagnetic waves in dispersive materials, and effective boundary conditions for heating and scattering problems in microwave cavities.

James MacLaurin

James MacLaurin's work centers on understanding randomness in biology. He is particularly interested in understanding how order and synchrony arise from the interplay of noise and structure at the microscopic level. A lot of his work concerns understanding the collective dynamics of large networks of noisy interacting neurons. This typically involves the analysis of high-dimensional `mean-field' systems of interacting stochastic units; understanding how such systems give rise to emergent phenomena such as traveling waves and synchronization patterns. He has also done extensive work on the phase reduction of stochastic biochemical oscillators. This includes the extension of classical methods of phase reduction for oscillators subject to continuous white noise, to the case where the oscillators are subject to discrete discontinuous forcing.

Simone Marras

Simone Marras's research spreads across three different fields of computational fluid dynamics: i) large eddy simulation of atmospheric dynamics, ii) turbulence modeling for large scale geophysical flows such as tsunamis and storm surge, and iii) analysis of natural hazards mitigation by numerical modeling. He is part of "The Climate Modeling Alliance" (CLIMA), a large multi-institutional project led by Caltech working towards the development of a machine-learning driver climate forecast model (https://clima.caltech.edu/).

Victor Matveev

The research of Victor Matveev is in the area of computational neuroscience, and is focused primarily on biophysical modeling and numerical simulations of synaptic function and its mechanisms. In his work, Victor Matveev employs analytical methods as well as a variety of computational techniques, from stochastic modeling to numerical solution of partial and ordinary differential equations. Victor Matveev performs most of his work in collaboration with experimental neurophysiologists, and develops models to explain and fit the experimental data. His current projects include the study of the mechanisms of short-term synaptic facilitation and other calcium-dependent processes involved in neurotransmitter secretion, and the modeling of presynaptic calcium diffusion and buffering. To facilitate his research, Victor Matveev also has been working on the development of a software application designed for solving the reaction-diffusion equation arising in the study of intracellular calcium dynamics ("Calcium Calculator").

Jay Meegoda

Jay Meegoda's research can be best described as mechanics of geo-environmental engineering where he utilizes scientific concepts and engineering technologies in real world applications. Under the heading of mechanics of geo-environmental engineering, his research can be further subdivided into five main trust areas: engineering properties of contaminated soils; centrifugal modeling of contaminant transport; micro-mechanics of civil engineering materials; reuse of contaminated soils; and ultrasound research. Micromechanic models were used

to explain the mechanical behavior of civil engineering materials. He received the best practice paper award in 2001 from the Environmental Multimedia Council of the Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE) for a publication resulting from the above research. Currently, his research is focused on use of a laser to detect segregation in asphalt pavements and development of smart pipes for drinking and waste water distributions.

Zoi-Heleni Michalopoulou

The research of Zoi-Heleni Michalopoulou focuses on inverse problems in ocean acoustics. The goal is to understand the properties of the propagation medium and detect and localize sound-emitting sources. To this end, methods are developed that combine ocean acoustic modeling and signal processing. Efforts are made to design direct (or exact) methodologies that return ocean medium property values using a set of measurements and the solution of an integral equation. In parallel, sound propagation modeling is combined with Bayesian models to provide a concurrent description of the water column and sediment and location of the source.

Petronije Milojevic

The research of P.S. Milojevic is focused on studying semilinear and (strongly) nonlinear operator equations using a combination of topological, approximation, and variational methods and applications to ordinary and partial differential equations. He has developed various fixed point results for condensing and A-proper maps. His studies of semilinear operator equations with monotone and (pseudo) A-proper maps involve nonresonance and resonance problems with Fredholm and hyperbolic-like perturbations of single valued and multivalued nonlinear maps, and Hammerstein equations. He has widely applied these abstract theories to BVPs for (contingent) ordinary and elliptic PDEs, to periodic and BVPs for semilinear hyperbolic and parabolic equations and to nonlinear integral equations. His study of nonlinear and strongly nonlinear operator equations is concerned with the existence and the number of solutions of such equations involving condensing, monotone, and various types of approximation maps. His current research deals with Hammerstein equations and weakly inward A-proper and pseudo A-proper maps and applications to differential and integral equations.

Richard O. Moore

Richard Moore's research focuses on wave phenomena in optical communication systems and optical devices. He is particularly interested in how such systems and devices are disturbed by a variety of influences relevant to their operating environments. Current projects include using a combination of perturbation methods and importance sampling to simulate rare events in optical communication lines, and using dynamical systems techniques and rigorous reduction methods to analyze the impact of heating due to optical field absorption in devices that convert optical frequencies using parametric gain media. More recent work explores the intersection between data assimilation and optimal control, including the development of efficient algorithms to compute optimal paths for autonomous vehicles navigating in noisy environments.

Cyrill B. Muratov

Cyrill Muratov's research is mainly in the area of applied analysis and calculus of variations. The problems under consideration arise from a variety of applications from materials science, fluid mechanics and biology and give rise to systems of nonlinear partial differential equations exhibiting self-organizing behavior. These difficult mathematical problems can be approached by the direct method of calculus of variations and singular perturbation techniques. Currently, the ongoing projects include the asymptotic analysis of energy-driven pattern formation problems in the presence of non-local effects, with major applications to ultrathin ferromagnetic films

and nanotechnology. Other projects involve modeling, analysis and simulations of rare events in noise-driven systems and studies of multiscale, multiphysics problems, with particular applications to NASA's space exploration systems.

Farzan Nadim

Farzan Nadim studies rhythmic motor activity generated in the central nervous system by combining experiments and computational techniques. Nadim has a joint appointment with the Federated Department of Biological Sciences and runs a laboratory that conducts experiments on isolated nervous systems of crustacea. These experiments involve electrophysiological recordings from multiple nerves and neurons, pharmacological manipulations of the system, and immunohistology. The neuronal circuits studied all produce oscillatory output of various frequencies. The lab also models these systems both at the detailed biophysical level and using analytic mathematical techniques. His current focus is on contribution of synaptic dynamics to network output and the interaction between multiple oscillatory systems.

Anand Oza

Anand Oza's primary research interests are fluid mechanics and physical applied mathematics, with applications to soft matter physics and biological systems. He uses a combination of modeling, analysis and numerical simulation, and typically works in collaboration with experimentalists in the field. His research has recently been directed towards understanding hydrodynamic interactions in active matter systems, in which collections of objects both generate and interact with fluid flows. Specifically, he has developed and analyzed mathematical models for the pilot-wave dynamics of droplets bouncing on a vibrating fluid bath, a system that offers a visualization of wave-particle coupling on a macroscopic scale. He has also developed a PDE model for liquid crystal-like assemblies comprised of microtubules and motor proteins in a fluid, a model system for studying the self-organization principles that underlie complex cellular structures. He is currently developing models for the interactions between flapping swimmers, with a view to understanding how hydrodynamics mediates schooling and flocking behavior in animal collectives.

Demetrios T. Papageorgiou

The research of Demetrios T. Papageorgiou focuses on the modeling, analysis, and computation of physical and technological problems that involve fluid dynamics and aerodynamics. His studies in surface tension driven flows cover the stability, dynamics, and breakup of single and compound liquid jets, both in the presence and absence of surface active agents, which affect interfacial tension. Analysis of finite-time-singularities has been used to motivate experiments for rheological measurements. His studies in bubble dynamics are a theoretical and experimental collaborative research effort to control the drag on rising bubbles using surfactants. Current projects include jet and bubble dynamics, nonlinear stability of core-annular flows when surfactants are present, nonlinear stability of electrified liquid films, and study of viscous flows in pulsating channels or tubes by construction of Navier-Stokes solutions both numerically and analytically with particular emphasis on chaotic regimes and their influence on applications.

