CAMS

Center for Applied Mathematics and Statistics

ANNUAL REPORT

2021 – 2022

July 1, 2021 – June 30, 2022

NJIT New Jersey Institute of Technology

TABLE OF CONTENTS

I. FROM THE DIRECTOR

The Center for Applied Mathematics and Statistics (CAMS) is entering its 36th 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, which this year included numerous undergraduate research projects.

This has been another challenging year due to Covid-19, especially with all university activities transitioning to online during the first Omicron wave in January-February. Fortunately, we were able to resume several CAMS activities later in the year. In particular, we were able to resume the annual "Frontiers in Applied and Computational Mathematics (FACM)" meeting. A successful in-person meeting was run, with the theme "New Perspectives in Mathematical Biology." We were also able to run a vigorous Applied Math Colloquium schedule which included a mix of in-person and online speakers.

Highlights and significant achievements in this past year, include:

• The addition of 19 new members from other departments within NJIT and researchers outside NJIT. The addition will help achieve CAMS aim to be a conduit for applied and computational mathematics research at NJIT.

• Four major grants awarded by the National Science Foundation.and other agencies

• The oversight of an additional thirty continuing grants from various agencies. CAMS receives substantial funding for graduate student and faculty research from sources such as the National Science Foundation, Simons Foundation, U.S. Navy, NASA, and other state and local agencies along with private industry.

As always, the accomplishments of CAMS have been built with the support and dedication of many individuals. We are grateful to Atam Dhawan, Interim Provost and Senior Vice President of Academic Affairs and Senior Vice President for Research, and Eliza Michalopoulou, Department of Mathematical Sciences Chair, for encouraging CAMS through their strong support of scientific research. We thank former President Joel Bloom and Provost Fadi Deek for being a constant source of support for CAMS and its mission. We look forward to working with new President Teik Lim in the upcoming year, as well as to the significant contribution of CAMS to the university's strategic priorities.

Michael Siegel, 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.

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
Frederick, Christina
Golowasch, Jorge
Goodman, Roy
Guo, Wenge
Hamfeldt, Brittany
Horntrop, David
Horwitz, Kenneth
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
Shang, Zuofeng
Shirokoff, David
Siegel, Michael
Subramanian, Sundarraman
Turc, Catalin
Wang, Antai
Young, Yuan-Nan

CAMS External Faculty Members from New Jersey Institute of Technology

Ahmadpoor, Fatemeh	Department of Mechanical & Industrial Engineering
Bunker, Daniel	Federated Department of Biological Sciences
Deek, Fadi	Office of the Provost
Dias, Cristiano	Department of Physics
Dytso, Alex	Department of Electrical & Computer Engineering
Farokhirad, Samaneh	Department of Mechanical & Industrial Engineering
Flammang, Brooke	Federated Department of Biological Sciences
Garnier, Simon	Federated Department of Biological Sciences
Golowasch, Jorge P.	Federated Department of Biological Sciences
Gor, Gennady	Department of Chemical & Materials Engineering
Holzapfel, Claus	Federated Department of Biological Sciences (RU)
Koutis, Yiannis	Department of Computer Science
Marras, Simone	Department of Mechanical & Industrial Engineering
Meegoda, Jay N.	Department of Civil & Environmental Engineering
Musialski, Przemyslaw	Department of Computer Science
Nadim, Farzan	Federated Department of Biological Sciences
Rosato, Anthony	Department of Mechanical Engineering
Rotstein, Horacio	Federated Department of Biological Sciences
Russell, Gareth	Federated Department of Biological Sciences
Shakib, Farnaz	Department of Chemistry & Environmental Science
Tafuni, Angelo	School of Applied Engineering & Technology
Voronov, Roman	Department of Chemical & Materials Engineering
Wang, Haimin	Department of Physics
Xu, Pan	Department of Computer Science

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
Mema, Ensela	Kean University
Moore, Richard	SIAM, Philadelphia
Pak, On Shun	Santa Clara University
Papageorgiou, Demetrios	Imperial College, London
Pugnaloni, Luis	University of La Pampa, Argentina
Roychoudhury, Satrajit	Pfizer
Sanei, Pejman,	New York Institute of Technology
Tao, Louis	Peking University, China
Vanden-Broeck, Jean-Marc	University of East Anglia, Norwich, England
Wang, Qiming	Scotiabank, Canada
Wylie, Jonathan	City University of Hong Kong

IV. COLLOQUIA AND SEMINARS

Applied Mathematics Colloquium/ Department of Mathematical Sciences Colloquium

September 3, **Michael Booty**, New Jersey Institute of Technology
Flows with Soluble Surfactant or Electrokinetic Effects

September 10, **Peter Baddoo**, Massachusetts Institute of Technology
New Methods for Data-Driven Modeling of Dynamical Systems

September 17, **Guido De Philippis**, New York University
(Boundary) Regularity for Mass Minimising Currents

September 24, **Stephen Shipman**, Louisiana State University
Embedded Eigenvalues for the Neumann-Poincaré

October 1, **Jiaoyang Huang**, New York University
Extreme Eigenvalues of Random d-regular Graphs

October 8, **Jeremy Marzuola**, University of North Carolina at Chapel Hill
Quantitative Bounds on Impedance-to-Impedance Operators with Applications to Fast Direct Solvers for PDEs

October 15, **Eduardo Corona**, University of Colorado Boulder
A Crash Course in Boundary Integral Methods with Applications to Stokesian Suspensions

October 22, **Edward Large**, University of Connecticut
A Dynamical, Radically Embodied, and Ecological Theory of Rhythm Development

October 29, **Eleni Katifori**l, University of Pennsylvania
Local Rules for Global Optimization of Distribution Networks

November 5, **Pejman Sanaei**, New York Institute of Technology
Fluid Structure Interaction, from Flight Stability of Wedges to Tissue Engineering and Moving Droplets on a Filter Surface

November 12, **Alex Barnett**, Flatiron Institute
Fresnel Diffraction for Starshade Modeling and the Nonuniform FFT

November 19, **James Yorke**, University of Maryland
The Equations of Nature and the Nature of Equations

December 3, **Eric Keaveny**, Imperial College London
An Algorithm for Two-Cost Budgeted Matrix Completion

January 21, **Patricia Ning**, University of Michigan, Ann Arbor
High-dimensional Parameter Learning over General Graphical State Space Models: Beating the Curse of Dimensionality

January 28, **Thi-phong Nguyen**, Purdue University
Fast and Efficient Numerical Methods for Inverse Scattering Problems in Complex Media

February 4, **Chrysoula Tsogka**, University of California Merced
Fast Signal Recovery from Quadratic Measurements

February 11, **Darren Crowdy**, Imperial College London
To Slip, or Not to Slip?

February 18, **Krasimira Tseneva**, University of Exeter
Mathematical-based Microbiome Analytics for Clinical Translation

February 25, **Lexing Ying**, Stanford University
Prony's Method, Analytic Continuation, and Quantum Signal Processing

March 11, **Monika Nitsche**, University of New Mexico
Accurate Near-Interface Velocity Evaluation in Vortex Sheet and Multi-Nested Stokes Flow

March 25, **Alejandro Aceves**, Southern Methodist University
Modeling Climate Change: A Dynamical Systems Approach

April 1, **Dimitri Papageorgiou**, Imperial College London
Evolution PDEs Arising in Multiphase-Multiphysics Flows

April 8, **Richard Braun**, University of Delaware
Data Extraction and Math Modeling for Tear Breakup via in vivo Fluorescence (FL) Imaging

April 22, **Zachary Kilpatrick**, University of Colorado Boulder
How Heterogeneity Shapes the Efficiency of Collective Decisions and Foraging

April 29, **Antoine Mellet**, University of Maryland
Free Boundary Problems for Cell Motility

Applied Statistics Seminar

October 7, **Linjun Zhang**, Rutgers University
The Cost of Privacy in Generalized Linear Models: Algorithms and Optimal Rate of Convergence

November 11, **Shyamal D. Peddada**, Biostatistics and Bioinformatics Branch, National Institute of Child Health and Human Development (NICHD), National Institutes of Health (NIH)
Analysis of Composition of Microbiome with Application to HIV-1 Data

December 2, **Brent Burger and Peixin Zhang**, JAZZ Pharmaceuticals
Count Data Regression Models - A Clinical Trial Application

December 9, **Molin Wang**, Harvard T.H. Chan School of Public Health
A Computationally Efficient Classification Algorithm in Posterior Drift Model: Phase Transition and Minimax Adaptivity

March 24, **Alex Dytso**, New Jersey Institute of Technology
Some Aspects of Totally Positive Kernels Useful in Estimation and Information Theory

April 19, **Yongzhao Shao**, NYU Grossman School of Medicine
Multicellular Network-based Survival Models for Drug Resistance and Predicting Patient Survival

April 28, **Hu Sun**, University of Michigan
Auto-regressive Model for Matrix-Valued Time-Series with Auxiliary Vector-Valued Time-Series Data

Mathematical Biology Seminar

September 8, **Lin Han**, Drexel University
Type V Collagen Regulates the Growth and Remodeling of TMJ Condylar Cartilage: A Fibrous-Hyaline Hybrid

September 22, **Danny Barash**, Ben Gurion University
Efficient Numerical Methods for the Solution and Parameter Estimation in Multiscale Models of Hepatitis C Viral Kinetics

October 6, **Ebru Demir**, Lehigh University
Locomotion at Small Scale: Microswimmers for Biomedical Applications

October 20, **Klavdia Zemlianova**, New York University
Biophysical Mechanisms for Keeping Time

November 3, **Nicholas Battista**, The College of New Jersey
Exploring the Sensitivity of Jellyfish Locomotion to Variations in Scale, Frequency, and Duty Cycle

November 10, **Peter Balogh**, New Jersey Institute of Technology
Large-Scale Simulation of Cellular-Scale Flows in the Microcirculation

November 17, **Seth H. Weinberg**, Ohio State University
Modeling of Nanoscale Structure and Cell-Cell Coupling in Cardiac Tissue

December 1, **Hyunjoong Kim**, University of Pennsylvania
Intercellular Communication by Direct Contact: Is it Better than Diffusion?

March 2, **Daniel Cooney**, University of Pennsylvania
A PDE Model to Study Natural Selection Across Multiple Levels of Organization

March 9, **Dobri Dotov**, McMaster University
From HKB to Cross-Frequency Coupling of Neural Dynamics: Trying to Explain Complex Patterns of Sensorimotor Coordination

March 30, **Gokberk Kabacaoglu**, Bilkent University
Neural Network Based Reduced Model for Stokesian Particulate Flows

April 13, **Hao Lin**, Rutgers University New Brunswick
Universal Statistics and Mechanical Properties in Planar Tessellated Networks

April 27, **Joel Tabak**, Exeter University
Flexible Coordination Between Neuronal Rhythms by the Duration of Synaptic Influence

Fluid Mechanics and Waves Seminars

September 20, **Laurel Ohm**, Princeton University
Mathematical Foundations of Slender Body Theory

October 4, **Nick Moore**, US Naval Academy
Karst Pinnacles and Rogue Waves

October 18, **Shima Parsa**, Rochester Institute of Technology
Polymer Flow in Porous Media: Role of the Network in Unexpected Bulk Transport

November 1, **Harishankar Manikantan**, University of California Davis
Tunable Collective Dynamics of Inclusions in Viscous Membranes

November 15, **Brennan Sprinkle**, Courant Institute of Mathematical Sciences
Towards a Continuum Method for Fluctuating Fiber Suspensions

February 14, **Mykhailo Potomkin**, University of California Riverside
Orientation Dynamics of a Microswimmer in Nematic Liquid Crystal

February 28, **Carlos Borges**, University of Central Florida
High-Fidelity Reconstructions of the Shape and Impedance using Scattered Data

April 4, **Stephen Guimond**, University of Maryland Baltimore County, Goddard Space Flight Center
Fluid Mechanics and Waves in Extreme Weather Systems

April 18, **Jason Kaye**, Flatiron Institute
Accelerating Green's Function Methods for Time-Dependent Quantum Many-Body Calculations: Fast History Integration for Dyson Equations

May 2, **Daria Sushnikova**, New York University
A Fast Linearly Scaling Direct Solver for Multiscale Boundary Integral Equations

V. PUBLICATIONS, PRESENTATIONS, AND REPORTS

A. PUBLICATIONS

Journal Publications

Denis L. Blackmore

Solutocapillary Marangoni flow induced in a waterbody by a solute source (with I. Benouaguef, N. Musunuri, E. Amah, I. S. Fischer, and P. Singh), *Journal of Fluid Mechanics*, Vol 922, pp. A23, July 2021.

Michael Booty

A model for the electric field-driven flow and deformation of a drop or vesicle in strong electrolyte solutions (with M. Ma, and M. S. Siegel), *Journal of Fluid Mechanics*, Vol 943, A47, pp. 44, June 2022.

Amitabha K. Bose

Beyond the limits of circadian entrainment: Non-24-hour sleep-wake disorder, shift work,and social jet lag (with C. Diekman), *J. Theoretical Biology*, 545, 111148. May 2022.

A biophysical counting mechanism for keeping time (with K. Zemlianova and J. Rinzel), *Biological Cybernetics*, Vol 116, pp. 205-218, January 2022.

Wooyoung Choi

Two-dimensional stability analysis of finite-amplitude interfacial gravity waves in a two-layer fluid (with S. Murashige), *Journal of Fluid Mechanics*, Vol 938, pp. A13: 1-27, March 2022.

Parasitic capillary waves on small-amplitude gravity waves with a linear shear current (with S. Murashige), *Journal of Marine Science and Engineering*, November 2021.

Linda J. Cummings

Filtration with multiple species of particles (with Y. Sun and L. Kondic), *Transport in Porous Media*, Vol 5, pp. 44306, May 2022.

Network-based membrane filters: Influence of network and pore size variability on filtration performance (with B. Gu and L. Kondic), *Journal of Membrane Science*, Vol 65, pp. 120668, May 2022.

A graphical representation of membrane filtration (with B. Gu and L. Kondic), *SIAM Journal on Applied Mathematics*, Vol 82, pp. 950, April 2022.

Influence of thermal effects on the breakup of thin films of nanometric thickness (with R. Allaire and L. Kondic), *Physical Review Fluids*, Vol 7, pp. 64001, March 2022.

Casey O. Diekman

The emergence of polyglot entrainment responses to periodic inputs in vicinities of Hopf bifurcations in slow-fast system, *Chaos*, Vol 32, Issue 63137, June 2022.

Beyond the limits of circadian entrainment: Non-24-hour sleep-wake disorder, shift work,and social jet lag (with A. Bose), *J. Theoretical Biology*, 545, 111148. May 2022.

The E3 ubiquitin ligase adaptor Tango10 links the core circadian clock to neuropeptide and behavioral rhythms (with J. Lee, C. Lim, T. H. Han, T. Adreani, and M. Moye), *PNAS*, Vol, 118, Issue 47, November 2021.

Entrainment dynamics organised by global manifolds in a circadian pacemaker model (with J. Creaser and K. Wedgwood), *Frontiers in Applied Mathematics and Statistics*, Vol 7, Issue 703359, July 2021.

Christina A. Frederick

Collective motion planning for a group of robots using intermittent diffusion (with M. Egerstedt and H. Zhou), *Journal of Scientific Computing*, Vol 90, Issue 13, November 2021.

Frame spectral pairs and exponential bases (with A. Mayeli), *Journal of Fourier Analysis and its Applications*, Vol 27, Issue 75, August 2021.

Roy Goodman

An optimal control approach to gradient-index design for beam reshaping (with J. Adriazola), *J. Opt. Soc. Amer. A*, 38, pp. 907–915, April 2022.

A reduction-based strategy for optimal control of Bose-Einstein condensates (with J. Adriazola), *Phys. Rev. E*, 105, 025311, February 2022.

Brittany Hamfeldt

A convergence framework for optimal transport on the sphere (with A.Turnquist), *Numerische Mathematik*, June 2022.

A convergent finite difference method for computing minimal Lagrangian graphs (with J. Lesniewski), *Communications on Pure & Applied Analysis*, Vol 21, Issue 2, pp. 393-418, February 2022.

Convergent finite difference methods for fully nonlinear elliptic equations in three dimensions (with J. Lesniewski), *Journal of Scientific Computing*, Vol 90, Issue 1, January 2022

Convergent numerical method for the reflector antenna problem via optimal transport on the sphere (with A. Turnquist), *Journal of the Optical Society of America A*, Vol 38, Issue 11, pp. 1704-1713, November 2021.

A convergent finite difference method for optimal transport on the sphere (with A. Turnquist), *Journal of Computational Physics*, Vol 445, Issue 15, November 2021.

Lou Kondic

Filtration with multiple species of particles (with Y. Sun and L. J. Cummings), *Transport in Porous Media*, Vol 5, pp. 44306, May 2022.

Network-based membrane filters: Influence of network and pore size variability on filtration performance (with B. Gu and L. J. Cummings), *Journal of Membrane Science*, Vol 657, pp. 120668, May 2022.

A Graphical Representation of Membrane Filtration (with B. Gu and L.J.Cummings), *SIAM Journal on Applied Mathematics*, Vol 82, pp. 950, April 2022.

Universal features of the stick-slip dynamics of an intruder moving through a confined granular medium (with L. Pugnaloni, M. Carlevaro, R. Kozlowski, H. Zheng, and J. Socoloar), *Physical Review E Letters*, Vol 105, pp. L042902, March 2022.

Influence of thermal effects on the breakup of thin films of nanometric thickness (with R. Allaire and L. J. Cummings), *Physical Review Fluids*, Vol 7, pp. 64001, March 2022.

On intermittency in sheared granular systems (with M. Kramar, C. Chao, and R. Basak), *Soft Matter*, Vol 18, pp. 3583, March 2022.

Understanding slow compression and decompression of frictionless soft granular matter by network analysis (with S. Luding, R. Basak, and K. Taghizadeh), *Soft Matter*, Vol 18, pp. 1868, March 2022.

Role of diffusion in crystallization of hard-sphere colloids (with M. A. Lam, B. Khusid, W. V. Meyer), *Physical Review E*, Vol 104, pp. 054607, November 2021.

Frost spreading and pattern formation on microstructured surfaces (with L. Hauer, W. Wong, A. Sharifi-Aghili, and D. Vollmer), *Physical Review E*, Vol 104, pp. 44901, October 2021.

Ji Meng Loh

Sufficient dimension reduction for spatial point processes using weighted principal support vector machines (with S. Datta), *Statistics and Its Interface*, Vol 15, Issue 4, pp. 415-431, March 2022.