Peter G. Petropoulos

The research of Peter G. Petropoulos has focused on the numerical modeling and asymptotic analysis of physical problems in the areas of transient electromagnetic wave propagation in complex media. His studies of pulsed electromagnetic waves in dispersive media mainly concern the asymptotic and numerical methods for studying the response of relaxing (Debye) and fractionally-relaxing (Cole-Cole) dielectrics, as well as the development

fourth-order accurate finite difference methods for the time-domain Maxwell equations with discontinuous coefficients. His current projects include analysis of the error in problems where impedance boundary conditions are employed, development of numerical techniques to simulate pulse propagation in Cole-Cole dielectrics, analysis of perfectly matched absorbing boundary conditions in relation to exact absorbing boundary conditions, and the development of fourth-order accurate schemes in the presence of curved boundaries.

Anthony D. Rosato

Anthony Rosato's research is concerned with granular flows as related to the solids handling and processing industries. The flows are modeled using dissipative molecular dynamics simulations to identify governing mechanisms that affect observable behavior. Currently, he is studying the development of velocity field structures in boundary-driven flows, and how they may influence segregation behavior in polydisperse systems. He is also interested in the application of dynamical systems modeling to these systems.

Horacio G. Rotstein

The research of Horacio G. Rotstein focuses mainly on the study of the biophysical and dynamic mechanisms underlying the generation of rhythmic oscillatory activity in the brain, particularly in the hippocampus and entorhinal cortex. Rhythmic oscillations at theta (8 - 12 Hz) and gamma (30 - 80 Hz) frequencies in these areas of the brain have been correlated with various forms of learning and memory. In addition, alteration in particular sorts of brain rhythmic oscillations have been shown to correlate with the existence and progression of a variety of neuropsychiatric conditions, including schizophrenia and dementia. Rhythms differ not only in their frequency range, but also in the underlying biophysical mechanisms by which they are generated. These mechanisms usually vary in different brain areas, and may operate at a single cell level or may involve the coherent activity of many cells and cell types in a network. The primary goal of my research is to uncover and understand the underlying biophysical and dynamic principles that govern the generation of rhythmic activity in the brain. As secondary goals I hope to understand the functional implications for brain functioning of the previous results, the relation between disruption of rhythmic activity and diseases of the nervous system, and the effects that changes at a subcellular level have on rhythms observed at the single cell and network levels.

David Shirokoff

David Shirokoff's research focuses on two main areas. (i) Numerical methods for fluid dynamics in the presence of irregular boundaries and interfaces, and (ii) Numerical methods for the simulation and characterization of materials governed by energy driven pattern formation. In the first area, his developments include reformulations of the Navier-Stokes equations as pressure-Poisson systems for improved accuracy and efficiency in fluid dynamics computations, and active high order penalty methods as a means to improve the accuracy and efficiency of Fourier based methods that are used to solve PDEs on irregular geometries. In the second area, of computational materials science, his interests focus on designing new numerical techniques to characterize the underlying energy landscape. The techniques rely on replacing a complicated energy with a simpler, convex one, which can then be minimized using tools from optimization theory to systematically obtain low energy states for use in thermodynamic simulations.

Michael Siegel

The research of Michael Siegel is focused on the analysis and numerical computation of moving boundary problems that arise in fluid mechanics, materials science, and physiology. His research in fluid dynamics covers singularity formation on interfaces for inviscid and low Reynolds number (Stokes) flow, the dynamics of drops and

bubbles (including the influence of surfactant), and effect of small regularization--such as surface tension--on mathematically ill-posed interfacial flow problems. His studies in materials science primarily involve crystal growth and diffusion controlled moving boundary problems. in physiology, he has studied optimal suturing patterns for skin wounds and formulated models for determining the stress and strain distribution in the heart wall that occur due to changes in heart geometry.

Sundar Subramanian

The research of Sundar Subramanian focuses on non- and semi-parametric statistical inference for censored time-to-event-data analysis. His investigations involve study of the large sample behavior of estimators using techniques from counting processes and martingales, empirical processes, kernel estimation, and information bound theory. His interests on the computational side include bootstrap methods for model selection and bandwidth computation, and mis-specification studies using simulation. The procedures have strong theoretical basis and find applications in Biostatistics.

Ronald Sverdlove

Ronald Sverdlove's research interests are in the areas of corporate finance, fixed income securities, and the overlap of the two. In the fixed income area, he studies the Credit Default Swap (CDS) market and its relations to the bond and stock markets. He uses price data in all three markets to determine the effectiveness of models for predicting future prices. In corporate finance, he studies how corporations make decisions about various aspects of their financing, in particular the seniority level of newly issued bonds. A second corporate decision is the relative importance of using "soft" or "hard" information in deciding on investments to be made. Hard information consists of those things that can be objectively measured in a reproducible way, while soft information is more subjective and often based on personal relationships. Different kinds of institutions make different choices between the two. Current work considers contracts that corporations offer to creators of intellectual property for the purchase of that property and the reasons for the existence of contingent payments in those contracts. A third type of corporate decision is particularly relevant in the financial industry, where institutions must decide how to structure themselves according to the regulations that will apply to each possible structure. Current work involves modeling the process by which a financial institution makes the decision whether or not to become a regulated bank, trading off the ability to offer deposit insurance to customers against the reduced amount of risk and leverage that can be used by an unregulated institution. Techniques of game theory are used to analyze many of these decisions involving negotiations between two or more institutions.

Louis Tao

The research of Louis Tao focuses on large-scale scientific computation, through a combination of numerical simulations, bifurcation theory, and asymptotics. He is mainly interested in the modeling and analysis of the dynamics of networks, with applications to specific problems in neuroscience and mathematical biology. His work in computational neuroscience has been in two distinct areas: a) how neurons in the visual cortex process elementary features of the visual scene and b) how recurrent networks perform computations. His current projects include the modeling of orientation selectivity in cortex and the analysis of the network dynamics that arises.

Catalin Turc

Catalin Turc’s research interests belong to the broad area of computational electromagnetics and acoustics. The main goal is the design and implementation of numerical methods that can be used for efficient simulation of

electromagnetic and acoustic wave interactions with complex material structures. During the past few years, he has worked on a variety of problems related to fast, high-order frequency domain integral equation methods for acoustic and electromagnetic scattering problems in domains with complex material and geometrical features. He has developed analytical and computational tools that enable solutions for problems of fundamental significance involving applications such as electromagnetic interference and compatibility (electronic circuits), dielectric/magnetic coated conductors, composite metamaterials (photonic crystals and negative index materials), and solar cells.

Jean-Marc Vanden-Broeck

Jean-Marc Vanden-Broeck's research is concerned with fluid mechanics and the theory of free boundary problems. He uses a combination of numerical and asymptotic methods to investigate new properties of nonlinear solutions. A large part of his research focuses on the effects of surface tension and on the computations of waves of large amplitude. Interfacial flows generated by moving disturbances, three dimensional solitary waves, waves on electrified fluid sheets, and the stability of Stokes flows in the presence of electric fields are among his recent interests.

Antai Wang

Antai Wang's research mainly focuses on survival data analysis, high dimensional data analysis and cancer data analysis. Currently his research goal is to develop new strategies to model dependent censored data or multivariate survival data using frailty models, copula models and nonparametric methods. For high dimensional data, Antai develops new methodologies to conduct variable selections for longitudinal data based on a Procrustes criterion which is used to extract data information while keeping the original data structure. The new research strategies are important and useful for correlated survival data analysis and microarray data analysis in medical research.

Yuan-Nan Young

The research of Yuan-Nan Young focuses on the multiphase flows in computational fluid dynamics (CFD), and relevant issues in numerical treatment of moving boundary problems. In particular he has numerically investigated how surfactants, both soluble and insoluble, can affect the pinch-off of bubbles in viscous fluids. He also investigates numerical schemes to optimize the accuracy of regularization of surface tension force in CFD codes. His current projects also include an investigation on the hysteretic behavior of drop deformation in highly viscous straining flows.