Muscle co-contractions are greater in older adults during walking over uneven compared to even surfaces (with M. DaSilva, V. Chandran, P. Dixon, J. Dennerlein, J. Schiffman, and S. Pal), *Journal of Biomechanics*, October 2021.

The ratio of equivalent mutants: A key to analyzing mutation equivalence (with M. Latif, D. Kim, I. Marsit, A. Ayad, M. N. Omri, and A. Mili), *Elsevier*, Vol 181, pp. 20, July 2021.

James Maclaurin

Stochastic oscillators in biology: introduction to the special issue (with J-M Fellous, P. J. Thomas, and B. Lindner), *Biological Cybernetics*, Vol 116, Issue 2, pp. 119-120, April 2022.

Stochastic oscillations in biology, *Bulletin of the American Physical Society*, Vol 60, December 2021.

Synchronization in stochastic biochemical oscillators subject to common multiplicative extrinsic noise (with P. A. Vilanova), *SIAM Journal on Applied Dynamical Systems*, Vo 20, Issue 3, pp. 1253-1276, July 2021.

Zoi-Heleni Michalopoulou

How machine learning contributes to solve acoustical problems (with M. Roch, P. Gerstoft, and B. Kostek), *Acoustics Today*, Vol 17, Issue 4, pp. 48-56, December 2021.

Tracking and inversion using mid-frequency signals in the Seabed Characterization Experiment (with P. Gerstoft, D. Rios, and W. Hodgkiss), *IEEE Journal of Oceanic Engineering*, pp. 1-12, December 2021.

Introduction to the special issue on machine learning in acoustics (with P. Gerstoft, B. Kostek, and M. Roch), *Journal of the Acoustical Society of America*, Vol 150, Issue 4, pp. 3204-3210, November 2021.

Cyrill B. Muratov

Conducting flat drops in a confining potential (with M. Novaga and B. Ruffini), *Archive for Rational Mechanics and Analysis*, Vol 243, pp. 1773-1810, February 2022.

Horacio G. Rotstein

Parameter estimation in the age of degeneracy and unidentifiability (with D. Lederman, R. Patel, and O. Itani), *Mathematics*, Vol 10, pp. 170, January 2022.

Machine learning for mathematical models of HCV kinetics (with A. Churki, S. Kriss, A. Uziel, A. Goyal, R. Zakh, H. Dahari, and D. Barash), *Mathematical Biosciences*, Vol 343, pp. 108756, December 2021.

Frequency preference response in covalent modification cycles under substrate sequestration conditions (with J. Reves-Szemere and A. Ventura), *(npj) Systems Biology and Applications - Nature*, Vol 7, pp. 32 , July 2021.

Periodic solutions in threshold-linear networks and their entrainment (with A. Bel, R. Cobiaga, and W. Reartes), *SIAM Journal on Applied Dynamical Systems (SIADS)*, Vol 20, pp. 1177-1208, July 2021.

Zuofeng Shang

Minimax optimal high-dimensional classification using deep neural networks (with S. Wang), *STAT*, June 2022.

An approach of bayesian variable selection for ultrahigh dimensional multivariate regression (with X. Dai, G. Fu, R. Reese, and S. Zhao), *STAT*, April 2022.

Online statistical inference for parameters estimation with linear-equality constraints (with R. Liu and M. Yuan), *Journal of Multivariate Analysis*, March 2022.

Testing community structures for hypergraph models (with M. Yuan, R. Liu, and Y. Feng), *Annals of Statistics*, February 2022.

Hypothesis testing in sparse weighted stochastic block model (with M. Yuan and F. Yang), *Statistical Papers*, October 2021.

Optimal nonparametric inference via deep neural network (with R. Liu and B. Boukai), *Journal of Mathematical Analysis and Applications*, August 2021.

Information limits for detecting a subhypergraph (with M. Yuan), *STAT*, July 2021.

Michael Siegel

A model for the electric field-driven flow and deformation of a drop or vesicle in strong electrolyte solutions (with M. Ma and M. R. Booty), *Journal of Fluid Mechanics*, Vol 943, pp. A4: 44, June 2022.

Collapse versus blow-up and global existence in the generalized Constantin–Lax–Majda equation (with Lushnikov, P. M. and Silantyev, D. A.), *Journal of Nonlinear Science*, 31(5), October 2021.

Antai Wang

The identifiability of copula models for dependent competing risks data with exponentially distributed margins, *Statistica Sinica*, September 2021.

Yuan-Nan Young

Gait switching and targeted navigation of microswimmers via deep reinforcement learning (with Z. Zou, Y. Liu, O. S. Pak, and A. C. H.Tsang), *Communications Physics*, Vol 5, pp.158, June 2022.

The effects of surface hydration on capillary adhesion under nanoscale confinement (with S. Huang, C. E. Colosqui, and H. A. Stone), *Soft Matter*, Vol 18, pp. 4786-4791, June 2022.
The effect of rigid cells on blood viscosity: linking rheology and sickle cell anemia (with A. Perazzo, Z. Peng, Z. Feng, D. K. Wood, J. M. Higgins, and H. A. Stone), *Soft Matter*, Vol 18, pp. 554-565, December 2021.

An arbitrary Lagrangian-Eulerian method for simulating interfacial dynamics between a hydrogel and a fluid (with L. Li, J. Zhang, Z. Xu, J. J. Feng, and P. Yue), *Journal of Computational Physics*, Vol 451, pp. 110581, November 2021.

Wall-induced translation of a rotating particle in a shear-thinning fluid (with Y. Chen, E. Demir, W. Gao, and O. S. Pak), *Journal of Fluid Mechanics*, Vol 927, pp. R2, September 2021.

Hydrodynamics of a semipermeable inextensible membrane under flow and confinement (with B. Quaife and A. Gannon), *Physical Review Fluids*, Vol 6, pp. 73601, July 2021.

Conference Publications and Abstracts

Lou Kondic

Phase-field modeling of colloid-polymer mixtures in microgravity (with L. Barnes, B. Khusid, W. Meyer, A. U. Oza), *American Physical Society*, Vol 66, Issue 17, November 2021.

Colloidal crystallization under microgravity (Q. Lei, B. Khusid, A. Hollingsworth, P. M. Chaikin, W. V. Meyer, and A. Reich), *American Society for Gravitational and Space Research (ASGSR)*, Vol 1, November 2021.

Temperature gradient effects in colloids of ellipsoidal particles under microgravity (Q. Lei, B. Khusid, A. Hollingsworth, P. M. Chaikin, W. V. Meyer, and A. Reich), *American Society of Mechanical Engineer*s, Vol 1, November 2021.

Building colloidal crystals under microgravity (Q. Lei, B. Khusid, A. Hollingsworth, P. M. Chaikin, W. V. Meyer, and A. Reich), *10th Annual International Space Station Research and Development Conference*, Vol 1, August 2021.

Zoi-Heleni Michalopoulou

Feature selection for seabed characterization using non-linear regression and decision trees (with N. Roselli, D. Rios, A. Patel, and Y. Sayes), *Journal of the Acoustical Society of America*, Vol 151, pp. A266, April 2022.

Uncertainty reduction in matched field inversion using gaussian processes (with P. Gerstoft) *Journal of the Acoustical Society of America*, Vol 151, pp. A66, April 2022.

Anand U. Oza

Phase-field modeling of colloid-polymer mixtures in microgravity (with L. Barnes, L. Kondic, B. Khusid, and W. Meyer), *American Physical Society*, Vol 66, Issue 17, November 2021.

Bound states of asynchronously flapping tandem wings (with M. Guzraty), *American Physical Society*, Vol 66, Issue 17, November 2021.

Monograph

Christina A. Frederick

Seeing through rock with Optimal Transport, *Snapshots of Modern Mathematics from Oberwolfach*, May 2022.

Newsletter

Christina A. Frederick

The loopy fluid dynamics of bird lungs (with A. U. Oza and L. Ristroph), *Society for Industrial and Applied Mathematics*, Vol 54, Issue 7, September 2021.

Anand U. Oza

The loopy fluid dynamics of bird lungs (with C. A. Frederick and L. Ristroph), *Society for Industrial and Applied Mathematics*, Vol 54, Issue 7, September 2021.

Software

Travis L. Askham

Inverse-obstacle-scattering-2d (with M. Rachh, J. Hoskins, and C. Borges), January 2022.

Technical Report

Sunil K. Dhar

Mathematical Problems in Industry, 2021: Differential Privacy in Travel Data (with M. Aminian, A.-S. Charest, et. al), Thirty Seventh Annual Workshop on Mathematical Problems in Industry, pp. 23, September 2021.