C. COLLABORATIVE RESEARCH

Shahriar Afkhami

"Numerical Investigation of Marangoni Flows in Mixing of Miscible Liquids" with I. Seric (NJIT, Graduate Student)

"A New Computational Method for Viscoelastic Two-Phase Flows" with V. Barra (NJIT, Graduate Student)

"Micorfluidics Flow Focusing" with A. Leshansky

"Cavitation in Insects: Mechanisms for Switching on the Embryonic Tracheal System" with A. Woods (UMontana)

"Numerical Simulation of Microlayer Formation in Nucleate Boiling" with J. Buongiorno (MIT)

"Magnetophoretic Interaction of Ferrofluid Droplets in a Rotating Magnetic Field" with J. Feng (UBC)

"Liquid Metals on Nanoscale: Modeling and Computation" with L. Kondic

John K. Bechtold

"Theoretical Combustion" with C. K. Law (Princeton University), H. G. Im (University of Michigan), and M. Matalon (Unnivesity of Illinois)

Denis L. Blackmore

"Discrete Dynamical Modeling of Logical Circuits" with A. Rahman (NJIT, Graduate Student)

"Analysis and Simulation of Infinite-Dimensional Dynamical Systems" with H. Wu (NJIT, Graduate Student)

"A Gauge-Theoretical Analysis of Magnetic Reconnection" with K. Urban NJIT, Applied Physics (Graduate Student)

"Integrability Analysis of Nonlinear Equations of Mathematical Physics" with A. Prykarpatski (AGH, Krakow, Poland)

"Perturbations of the Forced Van Der Pol Equation" with J. Tavantzis (NJIT)

"Local Periodic Pertubations of Limit Cycles" with J. Tavantzis (Rutgers-Newark)

"Innovations in Strange Attractor Theory and Applications" with Y. Joshi (Kingsborough Community College)

"Density Relaxation in Granular Systems" with A.D. Rosato and D. J. Horntrop

"Solutocapillary Flows" with P. Singh and I. S. Fischer

"New Techniques for Analyzing Strange Attractors" with Y. Joshi (Kingsborough CC) and A. Rahman (NJIT)

“Axial and Radial Pressure in Cylindrical Silos” with A. D. Rosato and X. Tricoche

“Dynamical Systems Foundations of Entropy” with J. Tavantzis NJIT (Emeritus) and R. Addabbo (Vaughn College)

“Dynamical Systems Modeling of Dilating/Contracting Granular Systems” with A. D. Rosato, L. Zuo (NJIT, Graduate Student), N. Ching (NJIT, Graduate Student), A. Harlow (NJIT, Graduate Student), X. Tricoche (Purdue University), and K. Urban (NJIT, Graduate Student)

“Dynamical Modeling and Analysis of Walking Droplets.” with A. Rahman (NJIT, Graduate Student)

“Dynamical Systems, Differential Topology and Analysis: Theory and Applications” with A. Rosato, A. Prykarpatsky, A. Rahman, M. Brons, and B. Shashikanth, J. Lee

Michael R. Booty

“Surfactant Effects in Low Reynolds Number Flows” with Y.-N. Young and M. Siegel

“Novel Approaches to Semiconductor Device Integration Using Magnetic Fields” with A. Ravindra and A. Fiory

Amitabha K. Bose

“Linear Conductance-Based Mechanisms Underlying Oscillations in Neuronal Networks” with J. P. Golowasch and F. Nadim

“Global Coupling of Genetic Oscillators” with C. O. Diekman and H. G. Rotstein

“Role of Linear Currents on Slow Oscillation” with J. P. Golowasch, F. Nadim, and Y. Guan (NJIT, Graduate Student)

Yassine Boubendir

“Well-Conditioned Integral Equations for Acoustic Transmission Problems” with C. Turc

“Acceleration of an Iterative Method for the Evaluation of High-Frequency Multiples Scattering Effects” with R. Fernando and F. Ecevit

“Coupling Finite and Boundary Element Methods Using Localized Adaptive Radiation Condition for Maxwell's Equations” with A. Bendali and N. Zerbib

“A Preconditioner for Wave Problems Based on the Perfectly Matched Layer” with P. Petropoulos, Y. Boubendir, and D. Midura (Graduate Student)

Bruce G. Bukiet

“Education Research” with J. M. Lipuma

“Math Modeling of Prostate Cancer Treatment” with H. Chaudhry (NJIT), T. Findley (VA Hospital East Orange), N. Gao (Rutgers-Newark), Z. Ji, and S. Dhar

Daniel E. Bunker

“Augmented Reality for Ecological Data and Processes” with G. J. Russell

“Spontaneous Dispersion of Particles in Liquid Surfaces” with P. Singh

“Life History Tradeoffs and Species Abundance” with B. Mitchell, T. Blockus, and A. Madala

“Cascading Effects of Urbanization on Pollinator and Plant Communities” with C. DeVan (Graduate Student), T. Blockus (Undergraduate Student), and D. Evangelista (Undergraduate Student)

“Effects of Generalist Herbivores on Plant Communities” with Linda Rohleder (Graduate Student), Timothy Blockus (Undergraduate Student), Dominic Evangelista (Undergraduate Student), Don Waller, Alex Royo, Bill McShea, Steeve Cote, Caroline DeVan (Graduate Student), and Brian Traw

Wooyoung Choi

“High Order Semi-Implicit Time Integration for the Dispersive Shallow Water Equations” with D. G. Shirokoff and L. Feng (NJIT, Graduate Student)

Linda J. Cummings

“Two-Dimensional Stokes Flow in Doubly-Connected Domains” with J. King (University of Nottingham, UK)

“Mathematical Model for Determining the Binding Constants between Immunoglobulins, Bivalent Ligands, and Monovalent Ligands” with R. Perez-Castillejos and E. Mack (BP)

“Extensional Dynamics of a Nematic Liquid Crystal Sheet” with T. Myers (CRM, Barcelona) and J. Low (CRM, Barcelona)

“Mathematical Models for Tissue Engineering” with J. Pohlmeyer (NJIT, Graduate Student) and S. Waters (University of Oxford)

“Liquid Metal Instabilities Driven By Pulsed Laser Heating” with L. Kondic and R. Allaire (NJIT, Graduate Student)

“Bistability and "Gliding" in a Nematic Liquid Crystal Display Device” with L. Kondic, C. Cai (NJIT, Graduate Student), and E. Mema (NJIT, Graduate Student)

“Free Surface Instability of a Thin Film of Nematic Liquid Crystal” with L. Kondic, M. Lam (NJIT, Graduate Student), T.-S. Lin (University of Loughborough), and U. Thiele (University of Loughborough)

“Mathematical Models Related to the Drawing of Glass Sheets and Optical Fibers” with C. Breward (University of Oxford), J. Abbott (Corning, Inc.), T. Witelski (Duke University), I. Griffiths (University of Oxford), M. Taroni (University of Oxford)

“Mathematical Models for Filtration” with P. Sanaei (New York University), G. Richardson (University of Southampton), L. Kondic, B. Gu (NJIT, Graduate Student), and Y. Sun (NJIT, Graduate Student)

Sunil K. Dhar

"Multivariate Logistic-Type Models Based on an Inverse Sampling Scheme" with Y. Zhu (NJIT, Graduate Student)

"Robust Spatial Release from Masking for Spectrally Degraded Vocoded Speech" with A. Ihlefeld (NJIT)

"Assessment and Comparison of the Slippage and Unintentional Opening of Epidural Catheters and Their Connectors." with C. Anthony (Rutgers, New Jersey Medical School), R. Horvath (B. Horvath, LLC), and A. Gonzalez Fiol (Yale, New Haven Hospital)

"Math Modeling of Prostate Cancer Treatment" with B. G. Bukiet, H. Chaudhry (NJIT), T. Findley (VA Hospital East Orange), N. Gao (Rutgers-Newark), and Z. Ji

Casey O. Diekman

"Correlated Expression of Ion Channel in Circadian Neurons" with J. P. Golowasch

"Global Coupling of Genetic Oscillators" with A. K. Bose and H. G. Rotstein

"Daylength Encoding By Circadian Clock Neurons" with M. Belle (University of Manchester) and H. Piggins (University of Manchester)

"Ion Channel Expression in SCN2.2 Cell Line" with J. P. Golowasch and R. Deek (Undergraduate Student)

"Involvement of Neural Oscillators and Proprioception in Locomotion of C. Elegans" with G. Haspel, J. Storm (NJIT, Graduate Student), and A. Jurko (NJIT, Graduate Student)

"Magnesium Regulates the Circadian Oscillator in Cyanobacteria" with Y. I. Kim, C. L. Dias, Y. Jeong (NJIT), and M. Kaur (NJIT, Graduate Student)

"The Various Effects of the Light/Dark Signals on the Biological Metabolite Signals for the Entrainment of the Cyanobacterial Circadian Clock" with Y. Jeong (NJIT), M. Kaur NJIT (Graduate Student), P. Petal (Graduate Student), A. Shah (Undergraduate Student), A. Ng (Undergraduate Student), and E. Khan (Graduate Student)

Christina A. Frederick

"Sampling, Frame Theory, Stability Estimates" with K. Yacoubou Djima (Amherst College)

"Mean Flow in Closed Pipe System" with A. U. Oza

"Optimal Control Strategies for Multirobot Path Planning" with H. Zhou (Georgia Tech) and M. Egerstedt (Georgia Tech)

"Multiscale Inverse Problems in Sonar Imaging" with Z.-H. Michalopoulou and S. Villar (NYU)

"Inverse Problems for Medical Imaging" with S. Valellian (NC State) and K. Ren (UT Austin)

Roy H. Goodman

“Interactions of Vortex Interactions in Bose-Einstein Condensates” with P. Kevrekidis (University of Massachusetts) and R. Carretero (San Diego State University)

“Instabilities of Localized Solutions to Nonlinear Wave Equations with Defects.” with M. Weinstein (Columbia University and J. Marzuola (University of North Carolina)

“Numerical Methods for Invariant Manifolds” with J. Wrobel (Graduate Student), C. Basarab (Graduate Student), and P. Shah (Undergraduate Student)

Wenge Guo

“New Directions for Research on Some Large-Scale Multiple Testing Problems” with S. K. Sarkar (Temple University)

“Analysis of Longitudinal Microarray Data” with A. Wang, J. M. Loh, X. Zhang (NJIT, Graduate Student), X. (James) Li (Georgetown University)

“Analysis of Error Control in Large Scale Two-Stage Multiple Hypothesis Testing” with J. P. Romano (Stanford University)

Brittany D. Hamfeldt

“Optimal Transport on the Sphere” with A. Turnquist (NJIT, Graduate Student)

“Eigenvalue Problems for Fully Nonlinear Elliptic PDEs” with J. Lesniewski (NJIT, Graduate Student)

“PDE Methods for Optimal Transport with General Costs” with M. Illingworth (NJIT, Graduate Student)

“Beam Shaping Following an Optimal Transportation Map” with Z. Feng (Beijing Institute of Technology)

David J. Horntrop

“Density Relaxation in Granular Systems” with A.D. Rosato and D. L. Blackmore

“Modeling and Simulation of Credit Risk” with B. Ren (NJIT, Graduate Student) and W. Morokoff (Standard & Poors)

“Variance Reduction for Stochastic Differential Equations” with M. Billamoria (NJIT, Undergraduate Student) and S. Singh (NJIT, Undergraduate Student)

Lou Kondic

“Instabilities of Fluid Films on Nanoscale” with T.-S. Lin (Graduate Student)

“Dynamics of an Intruder in Granular Matter” with X. Fang (Graduate Student)

“Liquid Metals on Nanoscale: Modeling and Computation” with S. Afkhami

“Liquid Metal Instabilities Driven By Pulsed Laser Heating” with L. J. Cummings and R. Allaire (NJIT, Graduate Student)

“Bistability and "Gliding" in a Nematic Liquid Crystal Display Device” with L. J. Cummings, C. Cai (NJIT, Graduate Student), and E. Mema (NJIT, Graduate Student)

“Free Surface Instability of a Thin Film of Nematic Liquid Crystal” with L. J. Cummings, M. Lam (NJIT, Graduate Student), T.-S. Lin (University of Loughborough), and U. Thiele (University of Loughborough)

“Mathematical Models for Filtration” with L. J. Cummings, P. Sanaei (New York University), G. Richardson (University of Southampton), B. Gu (NJIT, Graduate Student), and Y. Sun (NJIT, Graduate Student)

Ji Meng Loh

“Estimating the Survival Rate of Mutants” with A. Miliwith J. M. Loh

“Analysis of Longitudinal Microarray Data” with A. Wang, W. Guo, X. Zhang (NJIT, Graduate Student), and X. (James) Li (Georgetown University)

Enkeleida Lushi

“Fluid Dynamics of Free Swimming Zebrafish Larvae” with K. E. Severi and H. Zaki (Undergraduate Student)

Victor V. Matveev

“Properties of Synaptic Calcium Channels” with E. Stanley

“Calcium Nanodomains in Neurotransmitter and Hormone Release” with A. Sherman (NIH) and R. Bertram (Florida State University)

“Dynamics of Calcium-Dependent Insulin Secretion in Pancreatic Beta Cells”
with M. G. Pedersen, A. Sherman, and M. Riz (Graduate Student)

Zoi-Heleni Michalopoulou

“Detection of Weak Sources in Underwater Environments” with A. Abdi

“Statistical Modeling of the Invariance Principle for Tracking” with L. Zurk

“Sediment Layer Identification with Ambient Noise” with P. Gerstoft

“Sequential Particle Filtering” with C. Yardim and P. Gerstoft

“Multiscale Inverse Problems in Sonar Imaging” with C. Frederick, Z.-H.Michalopoulou, and S. Villar (NYU)

"Contaminant Behavior and Impacts to Environmental Systems" with L. B. Axe (NJIT), L. Wei (NJIT), K. Jahan, (Rowan University), J. Dyksen (United Water), B. Wang (NJIT, Graduate Student), N. Sandhu (NJIT Graduate Student), Z. Shu (NJIT, Graduate Student), S. Zhang, (NJIT, Graduate Student), and S. Gitungo (NJIT/Ha

Richard O. Moore

"Localized Patterns in Thermally Active Parametric Gain Media" with K. Promislow (Michigan State University)

"Heating of Thin Ceramic Slabs in Microwave Cavities" with S. Agrawal (NJIT, Graduate Student)

"Transitions and Soft Error Rates in Micromagnetic Devices" with Y. Yu (NJIT, Graduate Student) and C. B. Muratov

"Optimal Control in Data Assimilation" with D. McDougall and A. Hsieh

"Importance Sampling in Data Assimilation" with C. Jones (UNC-Chapel Hill) and D. McDougall (Institute for Computational Engineering and Sciences, U. Texas-Austin)

"Effects of Thermal Perturbations on Magnetic Droplet Solitons" with M. Hoefer and P. Wills (Graduate Student)

"Noise and Rare Events in Optical Systems" with D. Cargill (Institute for Computational and Experimental Research in Mathematics, Brown University) and C. McKinstrie (Alcatel-Lucent), and T. Schaefer (The College of Staten Island)

Cyrill B. Muratov

"Gamma-Convergence for Nonlocal Variational Problems" with M. Novaga (University of Pisa)

"Non-Local Geometric Variational Problems" with M. Novaga (University of Pisa)

"Nonlinear PDEs Involving Fractional Operators" with X. Yan (University of Connecticut)

"Transitions and Soft Error Rates in Micromagnetic Devices" with R. O. Moore and Y. Yu (NJIT, Graduate Student)

"Density Functional Theory for Massless Fermions in Graphene" with V. Moroz (University of Swansea) and J. Lu (Duke University)

"Supercritical Fronts for Reaction Diffusion Equations in Infinite Cylinders" with P. Gordon and M. Novaga (University of Padua)

"Front Propagation in Geometric and Phase Field Models of Stratified Media" with M. Novaga (University of Pisa), A. Cesaroni (University of Padua), and P. Gordon (University of Akron)

"Domain Walls in Thin Film Ferromagnets" with R. Lund (NJIT), A. Capella-Kort (UNAM), H. Knuepfer (University of Heidelberg), G. Chaves-O'Flynn (NYU), and V. Slastikov (Bristol University)