B. PRESENTATIONS

Travis L. Askham

March 3, 2022: SIAM Conference on Imaging Science (IS22) SIAM, Virtual
"A periodic fast multipole method"

Michael R. Booty

June 20, 2022: 19th US National Congress on Theoretical and Applied Mechanics, Austin, TX
"Induced charge electrokinetic flow for a dropt"

July 19, 2021: SIAM Annual Meeting 2021, Virtual
"A hybrid boundary integral method for two-phase flow with soluble surfactant"

Amitabha K. Bose

November, 2021:Applied Mathematics Colloquium, Northwestern University, Online
"Towards a neural and mathematical understanding of how we generate and keep a musical beat"

Bruce Bukiet

April 23, 2022: 2022 Spring ASEE Middle Atlantic Section Conference ASEE, NJIT, Newark NJ
"The NJIT/Newark math success initiative (MSI): A holistic program to prepare and support urban students to succeed in earning stem degrees in college"

Wooyoung Choi

May 16, 2022: Seoul National University, Seoul, Korea
"Characteristics and prediction of nonlinear ocean waves"

December 3, 2021: Annual Conference of Korean Society of Industrial and Applied Mathematics, Busan, Korea
"Resonant three-wave interactions in water"

November 5, 2021: Annual Conference of the Korean Society of Oceanography, Jeju, Korea
"A new unidirectional model for large amplitude long internal waves"

October 29, 2021: Annual Conference of the Korean Society of Coastal and Ocean Engineers, Jeju, Korea
"High-order nonlinear long wave models"

October 25, 2021: Pusan National University, Busan, Korea
"Fourier series and its applications to ocean waves"

Linda J. Cummings

May 15, 2022: XIX Regional Congress of Statistical Physics and its Applications to Condensed Matter Physics, Argentine Physical Society La Plata, Argentina
"Instabilities of liquid crystal films"

March 15, 2022: APS March Meeting, Chicago, IL
"Dielectrowetting of thin nematic liquid crystal films"

March 15, 2022: APS March Meeting, Chicago, IL
"Modeling thermal effects in the droplet assembly of nanoscale molten metal films"

November 23, 2021: APS DFD Meeting, Phoenix, AZ
"A graphical representation of membrane filtration"

November 23, 2021: APS DFD Meeting, Phoenix, AZ
"Dewetting of thin nematic films in the presence of spatially varying substrate anchoring"

November 23, 2021: APS DFD Meeting, Phoenix, AZ
"Dielectrowetting of thin nematic liquid crystal films"

August 20, 2021: Droplets 2021, University of Darmstadt, Bonn, Germany
"Modeling and computing heat flow for evolving films and drops on nanoscale"

Sunil K. Dhar

November 16, 2021: North Dakota State University, Fargo, ND
"Building geometric models, characterization, goodness-of-fit, and applications"

Casey O. Diekman

March 26, 2022: AMS Spring Central Sectional Meeting, Virtual
"Data assimilation and modeling of circadian clock neurons"

February 10, 2022: Math Biology / Applied Dynamical Systems Seminar, Ohio State University, Virtual
"Data assimilation and dynamical systems analysis of circadian rhythmicity and entrainment"

January 27, 2022: Department of Mathematics, University of Idaho, Virtual
"Data assimilation and dynamical systems analysis of circadian rhythmicity and entrainment"

December 1, 2021: Applied Mathematics and Scientific Computing Seminar, Temple University, Virtual
"Data assimilation and dynamical systems analysis of circadian rhythmicity and entrainment"

July 7, 2021: Development and Cancer Focus Group (DECAFOG), California State University - Northridge, Virtual
"Data assimilation and conductance-based modeling of circadian pacemaker neurons"

Christina A. Frederick

December 13, 2021: CENCAP Product 3 Integrated Minefield Planning Virtual Program Review, Office of Naval Research
"Mobile sensor placement"

November 18, 2021: Georgia Tech Mathematics Colloquium, Georgia Tech, Atlanta, GA
"Constructions of exponential bases"

September 19, 2021: SIAM SEASSIAM Southeastern Atlantic Section Conference, Auburn, AL
"Machine learning for inverse problems in sonar imaging"

Roy H.Goodman

March 2022: Conference on Nonlinear Waves, IMACS, Athens, GA
"Leapfrogging vortex pairs"

Brittany Hamfeldt

June 17, 2022: AWM Research Symposium, Minneapolis, MN
"Numerical optimal transport on the sphere"

September 30, 2021: Machine Learning and Optimization Seminar, NJIT, Newark, NJ
"Full waveform inversion using the wasserstein metric"

September 23, 2021: Applied Mathematics Seminar, Johns Hopkins University, Baltimore, MD
"Numerical optimal transport on the sphere"

Kenneth Horwitz

April 23, 2022: 2022 Spring ASEE Middle Atlantic Section Conference, NJIT, Newark, NJ
"The NJIT/Newark math success initiative (MSI): A holistic program to prepare and support urban students to succeed in earning stem degrees in college"

July 17, 2021: 14th International Congress on Math Education, Shanghai, China
"Using open educational resources to promote the active learning of calculus in urban districts"

Lou Kondic

May 15,2022: XIX Regional Congress of Statistical Physics and its Applications to Condensed Matter Physics, Argentine Physical Society La Plata, Argentina
"Analyzing force networks in granular systems using topological data analysis"

May 15, 2022: XIX Regional Congress of Statistical Physics and its Applications to Condensed Matter Physics, Argentine Physical Society La Plata, Argentina
"Instabilities of liquid crystal films"

May 15, 2022: XIX Regional Congress of Statistical Physics and its Applications to Condensed Matter Physics, Argentine Physical Society La Plata, Argentina
"Universal properties of the stick-slip dynamics of an intruder in confined granular matter"

May 10, 2022: Granular Workshop La Plata, Argentina
"Analysis of force networks in granular systems using topological data analysis"

March 15, 2022: American Chemical Society Spring Meeting, San Diego, CA
"Recent experiments on hard sphere colloidal crystallization in microgravity on the international space station"
March 15, 2022: APS March Meeting, Chicago, IL
"Dielectrowetting of thin nematic liquid crystal films"

March 15, 2022: APS March Meeting, Chicago, IL
"Mathematical analysis of force networks in granular and suspension flow,"

March 15, 2022:APS March Meeting, Chicago, IL
"Modeling thermal effects in the droplet assembly of nanoscale molten metal films"

March 15, 2022: APS March Meeting, Chicago, IL
"Stick-slip dynamics of an intruder pulled through granular matter"

March 1, 2022: MSM Group Seminar, University of Twente, Enschede, Netherlands
"Force networks in particulate systems"

November 23, 2021: APS DFD Meeting, Phoenix, AZ
"A graphical representation of membrane filtration"

November 23, 2021: APS DFD Meeting, Phoenix, AZ
"Dewetting of thin nematic films in the presence of spatially varying substrate anchoring"

November 23, 2021: APS DFD Meeting, Phoenix, AZ
"Dielectrowetting of thin nematic liquid crystal films,"

November 23, 2021: ASME IMECE, Virtual
"Temperature gradient effects in colloids of ellipsoidal particles under microgravity"

November 15, 2021: Fluid Mechanics Meeting of Argentine Physics Society, Buenos Aires, Argentina
"Hydrodynamic instability and phase separation in nanometric thin films of melted metallic alloys"

October 1, 2021: University of Strathclyde, Glasgow, UK
"Modeling thin liquid films including thermal effects"

September 20, 2021: Tri-Agency Symposium on "Multifunctionality, System Endurance & Intelligent Structures ARO," Virtual
"Structure of interaction networks in particulate systems"

September 1, 2021: University of Ljubljana, Slovenia
"Modeling nematic liquid crystal films on nanoscale"

August 20, 2021: Droplets 2021, University of Darmstadt, Bonn, Germany
"Modeling and computing heat flow for evolving films and drops on nanoscale"

Ji Meng Loh

June 30, 2022: IMS Annual Meeting, Institute of Mathematical Statistics, London
"Parameter estimation and inference of spatial autoregressive model by stochastic gradient descent"

August 2021: Joint Statistical Meeting, American Statistical Association, Virtual
"Inference for spatial autoregressive models using stochastic gradient descent"

James MacLaurin

July 14, 2022: SIAM Life Sciences 2022, Virtual
“Asymptotics of calcium puff frequency”

March 16, 2022: American Physical Society March Meeting 2022, Chicago, IL
“Reduced equations for stochastic spin glasses ”

November 22, 2021: Mathematical Biology Seminar, University of Alberta, Canada
“Metastability of waves, patterns and oscillations subject to spatially-extended noise”

Victor V. Matveev

June 19, 2022: FASEB Retinal Neurobiology and Visual Processing Conference, Boston, MA
"Ultrafast vesicle cycling at aii amacrine lobular synapses"

Zoi-Heleni Michalopoulou

May 2022: Meeting of the Acoustical Society of America, Denver, CO
"Feature selection for seabed characterization using non-linear regression and decision trees"

May 2022: Meeting of the Acoustical Society of America, Denver, CO
"Uncertainty reduction in matched field inversion using gaussian processes"

March 2022: Waves Seminar Series, University of California - Merced, Virtual
"Inverse problems in ocean acoustics: particle filtering and linearization for parameter estimation"

October 2021: STEM Women+
"Parameter estimation in the sbcex 17 experiment: geoacoustic inversion and source localization"

Nadim Farzan

November 13, 2021: 2021 Annual Meeting of the Society for Neuroscience (SFN)
"Excitatory neuromodulation reduces inter-animal variability of neuronal activity"

Anand U. Oza

November 12, 2021: Mathematics Department Colloquium, California State University, Fullerton, CA Virtual
"Orderly formations and traveling waves exhibited by schooling wings"

September 16, 2021: LadHyX SeminarEcole Polytechnique, Paris, France, Virtual
"Orderly formations and traveling waves exhibited by schooling wings"

July 29, 2021: International Conference for Advances in Pilot-Wave Theory, University of Lisbononline
"Exploring diffraction with a pilot-wave model"

Horacio G. Rotstein

November 13, 2021: 2021 Annual Meeting of the Society for Neuroscience (SFN)
"Excitatory neuromodulation reduces inter-animal variability of neuronal activity"

November 13, 2021: 2021 Annual Meeting of the Society for Neuroscience (SFN)
"Resonance-based flexible selection of cognitive tasks and memory suppression in a hippocampus – prefrontal cortex network regulated by the nucleus reuniens."