Farzan Nadim

"Temporal Fidelity of Axonal Action Potential Conduction and Its Neuromodulation" with D. M. Bucher

"Linear Conductance-Based Mechanisms Underlying Oscillations in Neuronal Networks" with J. P. Golowasch and A. K. Bose

"Role of Linear Currents on Slow Oscillation" with J. P. Golowasch, A. K. Bose, and Y. Guan (NJIT, Graduate Student)

Anand U. Oza

"Mean Flow in Closed Pipe System" with C. A. Frederick

Peter G. Petropoulos

"Algorithms for the Computation of Fractional Derivatives" with M. Causley

"Numerical Simulation of Pattern Formation in Systems with Global Feedback" with H. G. Rotstein

"Electrohydrodynamics and Interfacial Fluid Dynamics" with L. Barannyk and D. Papageorgiou

"Electrohydrodynamics and Interfacial Fluid Dynamics" with T. Anderson (Undergraduate Student) and D. Papageorgiou

"A Preconditioner for Wave Problems Based on the Perfectly Matched Layer" with P. Petropoulos, Y. Boubendir, and D. Midura (Graduate Student)

Horacio G. Rotstein

"Pattern Formation in Relaxation Oscillators with Inhibitory Global Feedback" with H. Wu (NJIT, Graduate Student)

"Numerical Simulation of Pattern Formation in Systems with Global Feedback" with P. G. Petropoulos

"The Canard Phenomenon in Piece-Wise Linear Systems" with S. Coombes

"Dynamics of Fronts in Bistable Systems with Delayed Global Feedback" with Y. Boubendir

"Global Coupling of Genetic Oscillators" with C. O. Diekman and A. K. Bose

"Coregulation of Conductances in Neuronal Models" with J. P. Golowasch and M. Olarinre (Graduate Student)

"Dynamic Compensation Mechanism Give Rise to Period and Duty Cycle Level Sets in Oscillatory Neuronal Models" with J. P. Golowasch and M. Olarinre (Graduate Student)

"Dynamics of Medial Entorhinal Cortex Layer II Stellate Cells and Related Networks" D. Kim (Graduate Student), J. White, and T. Kispersky

"Subthreshold and Superthreshold Frequency Preferences (Resonance) in Nonlinear Neural Models" with D. Kim (Graduate Student), F. Nadim, and N. Sheikholeslami (Graduate Student)

David G. Shirokoff

"FFT Based Optimization for Variational Problems with Fourier Constraints" with M. Bandegi (NJIT, Graduate Student)

"High Order Semi-Implicit Time Integration for the Dispersive Shallow Water Equations" with W. Choi and L. Feng (NJIT, Graduate Student)

"High Order Methods for a Pressure Poisson Equation Reformulation of the Navier-Stokes Equations with Electric Boundary Conditions" with D. Zhou (Temple), B. Seibold (Temple), and R. Rosales (MIT)

"Resolving Order-Loss in Runge-Kutta Methods for Boundary Value Problems" with B. Seibold (Temple University), D. Zhou (Temple University), and R. Rosales (MIT)

Michael S. Siegel

"Efficient Surface-Based Numerical Methods for 3D Interfacial Flow with Surface Tension" with D. Ambrose (Drexel)

"Mechanics of Retinal Detachment" with T. Chou

"Surfactant Effects in Low Reynolds Number Flows" with Y.-N. Young and M. Booty

Sundarraman Subramanian

"Log-Rank Test from Twice Censored Data" with A. Javidi (NJIT, Graduate Student)

"Model Checks for Two-Sample Location-Scale" with A. Javidialsaadi (NJIT, Graduate Student), S. Mondal, and B. Ingelheim

Catalin C. Turc

"Reduced Bases Simulation of Wave Propagation in Urban Environments" with O. Bruno (Caltech) and M. Lyon (U New Hampshire)

"High-Order Solutions of Integral Equation Formulations of Helmholtz Transmission Problems in Two-Dimensional Domains with Corners" with V. Dominguez (U Navarra Spain) and M. Lyon (U New Hampshire)

Antai Wang

"Analysis of Clustered Survival Data Using Frailty Models" with X. Jia (NJIT, Graduate Student)

"Analysis of Longitudinal Microarray Data" with J. M. Loh, W. Guo, X. Zhang (NJIT, Graduate Student), and X. (James) Li (Georgetown University)

Yuan-Nan Young

“Electrodeformation of a Surfactant-Laden Viscous Drop” with H. Nganguia (NJIT, Graduate Student)

“Poration of a Lipid Bi-Layer Membrane” with H. Nganguia (NJIT, Graduate Student)

“Swimming of Bacteria with Two Flagella” with N. Patel Northwestern University (Graduate Student)

“Dynamics of Primary Cilium” with C. Jacobs (Columbia University)

“Elastic Filament and Viscous Drop in Stokes Flow and Rheology of Soft-Particle Suspensions” with M. Shelley

“Surfactant Effects in Low Reynolds Number Flows” with M. Booty and M. Siegel

“Dynamics and Rheology of a Compound Vesicle in Shear Flow” with J. Blazdziewicz, P. Vlahovska, and S. Veerapaneni

X. STUDENT ACTIVITIES

A. UNDERGRADUATE ACTIVITIES

Report on Undergraduate Studies
David J. Horntrop, Associate Chair for Undergraduate Studies

The undergraduate program of the Department of Mathematical Sciences continued to be very active during the past academic year.

In addition to their studies in our rigorous academic programs, many of our undergraduates also engaged in research. One of the main focuses of this research activity has been the NSF-funded EXTREEMS-QED program, which began in Fall 2013 and has now entered its fourth year. The PI is Michael Siegel and the Program Director is David Horntrop. Students in each year's cohort begin their research projects in January and complete them in December of the same year. The 2018 cohort consisted of nine students: Amina Bendaoud, Joshua Colditz, Kyle D'Souza, George Haramuniz, William McCann, Chiara Milla, Daniel Newton, Jacob Piccolo, and Thomas Slawinski. Their research mentors were Shahriar Afkhami, Casey Diekman, and Eliza Michalopoulou. The 2019 cohort consists of four students: Manan Brahmbhatt, Brandon Chin, John Desalvo, and Justin Maruthanal. Their research mentors are Shahriar Afkhami and Sundar Subramanian. EXTREEMS-QED students presented their research at a number of conferences recently including the MBI Undergraduate Research conference.

Many students have been engaged in research outside the EXTREEMS-QED program and have presented and published their work at various conferences including the NJIT Undergraduate Summer Research Symposium. Many of our students have industrial internships during the summer, particularly, but not exclusively, students in the Mathematics of Finance and Actuarial Science concentration. Each summer a number of students have internships at MetLife and Prudential Financial while some students intern at consulting firms such as Mercer Consulting and Oliver Wyman Actuarial Consulting. Companies such as Chubb, Aon, and Panasonic also employ our students as summer interns.

Our students have also received many honors and awards during the past year and have also found success on their actuarial examinations with more than 14 passed during the year. This year's Pi Mu Epsilon Mathematics Honor Society Induction Ceremony took place in April with Amina Bendaoud, Manan Brahmbhatt, Songhai Chen, Kyle D'Souza, Yassine Dribki, Emily Jensen, William McCann, Daniel Newton, Umang Pathak, Jake Piccolo, and Jose Rivera being inducted into membership. The department itself was honored by having its Mathematics of Finance and Actuarial Science program ranked fifth nationally in a study commissioned by SafecoInsurance.com.

Many students who graduate from our program continue either to enter graduate programs at other prestigious institutions or find gainful employment. Examples of graduate schools recently attended by our undergraduates include UTexas-Austin, UCLA, CalTech, RPI, Columbia, Northwestern, and the University of Delaware. Examples of employers of our recent graduates include MetLife, Prudential Financial, Chubb, NYLife, Aon, Buck Consultants, and Trillium Management.