November 13, 2021: 2021 Annual Meeting of the Society for Neuroscience (SFN)
"Revealing the link between spiking cross-correlation patterns and the underlying subthreshold dynamics: oscillations and resonances"

November 13, 2021: 2021 Annual Meeting of the Society for Neuroscience (SFN)
"Statistical estimation of synaptic coupling with confounding background influences"

October 25, 2021: CompNeurOsc Journal Club (NJIT/Rutgers/NYU/CCNY)
"Parameter estimation in the age of unidentifiability and degeneracy"

October 7, 2021: CRCNS PIs Meeting 2021
"Neuronal resonance can be generated at multiple levels of organization"

July 29, 2021: Tel Aviv University, Sackler School of Medicine, Stark Group
"Networks of e-i firing rate models and spiking (lif) models show similar resonances by different mechanisms"

July 3, 2021: Computational Neuroscience Meeting (CNS-2021)
"Flexible selection of cognitive tasks and memory suppression in a hippocampus – prefrontal cortex network regulated by the nucleus reuniens"

July 3, 2021: Computational Neuroscience Meeting (CNS-2021)
"Frequency filter interactions in networks of non-oscillatory cells"

July 3, 2021: Computational Neuroscience Meeting (CNS-2021)
"Network patterns emerging from the interplay of lateral inhibition and the intrinsic properties of striatal msns"

July 3, 2021: Computational Neuroscience Meeting (CNS-2021)
"Neuronal oscillations level sets for activity constancy: from single neurons to networks"

July 3, 2021: Computational Neuroscience Meeting (CNS-2021)
"Revealing the link between spiking cross-correlation patterns and the underlying subthreshold neuronal dynamics"

July 3, 2021: Computational Neuroscience Meeting (CNS-2021)
"Segregated resonant mechanisms in ca1 pyramidal cells: interplay of ionic currents and cell's spatial structure"

David G. Shirokoff

May 7, 2022: ICCMAE 2022: The Second International Conference on Computational Methods and Applications in Engineering, Mississippi State University, Starkville, MS
"Weak stage order barriers for runge-kutta schemes"

April 2022: NJIT Optimization and Machine Learning Talks, NJIT, Newark, NJ, Virtual
"Stochastic gradient descent as a markov chain"

March 30, 2022: Mathematical Sciences Colloquium, University of Massachusetts, Lowell, MA, Virtual
"Convex relaxations for variational problems arising from pairwise interaction problems"

January 10,2022: ICERM Workshop: Holistic Design of Time-Dependent PDE Discretizations, Institute for Computational Experimental Research in Mathematics (ICERM), Providence, RI, Hybrid
"Implicit-explicit (imex) stability and applications to the dispersive shallow water equations"

January 10, 2022: ICERM Workshop: Holistic Design of Time-Dependent PDE Discretizations, Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, RI, Hybrid
"Panelist for Panel 1: Implicit-explicit time stepping"

November 23, 2021: Numerical Analysis and Scientific Computing Seminar, University of Waterloo, ON, Canada, Virtual
"Implicit-explicit (imex) stability and applications to the dispersive shallow water equations"

November 19, 2021: Mathematics Seminar, Mississippi State University, Starkville, MS
"Implicit-explicit (imex) stability and applications to the dispersive shallow water equations"

November 2, 2021: Numerical Analysis Seminar, North Carolina State University, Rayleigh, NC, Virtual
"Implicit-explicit (imex) stability and applications to the dispersive shallow water equations"

Michael S. Siegel

June 20, 2022: 19th US National Congress on Theoretical and Applied Mechanics, US National Committee on Theoretical and Applied Mechanics, Austin, TX
"Induced charge electrokinetic flow for a drop"

July 19, 2021: SIAM Annual Meeting 2021, Virtual
"A hybrid boundary integral method for two-phase flow with soluble surfactant"

Sundarraman Subramanian

August 8, 2021: Joint Statistical Meetings, American Statistical Association
"Model checks for two-sample location-scale"

Antai Wang

September 29, 2021: Statistics Seminar, University of Central Florida
"Analysis of semi-competing risks data using copula models"

August 27, 2021: Statistics Seminar, University of North Carolina at Greensboro
"Analysis of semi-competing risks data using copula models"

August 19, 2021: World Statistics Congress 2001, International Statistical Institute, Virtual
"Analysis of semi-competing risks data using copula models"

Peter Ward

April 23, 2022: ASEE Middle Atlantic Section Conference Spring 2022, ASEE - MAS, NJIT, Newark, NJIT
"The NJIT/Newark math success initiative (MSI): A holistic program to prepare and support urban students to succeed in earning stem degrees in college"

Yuan-Nan Young

June 23, 2022: US National Congress on Theoretical and Applied Mechanics (USNCTAM), Austin, Texas
"The many behavior of active droplets"

June 22, 2022: US National Congress on Theoretical and Applied Mechanics (USNCTAM), Austin, Texas
"Boundary conditions at the fluid-hydrogel interface"

June 6, 2022: European Community on Computational Methods in Applied Sciences 2022, European Community on Computational Methods in Applied Sciences, Oslo, Norway
"The many behaviors of active droplets"

May 27, 2022: Biological Physics & Physical Biology Seminar
"Mechanics of primary cilia"

November 23, 2021: American Physical Society, Division of Fluid Dynamics, Annual Meeting 2021APS/DFD, Phoenix, AZ
"Arbitrary lagrangian-eulerian simulations of interfacial dynamics between a hydrogel and a fluid"

November 22, 2021: American Physical Society, Division of Fluid Dynamics, Annual Meeting 2021APS/DFD, Phoenix, AZ
"Hydrodynamics of janus particles self-assembled as vesicles"

November 22, 2021: American Physical Society, Division of Fluid Dynamics, Annual Meeting 2021APS/DFD, Phoenix, AZ
"The many behaviors of deformable active droplets"

November 21, 2021: American Physical Society, Division of Fluid Dynamics, Annual Meeting 2021 APS/DFD, Phoenix, AZ
"Hydrodynamics of a multicomponent vesicle under strong confinement"

November 21, 2021: American Physical Society, Division of Fluid Dynamics, Annual Meeting 2021 APS/DFD, Phoenix, AZ

"Hydrodynamics of a permeable membrane deformed by pulling forces: A model for microtubule-mediated deformation of a nucleus membrane"

November 21, 2021: American Physical Society, Division of Fluid Dynamics, Annual Meeting 2021 APS/DFD, Phoenix, AZ

"Hydrodynamics of a semipermeable inextensible membrane under flow and confinement"
November 8, 2021:The Cold Place Mathematical Biology Seminar, University of Minnesota
"The many behaviours of deformable active droplets"

October 14, 2021: Math Colloquium, Old Dominion University
"The many behaviours of deformable active droplets"

VI. EXTERNAL ACTIVITIES AND AWARDS

A. FACULTY ACTIVITIES

Shahriar Afkhami

Associate Editor, Journal of Engineering Mathematics, January 2016 - 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

Linda J. Cummings

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

Shidong Jiang

Editorial Board, Journal of Scientific Computing, 2020 - Current

Lou Kondic

Fellow, American Physical Society

Associate Editor, Crystals, 2021 - Current

Associate Editor, Nanomaterials, 2021 - Current

Associate Editor, Journal of Engineering Mathematics, 2020 - Current

Associate Editor, Papers in Physics, 2019 - Current

Simone Marras

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

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

Luis Pugnaloni

Managing Editor, Papers in Physics, 2009 - Current
Zoi-Heleni Michalopoulou

Associate Editor, Journal of the Acoustical Society of America

Associate Editor, IEEE Journal of Oceanic Engineering

Michael Siegel

Associate Editor, Journal of Engineering Mathematics

B. FACULTY AWARDS

Christina Frederick

Summer Faculty Fellow, Office of Naval Research, December 2022

Brittany D. Hamfeldt

Editor's Pick, Journal of the Optical Society of America, November 2021

B. FACM 2022 CONFERENCE: FRONTIERS IN APPLIED AND COMPUTATIONAL MATHEMATICS

After a two-year break precipitated by the COVID pandemic, this year saw the return of our Annual Conference on Frontiers in Applied and Computational Mathematics (FACM 2022), held at the New Jersey Institute of Technology on May 20 – 21, 2022. In this cycle, the Conference focused on the most novel and promising trends in mathematical biology, and was run under the title 'New Perspectives in Mathematical Biology'. The conference was supported by the National Science Foundation's Division of Mathematical Sciences grant award DMS-2154556. We are grateful to NSF for their support that has allowed us to return to this stimulating and productive in-person conference experience. Travel funds provided by this grant were specifically targeted to support the participation of junior researchers, particularly those from groups under-represented in mathematics and the life sciences, helping in the advancement of their career paths.