Capstone Laboratory Projects on Modeling and Simulation of Synchronized Oscillators

Instructor: Michael Siegel; Lab Assistant: Andrew deStefan

Participating Students: Michael Anchundia, Patricia Bobila, Sal Cordaro, Joe D'Adessa, Yassine Dribcki, George Haramuniz, Visar Kola, Jacob Piccolo, Aybala Sen, and David Youssif

The project in Prof. Michael Siegel's capstone class involved the modeling and simulation of synchronized oscillators. Synchronization of oscillators was discovered by Christian Huygens in 1657, who noticed that two pendulum clocks mounted on a common base would swing at the same frequency (but 180 degrees out of phase). The phenomena is important in biology, where synchronization of oscillators are observed, for example, in swarms of flashing fireflies and in networks of pacemaker cells in the heart, among other systems.

The coupled oscillator system modeled in the class consisted of a pair of metronomes sitting on a freely moving base made up of a balsa board and two soda cans (see Figure 1). Experiments performed by the students showed that the oscillators synchronized whenever the difference in natural frequencies Δ of the individual oscillators was sufficiently small.

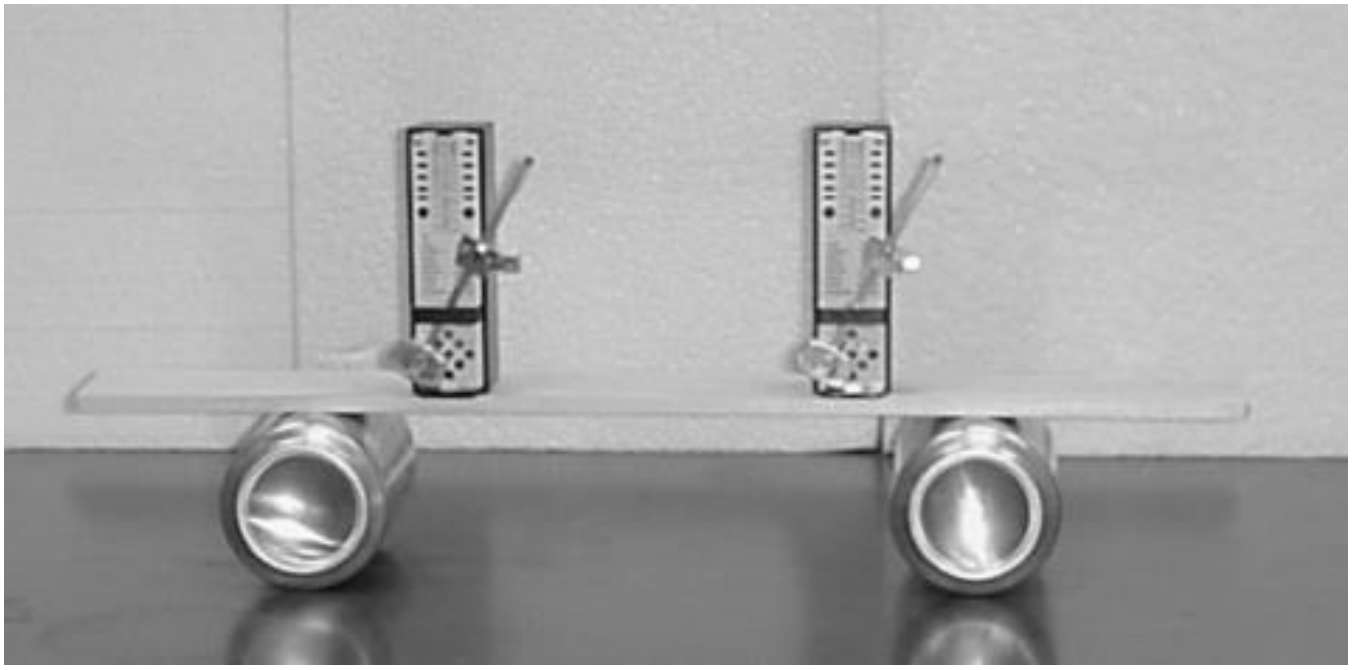


Figure 1: The experimental setup (from Pataleone, Am. J. Phys. 70 (10), 992, (2002))

A mathematical model for the coupled oscillator system was derived using Lagrangian mechanics. This gives a coupled system of ODE's for the oscillation angles, with several free parameters that need to be determined form the experiment. The system of ODE's were numerically solved using Matlab. The free parameters were fitted to the experimental data using 'sensitivity analysis', a form of data analysis that employs Gauss-Newton minimization to fit parameters of an ODE to best represent real data. The fitting of parameters was a main component of the project.

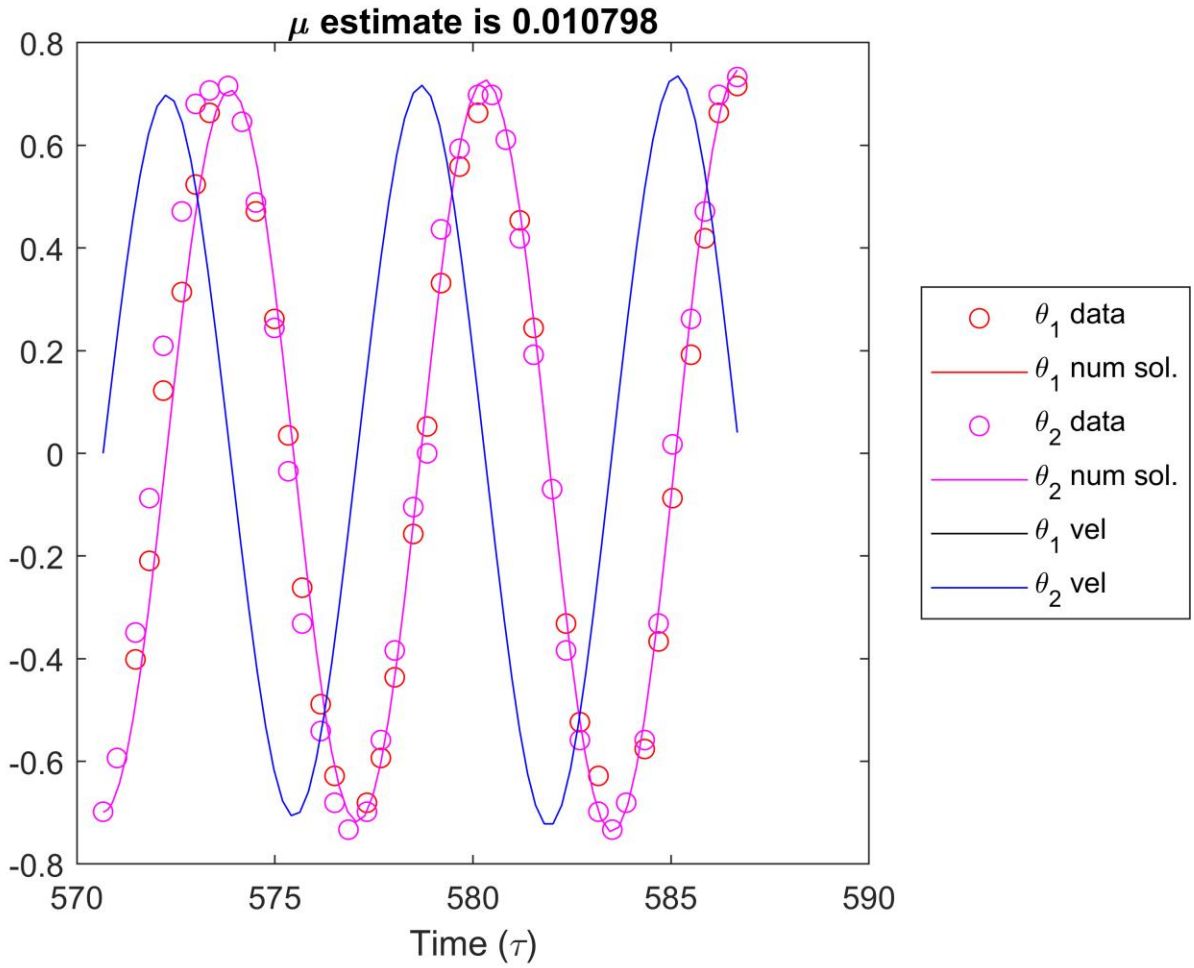


Figure 2: Parameter fit using Gauss minimization. Solid curves: oscillation angles ϑ_1, ϑ_2 from ODE model. Circle markers: experimental data for ϑ_1.