FACM 2022 was focused on bringing together researchers that develop and use cutting-edge tools of applied and computational mathematics to glean deeper understanding of some of the most fundamental problems in the life sciences. The conference covered such diverse but overlapping topics as stochastic modeling of biological processes, collective behavior of large biological populations, data-driven approaches to the understanding of biological fluids, and learning paradigms in biological and artificial neuronal networks. These related fields of research have been particularly active in recent years and hold much promise in both promoting our understanding of complex biological systems and contributing to the advancement of the "Big Ideas" articulated in 2016 by the National Science Foundation. Further, the FACM 2022 conference highlighted the close interaction between researchers working in applied mathematics and biology at NJIT, and the prominence of interdisciplinary research at our University.

The conference had a total of 93 participants and included 4 plenary speakers, 19 invited lecture presentations, 41 poster presentations, as well as a very successful discussion session focusing on the most promising new trends in mathematical biology and on career advice for junior researchers.

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

- Carina Curto, Pennsylvania State University, "Sequences and modularity of dynamic attractors in inhibition-dominated neural networks"
- Anita Layton, University of Waterloo, "His and her computational models of kidney function"
- Grzerorz Rempala, Ohio State University, "Modeling Epidemics after COVID-19: What are we still missing?"
- Corina Tarnita, Princeton University, " Lack of synchronization: a key for collective systems robustness?"

The organizing committee for this year's conference was: Victor Matveev (Co-Chair), Amitabha Bose (Co-Chair), Casey Diekman, Simon Garnier, Enkeleida Lushi, James MacLaurin, Peter Thomas (Case Western Reserve University), and Yuan-Nan Young.

FACM 2022 Group Photo

FACM 2022 Lecture Presentation of Dr. Peter J. Thomas, Case Western Reserve University

VII. FUNDED RESEARCH

A. EXTERNALLY FUNDED RESEARCH

Continuing Funded Projects

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

Collaborative Research: Novel Microlocal-Analysis and Domain-Decomposition Based Fast Algorithms for Elastic Wave Modeling and Inversion in Variable Media
National Science Foundation: August 1, 2020 - July 31, 2023
Yassine Boubendir

Efficient High Frequency Integral Equations and Iterative Methods
National Science Foundation: August 1, 2017 - June 30, 2021
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 - August 31, 2021
Bruce Bukiet

Liquid Crystal Films Across Scales: Dewetting & Dielectrowetting
National Science Foundation: September 1, 2018 - August 31, 2023
Linda Cummings (PI), Lou Kondic (Co-PI)

GOALI: Predicting Performance & Fouling of Membrane Filters
National Science Foundation: September 1, 2016 - August 31, 2022
Linda Cummings (PI), Lou Kondic (Co-PI)

CAREER: Neuronal Data Assimilation Tools and Models for Understanding Circadian Rhythms
National Science Foundation: July 1, 2016 - September 30, 2022
Casey Diekman

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

Meshfree Finite Difference Methods for Nonlinear Elliptic Equations
National Science Foundation: September 1, 2016 - August 31, 2021
Brittany Hamfeldt

Conference on Frontiers in Applied and Computational Mathematics
National Science Foundation: May 1, 2019 – October 31, 2021
Lou Kondic (PI), Denis Blackmore (Co-PI), Linda Cummings (Co-PI), Michael Siegel (Co-PI)

Stick-Slip Dynamics and Failure in Granular Materials
Duke University: July 15, 2018 – July 31, 2022
Lou Kondic

Scalable Inference of quantile Regression for Large-Scale Health Care Data
National Institutes of Health: May 15, 2019 – April 30, 2023
Ji Meng Loh

Modeling and Simulations of Problems in Active Matter
The Simons Foundation: September 1, 2019 - August 31, 2024
Enkeleida Lushi

Collaboration in Mathematical Biology
The Simons Foundation: September 1, 2020 - August 31, 2025
James Maclaurin

Collaborative Research: Understanding the Turbulent Dynamics of Convective Bursts and Tropical Cyclone Intensification Using Large Eddy Simulation and High Order Numerics
National Science Foundation: August 1, 2021 - July 31, 2024
Simone Marras

Supplement Collaborative Research: Understanding the Turbulent Dynamics of Convective Bursts and Tropical Cyclone Intensification Using Large Eddy Simulation and High Order Numerics
National Science Foundation REU: August 1, 2021 - July 31, 2024
Simone Marras

Geoacoustic Inversion in Shallow Water - Analytic and Optimization Methods
U.S. Navy: Office of Naval Research: March 1, 2020 - February 28, 2023
Zoi-Heleni Michalopoulou

Geoacoustic Inversion in Shallow Water
U.S. Navy: Office of Naval Research: March 1, 2018 - February 28, 2022
Zoi-Heleni Michalopoulou

Coherent Structures in Nanomagnetism
National Science Foundation: July 1, 2019 - June 30, 2023
Cyrill Muratov

Phase Transitions in Colloid-Polymer Mixtures in Microgravity
NASA: November 5, 2019 - November 4, 2022
Anand Oza

Wave-Coupled Active Matter
Simons Foundation: September 1, 2018 - August 31, 2022
Anand Oza

US-Israel Research Proposal: Network Resonance: Spiking Mechanisms and Behavioral Implications
National Science Foundation: September 15, 2016 - August 31, 2022
Horacio Rotstein

CDS&E: Collaborative Research: Scalable Nonparametric Learning for Massive Data with Statistical Guarantees
National Science Foundation: August 1, 2019 - July 31, 2023
Zuofeng Shang

Collaborative Research: Euler-Based Time-Stepping with Optimal Stability and Accuracy for Partial Differential Equations
National Science Foundation: August 15, 2020 - July 31, 2023
David Shirokoff

Collaborative Research: Overcoming Order Reduction and Stability Restrictions in High-Order Time-Stepping
National Science Foundation: August 1, 2017 - July 31, 2022
David Shirokoff

Numerical Methods and Analysis for Interfacial Flow with Ionic Fluids and Surfactants
National Science Foundation: August 1, 2019 - July 31, 2023
Michael Siegel

Optimized Domain Decomposition Methods for Wave Propagation in Complex Media
National Science Foundation: September 1, 2019 - August 31, 2022
Catalin Turc

Efficient Solutions of Wave Propagation Problems in Multi-Layered, Multiple Scattering Media
National Science Foundation: September 1, 2016 - August 31, 2022
Catalin Turc

Collaborative Research: Mathematical, Numerical, and Experimental Investigation of Flow Sensing by the Primary Cilium
National Science Foundation: August 1, 2020 - July 31, 2023
Yuan-Nan Young

Collaborative Research: Theoretical, Computational, and Experimental Investigations on the Interaction Between a Lipid Bilayer Membrane and a Solid Substrate or Particle
National Science Foundation: September 1, 2016 - August 31, 2022
Yuan-Nan Young

Projects Funded During the Present Academic/ Fiscal Year

Nonlinear Resonant Wave Interactions in Density-Stratified Flows
National Science Foundation: September 1, 2021 - August 31, 2024
Wooyoung Choi

Strategies, algorithms, and analysis for autonomous mobile sensor deployment
US Dept. Of Navy: August 20, 2021 - August 19, 2024
Christina A. Frederick

Active Oil-Water Separation Using Surface Chemistry and Acoustowetting
American Chemical Society: August 1, 2021 - August 31, 2023
Lou Kondic

Phase Separation of Two-Fluid Mixtures using Surface Acoustic Waves: Developing Basic Principles in a Quest for Enhanced Water Recovery
US- Israel Binational Science Foundation: October 1, 2021 - September 30, 2025
Lou Kondic

Development of a graduate course on granular matter
Ministry of Education, Argentina: April 1, 2022 - October 1, 2022
Lou Kondic

Conference on Frontiers in Applied and Computational Mathematics
National Science Foundation: May 1, 2022 – April 30, 2023
Victor Matveev (PI), Amitabha Bose (Co-PI)

Modeling and Simulation of Interacting Wings: Collective Dynamics in Inertial Fluid Flows
National Science Foundation:July 15, 2021 - June 30, 2024
Anand U. Oza

Flows about Grooved Superhydrophobic Surfaces
US- Israel Binational Science Foundation: October 1, 2021 - September 30, 2025
Michael Siegel

B. PROPOSED RESEARCH

Projects Proposed During Present Fiscal Year

Shahriar Afkhami

Magnetophoretic transport and assembly of paramagnetic particles
National Science Foundation, November 15, 2021

A multi-scale numerical method for viscoelastic flows
National Science Foundation, December 1, 2021

Numerical investigation of mixing and spreading of liquids with varying surface tension and surfactant effects
National Science Foundation, December 7, 2021

Travis L. Askham

High-order and high-throughput methods for the Navier-Stokes Equations in complex geometries
National Science Foundation, November 30, 2021

Collaborative Research: Elements: A Fast, Accurate, and Easy-to-Use Integral Equation Toolbox
National Science Foundation, December 8, 2021

Bruce G. Bukiet

STEM for Success Scholarship and Service
National Science Foundation, February 22, 2022

Linda J. Cummings

NSF GRFP: Separating oil-water emulsions using surface acoustic waves
National Science Foundation, October 28, 2021

GOALI: Network models for membrane filtration
National Science Foundation, November 15, 2021

Casey O. Diekman

GOALI: Merging Deep Learning and Mechanistic Modeling to Analyze the Electrophysiology of Circadian Clock Neurons, Aging, Cardiac Arrhythmias, and Alzheimer's Disease
National Science Foundation, September 7, 2021

Roy H. Goodman

New problems in vortex dynamics and quantum graphs
The Simons Foundation, January 26, 2022