In addition to the full numerical solution, the method of multiple scale analysis was used to derive 'envelope' equations for the amplitude and phase difference of the coupled oscillators. An analysis of the steady state solutions for the oscillation amplitude and phase difference, and their stability, can be made from the simplified equations. This analysis suggests that synchronization occurs only for Δ sufficiently small, and gives a critical value above which synchronization does not occur. The predicted critical value of Δ was in reasonable agreement with experiment.

Capstone Laboratory Projects on Thin Film Flow inside a Funnel

Instructor: Lou Kondic; Lab Assistant: Ryan Allaire
Participating Students: Pablo Sota Arrutia, Elliot Figueroa, Viranch Kumar,
Jody Parchment, Justin Smith, Yimei Xu, Michael Vaks

This Capstone projects focuses on the problem of analysis of converging flows, such as flow on the inside of a funnel. Figure 1 shows an example of a physical experiment where thin film is released close to the upper edge of a funnel, and then let to evolve. While this setup is related to a number of classical problems involving thin films, it introduces a novel twist related to converging nature of the flow. The participating students have carried out four separate but related projects (i) physical experiments, image analysis, and quantification of the instabilities that develop during the flow; (ii) asymptotic analysis, (iii) numerical simulations, and (iv) self-similar type of analysis of a simplified setup. The direct comparison between experimental, analytical, and numerical results allowed to the participating students to develop better understanding of fluid instabilities, and, more broadly, of the techniques used in applied mathematics research.

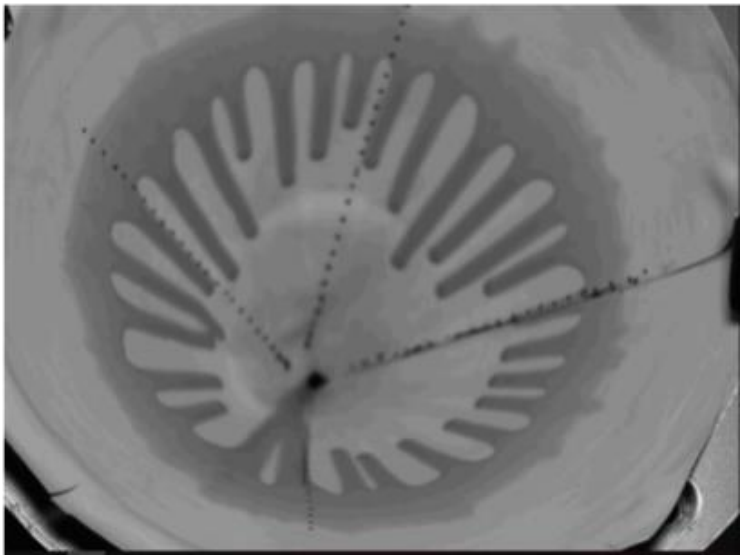


Figure 1: An example of experimental results showing well developed instability of a converging thin film in a funnel: the view is from above, and one can see a number of finger-like fluid structures (dark) that spontaneously develop during flow evolution.

The instructor thanks to Joshua Dijksman (Wageningen University, The Netherlands) for significant help with the experimental aspects of the project, and to Te-Sheng Lin (National Chiao Tung University, Taiwan) for his support with numerical and analytical aspects.

This project is supported in part by the NSF Grant No. CBET-1604351.

B. GRADUATE PROGRAMS

Graduate Activities Report
Michael Siegel, Associate Chair for Graduate Studies

The Department of Mathematical Sciences takes great pride in the quality of its graduate programs. In addition to four Master's programs in Applied Mathematics, Applied Statistics, Biostatistics, and Mathematical & Computational Finance, our PhD program continues to attract high-caliber students who work closely with faculty to conduct original research at the cutting edge of applied mathematics and statistics We have recently introduced graduate certificates in Applied Statistics and Biostatistics, and a new certificate in Data Science will be available starting next year. Each Graduate Certificate provides its students with a four-course set of specialized training that can be used to enhance an existing career or to explore advanced material prior to enrolling in a Master's Program.

Our doctoral students have an impressive collective record of presenting and publishing their research. Each year, they earn invaluable experience and recognition for their accomplishments at high-profile international meetings such as those organized by SIAM and the APS. Almost all of our students also present posters at our annual Frontiers in Applied and Computational Mathematics conference, which is described in Section VIB of this report. Most of our students have at least one high-quality publication accepted by the time of their graduation, which is essential for success in today's job market.

Our doctoral students are very engaged in departmental activities, and they regularly organize academic, career-oriented, and social events under the banner of the NJIT SIAM Chapter. Many of them take advantage of training opportunities such as the annual Workshop on Mathematical Problems in Industry, which was hosted by NJIT in June of 2019. Our students have had much recent success in finding internships, in governmental research facilities such as NASA, Oak Ridge National Laboratory, and Argonne National Laboratory or in private industries such as Pixar Animation Studios and Glaxo Smith-Kline. Students who performed internships will participate in a special internship seminar at NJIT in October 2019.

It is ultimately the offers our students receive after graduation that indicate the health of our programs. Our recent graduates have been very successful, receiving offers for tenure track positions at institutions such as the New York Institute of Technology, postdoctoral positions at elite universities such as New York University, and appointments to the government supported Applied Physics Laboratory at Johns Hopkins.

2019 Mathematical Problems in Industry (MPI)

The 2019 Mathematical Problems in Industry (MPI) workshop took place in June 2019 in NJIT's Central King Building, organized by Linda Cummings and Richard Moore, with the professional and capable support of the DMS Office staff who assured that everything went like clockwork. Industrial problems were presented by W.L. Gore and Associates, Iterex, Certara and UnderArmour, and covered topics ranging from medical diagnostics through sportswear design, macular degeneration and filtration.

As usual, MPI was preceded by the Graduate Student Mathematical Modeling Camp (hosted by U Delaware), which trained a number of graduate students in mathematical modeling skills in readiness for meeting the real-world challenges of MPI. A cohort of additional experienced graduate students and postdocs, together with senior faculty, rounded out the academic teams to work on each problem. A new and very successful feature of MPI in 2019 was an industrial careers panel session led by the industrial problem presenters, which stimulated much debate and many questions from the PhD students in attendance. Another highlight of MPI 2019 was the workshop dinner, which was held on a rooftop terrace in midtown Manhattan, courtesy of Iterex.

As always, the week was full of hard work, discoveries and fun, with much progress made on all industrial problems. The final summary presentations on the last day of the workshop were truly impressive, and allowed graduate students to shine as they showcased the work they had done, as well as their polished presentation skills. The traditional Coleman Balls award for the silliest mathematical utterance of the week rounded off a successful workshop, with David Edwards of U Delaware receiving the prize of an NJIT umbrella to commemorate a rainy week in Newark.

Yixuan Sun, NJIT Ph.D. Student, Presenting at MPI 2019 (Above)

PhDs Awarded in the Period Covered by the Report

Michael Pedneault
Thesis: Domain Decomposition Methods for the Solution of Multiple Scattering Problems
Dissertation Advisor: Catalin C. Turc

Li Yu
Thesis: FWER Controlling Procedures in Simultaneous and Selective Inference
Dissertation Advisor: Wenge Guo

YiMing Yu
Thesis: Rare Event Sampling in Applied Stochastic Dynamical Systems
Dissertation Co-Advisors: Richard O. Moore and Cyrill B. Muratov

Publications, Presentations, & Conferences
***Not Including FACM Participation or DMS Summer Student Talks**

Mahdi Bandegi

Posters

April 18, 2018: 2018 Dana Knox Student Research Showcase, NJIT, Newark NJ
Conic programming of a variational inequality motivated from self-assembly

Presentations

June 8, 2018: NJIT Graduate Student Summer Seminar, NJIT, Newark, NJ
Efficient solvers for some conic variational problems

Rituparna Basak

Posters

June 3 - 7, 2019: 4th International Conference on Packing Problems, Yale University, New Heaven, CT
Application of Machine Learning Techniques to the Stick-Slip Dynamics of a Particulate Media

Presentations

June 17 - 21, 2019: Mathematical Problems in Industry, NJIT, Newark, NJ
IterexTherapeutics: Machine-Learned Applications for Home-Based Triage and Management of Chronic Illnesses and presented the final presentation.

June 12 - 15, 2019: Graduate Students Mathematical Modeling Camp, University of Delaware, Newark, DE
Flow and Fouling in Elastic Membrane Filters

Conference and Workshop Attendance

April 13 - 18, 2019: Topological and Rigorous Computational Methods for High Dimensional Dynamics, Centre de Recherches Mathematiques, Montreal, Canada

Malik Chabane

Publications

On Resonant Interactions of Gravity-Capillary Waves without Energy Exchange (with Wooyoung Choi), *Studies in Applied Mathematic*s, Vol. 142, pp. 528-550, May 2019.

Presentations

June 11-14, 2019: SIAM Conference on Nonlinear Waves and Coherent Structures, Anaheim, CA
On Resonant Interactions of Gravity-Capillary Waves without Energy Exchange

Yinbo Chen

Posters

March 4, 2019: 63rd Annual Meeting of the Biophysical Society, Baltimore, MD
Padé Approximation of Single-Channel Calcium Nanodomains in the Presence of Cooperative Calcium Buffers

April 29, 2019: 2nd Annual IBNR Graduate student/Postdoctoral Research Showcase, NJIT, Newark, NJ
Novel Approximations of Stationary Single-Channel Ca2+ Nanodomains

Chao Cheng

Posters

June 3-7, 2019: 4th International Conference on Packing Problems, Yale University, New Haven, CT
The Precursors to Stick-Slip Events in Sheared Granular System

Linwan Feng

Presentations

April 17, 2019: 2019 Dana Knox Student Research Showcase, NJIT, Newark, NJ
Numerical Methods for Dispersive Shallow Water Equations

November 9, 2018: 2018 Mid-Atlantic Numerical Analysis Day, Temple University, Philadelphia, PA
Numerical Methods for Dispersive Shallow Water Equations

September 29, 2018: 2018 American Mathematical Society Fall Eastern Sectional Meeting, University of Delaware, Newark, DE
Numerical Methods for Dispersive Shallow Water Equations

Binan Gu

Posters

January 23 - 25, 2019: Princeton University, Princeton, NJ
Modeling Connectivity and Asymmetry in Membrane Filters Transport in Disordered Systems

Presentations

April 17, 2019: Dana Knox Research Showcase, NJIT, Newark, NJ
Stochastic Modeling of Membrane Filtration

January 18, 2019: 10th Northeastern Complex Fluids & Soft Matter Workshop, Rutgers University, New Brunswick, NJ
Modeling Connectivity and Asymmetry in Membrane Filters

November 18 - 20, 2018: American Physical Society Division of Fluid Dynamics 2018, Atlanta, GA

Modeling Connectivity and Asymmetry in Membrane Filters

Guangyuan Liao

Posters

May 18 - 23, 2019: SIAM Conference on Dynamical Systems, Snowbird, UT
Mathematical Models and Tools for Understanding the Entrainment of Hierarchical Circadian Systems

Yuexin Liu

Awards

NSF I-Corps Site at NJIT, Fall 2018 Award ($2500)

Axel Turnquist

Presentations

April 24, 2019: Courant Optimal Transport Discussion Group
Numerical Methods for Kantorovich and Viscosity Solutions of the Monge-Ampère PDE

April 10, 2019: Courant Optimal Transport Discussion Group
Monge-Ampère PDE and Generalized Solutions

March 13, 2019: Courant Optimal Transport Discussion Group
Kantorovich and Monge Problems: Existence, Uniqueness, and Duality Gap

AWARDS

Ryan Allaire

AY 2018 – 2019: Ahluwalia Doctoral Fellowship

Mahdi Bandegi

AY 2018 – 2019: G. A. Kriegsmann Graduate Fellowship

Subha Datta

AY 2018 – 2019: Ahluwalia Doctoral Fellowship

Matthew Moye

AY 2018 – 2019: Ahluwalia Doctoral Fellowship

Yuexin Liu

Fall 2018: NSF I-Corps Site at NJIT
PhD Summer Program Activities

Student Talks - Summer 2019

Tuesday, June 11, **Andrew deStefan**
Optimal Sampling Paths for Autonomous Vehicles in Uncertain Ocean Flows

Tuesday, June 25, **Matthew Moye**
Data Assimilation Methods for Neuronal State and Parameter Estimation

Thursday, June 27, **Zhongcheng Lin**
Dependent Censoring in Survival Analysis

Thursday, June 27, **Guangyuan Liao**
2-D Entrainment Map to Understand the Entrainment of Coupled Circadian Oscillators

Tuesday, July 2, **Linwan Feng**
Numerical Methods for Dispersive Shallow Water Equations

Tuesday, July 9, **Mahdi Bandegi**
Ground States for the Helmholtz Free Energy Functional Via Conic Programming

Tuesday, July 9, **Keyang Zhang**
Convergence of a boundary integral method for interfacial Stokes flow

Thursday, July 11, **Yixuan Sun**
Modeling and Design Optimization for Pleated Membrane Filters

Thursday, July 11, **Subha Datta**
Dimension Reduction Using Weighted Principal Support Vector Machine for Spatial Point Processes

Tuesday, July 16, **Malik Chabane**
On Resonant Interactions of Gravity-Capillary Waves without Energy Exchange

Tuesday, July 16, **Axel Turnquist**
Convergent Finite Difference Schemes for Optimal Transport in non-Euclidean Geometries

Thursday, July 18, **Soheil Saghafi**
Modeling Worm Locomotion

Thursday, July 18, **Ryan Atwater**
Studies of Two-Phase Flow with Soluble Surfactant

Tuesday, July 23, **Yinbo Chen**
Stationary Approximations to Single-Channel Ca2+ Nanodomains

Thursday, July 25, **Emel Khan**
Mathematical Modeling and Analysis of the Cyanobacterial Circadian Clock

Thursday, July 25, **Erli Wind-anderson**
The Exterior Helmhotz Equation on a Bounded Domain

Tuesday, July 30, **Beibei Li**
FDR Controlling Procedures for Testing Structured Hypotheses

Tuesday, July 30, **Atefeh Javidialsaadi**
Model Checks for Two-Sample Location-Scale

Tuesday, July 30, **Connor Robertson**
Aligning Self-Propelling Particles in Non-Trivial Domains

Thursday, August 1, **Diego Rios**
Arrival Time Estimation for Travel Paths

Thursday, August 1, **Rituparna Basak**
Application of Machine Learning to the Stick-Slip Dynamics of Particulate Media

Thursday, August 1, **Chao Cheng**
The Precursors to Stick-Slip Events in Sheared Granular Systems

Tuesday, August 6, **Kosuke Sugita**
Stokes Flow Problems with Singularities in a Viscous Liquid

Tuesday, August 6, **Tadanaga Takahashi**
Domain Decomposition Method for a Herogeneous Scattering Problem

Tuesday, August 6, **Brandon Behring**
Leapfrogging Vortex Pairs: A Semi-Analytic Approach to the Stability of Periodic Orbits

Thursday, August 8, **Ruqi Pei**
Panel-Based Generalized Gaussian Quadrature Scheme for the Discretization of Boundary Integral Equations

Thursday, August 8, **Lauren Barnes**
Walking Droplets and RT Resonance

Thursday, August 8, **Binan Gu**
Stochastic Modelling of Sieving in Membrane Filtration

Center for Applied Mathematics and Statistics
Department of Mathematical Sciences
606 Cullimore Hall
University Heights, Newark, NJ 07102
Phone: (973) 596-5782 • Fax: (973) 596-5591
http://math.njit.edu/research/