Lou Kondic

Phase Separation of Two-Fluid Mixtures using Surface Acoustic Waves: Developing Basic Principles in a Quest for Enhanced Water Recovery
US- Israel Binational Science Foundation, July 20, 2021

CDS&E Collaborative Research: Dense suspension flows - Network analysis of flow properties and material dynamics
National Science Foundation, September 15, 2021

Development of a graduate course on granular matter
Ministry of Education, Argentina, February 7, 2022

BRITE PIVOT: Towards better understanding of advanced materials using topological data analysis
National Science Foundation, April 25, 2022

Ji Meng Loh

Statistical methods for univariate, bivariate and linked spatial point processes
National Science Foundation, January 25, 2022

Enkeleida Lushi

Analysis and simulation of chiral active suspensions
National Science Foundation, November 15, 2021

Fast simulations of motile particles in complex confinement
National Science Foundation, December 1, 2021

James N. MacLaurin

Glassy Dynamics in Disordered Media
National Science Foundation, September 27, 2021

The Ergodicity of Waves and Patterns
National Science Foundation, November 15, 2021

Victor V. Matveev

Conference on Frontiers in Applied and Computational Mathematics (FACM-2022): New Perspectives in Mathematical Biology
National Science Foundation, September 29, 2021

Anand U. Oza

MPS AGEP-GRS: Modeling and Simulation of Interacting Wings: Collective Dynamics in Inertial Fluid Flows
National Science Foundation, June 27, 2022

Zuofeng Shang

CDS&E: Collaborative Research: Scalable Nonparametric Learning for Massive Data with Statistical Guarantees (supplement)
National Science Foundation, July 22, 2021

CDS&E: Optimal Nonparametric Inference Involving Data Quantization and Deep Learning
National Science Foundation, September 20, 2021

Optimal Nonparametric Inference with Applications to Massive Data
National Security Agency, October 15, 2021

Optimal Nonparametric Inference with Applications to Massive Data
National Science Foundation, December 15, 2021

Yuan-Nan Young

Collaborative Research: Mathematical modeling and simulation of self-assembling amphiphilic particles in solvent
National Science Foundation, November 15, 2021

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	**368**	**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 30 nodes and 368 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 the Kong.njit.edu cluster was replaced with the far more powerful Lochness.njit.edu cluster. Lochness utilizes a shared infrastructure model with public, private, and Stheno nodes supported. The public portion of Lochness consists of 35 nodes and 3360 cores. Each node has

- 385GB RAM
- 2x Intel Xeon Gold 6226R CPU @ 2.90GHz
- 1TB of SSD storage

- 100Gb/sec Infiniband network interface
- 10GigE Ethernet interface
- CentOS Linux 7 (Core)”operating system

B. STATISTICAL CONSULTING LABORATORY REPORT

July 2021 - June 2022

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.

Ji Meng Loh, together with a student Chhavi Tyagi, worked with Ken Beyer (Unique Wire Weaving Co, Inc, acting as representative for ASTM members), from Nov 2021 to Feb 2022, to study the distribution of sieve opening measurement data in order to assess whether standards requirements for the manufacture of sieves should be updated based on a t distribution rather than the normal distribution. New data is currently being collected for further analysis.

Sunil Dhar also worked with the following:

Hamed Mohammed Albisher, a Ph.D. student under Professor Sanchoy Das, Mechanical and Industrial Engineering, Newark, New Jersey in June 2022. A method to accurately estimate the true correlation of the simulated bivariate truncated distribution was given and discussed.

Director and Professor Anthony D. Rosato, Granular Science Laboratory, New Jersey institute of Technology, Newark, New Jersey in March 2022. The Levene's test was used to test if the variances of the variables XX, YY and ZZ are statistically different and other related statistical analyses are provided.

Nikhat Parveen, Associate Professor, ICPH Microbiology, Biochemistry and Molecular Genetics Rutgers-New Jersey Medical School, Newark, New Jersey, in September 2021. Power analysis for proportion of outcomes in the treatment group to be larger than that of the control group, are considered for a one-sided hypothesis test of comparing two proportions using Fisher's exact conditional test, with a Walters's normal approximation, is provided.

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, Flammang, Garnier, Golowasch, Golowasch, Holzapfel, Lushi, MacLaurin, Matveev, Nadim, 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, stochastic 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, Amitabha Bose and James MacLaurin. 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 and dynamical systems techniques to understand neuronal networks. In particular, he is interested in developing models for beat perception in the context of music and for circadian oscillations. James MacLaurin studies many aspects of neuroscience, including the effect of white noise on waves and patterns, derivation of population-density equations to describe the collective behavior of large ensembles of neurons, and techniques for the phase reduction of noisy irregular oscillations.

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. Lushi and other CAMS members work on the modeling and simulation of active matter.

Fluid Dynamics and Material Science

Researchers in CAMS working on problems related to Fluid Dynamics and Material Science: Afkhami, Ahmadpoor, Askham, Bechtold, Booty, Bukiet, Choi, Cummings, Dias, Diez, Farokhirad, Gor, Huang, Jiang, Kondic, Luke, Lushi, Marras, Meegoda, Mema, Oza, Pak, Papageorgiou, Petropoulos, Rosato, Sanei, Shirokoff, Shakib, Siegel, Tafuni, Vanden-Broeck, Voronov, Wang H., Wang Q., Wylie, and Young.

A large group of members within the Department of Mathematical Sciences (DMS) and Center for Applied Mathematics and Statistics (CAMS) have research interests in fluid dynamics and Material Science. 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, including data science

The fluid dynamics group in the Department of Mathematical Sciences at NJIT has an active research program covering interfacial fluid dynamics, thin films, electrohydrodynamics, hydrodynamic stability theory, sedimentation, granular flow and combustion. A particular focus for several of the faculty members 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. In particular, there is an active research program in active matter. This and other topics in complex fluids is the focus of a complex fluids and soft matter working group, headed by Anand Oza.

There are also various research activities in material science. This includes molecular dynamics, variational methods, thin film materials, gels and soft matter, and data science methods.

Wave Propagation

Researchers in CAMS working on problems related to Wave Propagation: Ahluwalia, Askham, Booty, Boubendir, Choi, Erneux, Frederick, Goodman, Jiang, 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.

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 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. In particular, Zoi-Heleni Michalopoulou and Christina Frederick work on developing powerful new algorithms for inverse problems in acoustics. Their research brings forward state-of-the-art techniques, including machine learning, to these challenging problems.

Numerical Methods

Researchers in CAMS working on problems related to Numerical Methods: Afkhami, Askham Boubendir, Bukiet, Choi, Dias, Dytso, Frederick, Goodman, Hamfeldt, Horntrop, Jiang, Kondic, Koutis, Luke, Lushi, Matveev, Michalopoulou, Moore, Musialski, Muratov, Papageorgiou, Petropoulos, Rosato, Shirokoff, Siegel, Shang, Tao, Turc, Xu 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 achieve 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. Recently, there has been significant research efforts by CAMS members on emergency methods in data science. Focus areas include statistical learning and applications of data science in acoustics, solar physics, and fluids.

Statistics

Researchers in CAMS working on problems in Applied Probability and Statistics: Dhar, Guo, Loh, Roychoudhury, Shang, 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.

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. In addition to participating in the Provost's Summer Undergraduate Research Program, many students have engaged in research by working with individual professors and by participating in REU programs such as the RIPS program at UCLA.

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, Google, 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 16 passed during the year. 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.

Modeling thin film flow under the action of surface acoustic waves

Instructor: Lou Kondic

Lab Assistant: Joseph D'Addesa

Participating Students: Bhargav Samineni, Jung Park, George Bizos

This Capstone project focuses on modeling flow of thin films under the action of surface acoustic wave (SAW). Corresponding physical experiments, recently carried out by a collaborating group at Technion, suggest that SAWs induce forcing that could be used to drive the flow of thin films on substrates. In this project, participating students worked on developing an asymptotic model describing coupling of acoustics and fluid dynamics, leading to a nonlinear partial differential equation governing the flow. The students then developed a finite difference-based numerical method for the purpose of solving the resulting equation numerically. The included graphics show the result of these simulations, where action of SAW is used to drive the fluid flow over an imposed obstacle. During the course of semester, the students also had a chance to discuss their project virtually and in person with the leader of the experimental team, prof. Ofer Manor from Technion. The web page illustrating the results (prepared by B. Samisen) can be found at http://cfsm.njit.edu/capstone.

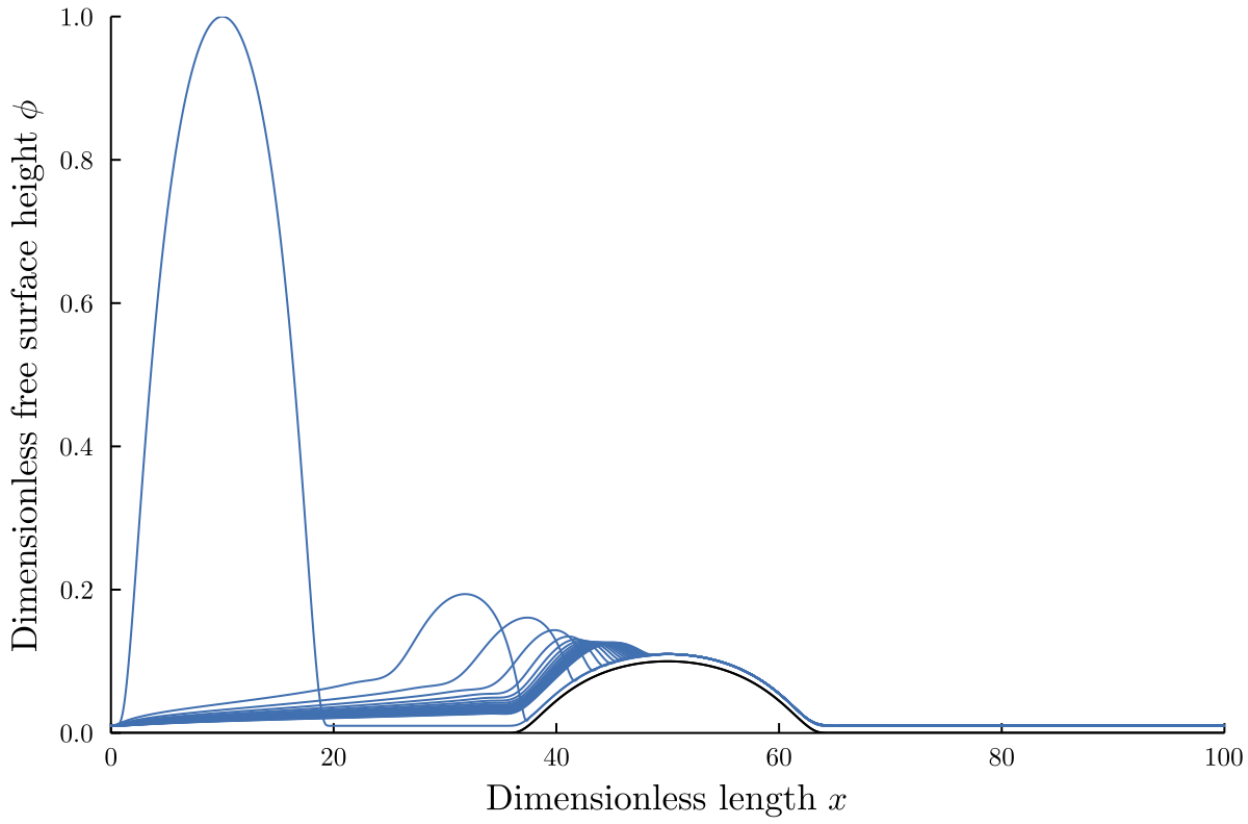

Figure 1 caption: Modeling the flow of a fluid drop (initially at the left side) over the imposed surface perturbation (on the right) under the action of a surface acoustic wave. (figure produced by B. Samineni).

This project is supported in part by the Binational Science Foundation grant No. 2020174 and American Chemical Society PRF grant No. 62062-ND9.

Modeling thin film on top of a vibrated substrate

Instructor: Lou Kondic

Lab Assistant: Joseph D'Addesa

Participating Students: Marina Markaki, Denisse Mendoza

This Capstone project focuses on modeling the dynamics of thin films on a vibrated substrate. Corresponding physical experiments, recently carried out by a collaborating group at TU Darmstadt, Germany, suggested occurrence of novel dynamics occurring in a setup involving closing of a hole in a thin film. The participating students worked on setting up a model describing the dynamics of a thin film on top of vibrated substrate. The simulations of the governing partial differential equation allowed the students to quantify evolution of the film profile. The graphics show the initial and close-to-final stages of a collapse of a hole in the film. The web page illustrating the results in more detail can be found at http://cfsm.njit.edu/capstone.

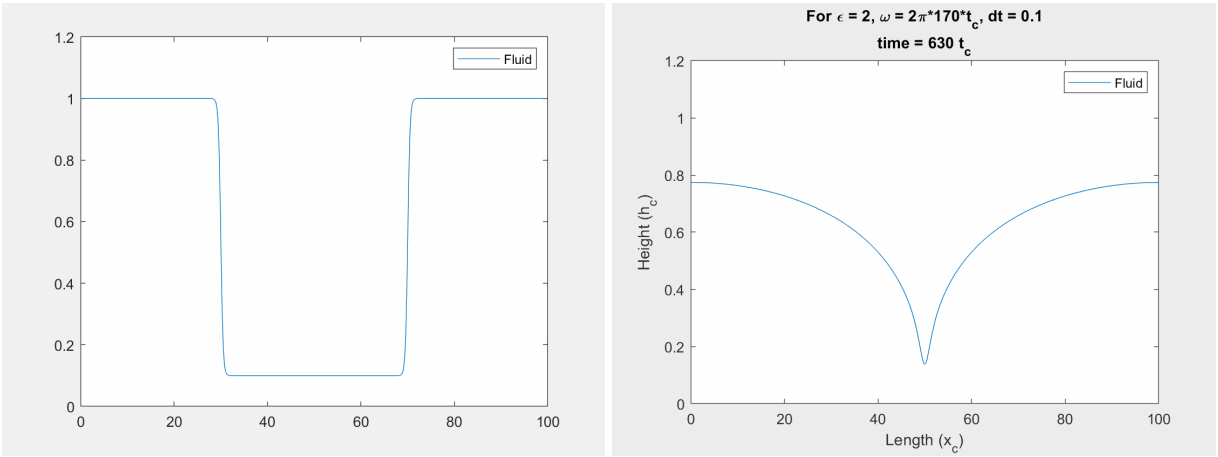

Figure 1 caption: Initial (left) and close-to-final (right) profile of a collapsing hole in a thin film on a vibrated substrate.

This project is supported in part by the NSF Grant No. 996985.

Modeling growth of frost via Monte-Carlo Simulations

Instructor: Lou Kondic

Lab Assistant: Joseph D'Addesa

Participating Students: Ricky Palaguachi, Noah Roselli, Divjyot Singh, Joseph Torsiello

This Capstone project focuses on modeling frosting on a microstructured substrate using Monte-Carlo simulations. Corresponding physical experiments, recently carried out by collaborating group at Max Planck Institute in Mainz, Germany, shows a variety of emerging patterns whose properties depend on relative humidity and temperature. The participating students modeled frost formation and spreading via Monte-Carlo simulations based on a random walk model simulating the frosting process from the point of view of diffusion limited aggregation. The graphics show an example of a fractal pattern produced by the model.
The web page illustrating the results, including parametric dependence of the results, can be found at http://cfsm.njit.edu/capstone.

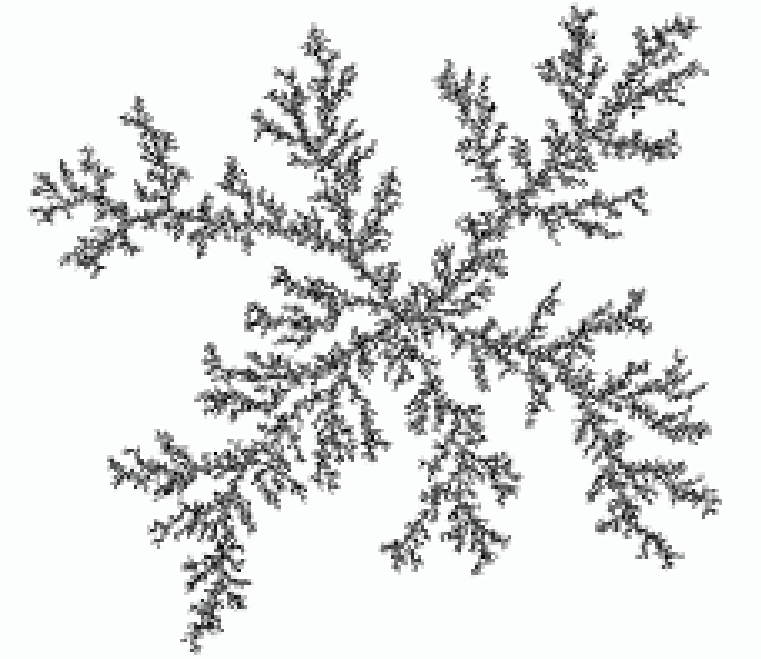

Figure 1 caption: Fractal pattern obtained in modeling frost growth via Monte-Carlo simulations.

This project is supported in part by the NSF Grant No. DMS-996985.

B. GRADUATE PROGRAMS

Graduate Activities Report
Shahriar Afkhami, Associate Chair for Graduate Studies

This was a banner year for the graduate program in the Department of Mathematical Sciences. We had a high yield on our offers of graduate admissions, culminating in an incoming class of 5 Ph.D. students in Applied mathematics and Applied Statistics. The new students have diverse backgrounds, coming from undergraduate and masters programs in mathematics (pure and applied), engineering, and statistics. One of the incoming students was awarded a prestigious NJIT Gary Thomas Provost Fellowship. Several current students secured summer internships at government labs, as well as local pharmaceutical companies. The Masters program in Data Science (Statistics track) is up and running in our new Jersey City Campus and has attracted significant enrollment.

The Department of Mathematical Sciences takes great pride in the quality of its graduate programs. In addition to master's programs in Applied Mathematics, Applied Statistics, Biostatistics, and Data Science (Statistics track), our PhD program continues to attract high caliber students who work closely with faculty to conduct original research in applied and computational mathematics and statistics. We have recently introduced graduate certificates in Applied Statistics, Biostatistics, and Data Science. 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 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. 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 tea-time as well sd academic, career-oriented, and social events under the banner of the NJIT SIAM Chapter, such as a student organized seminar series in machine learning in addition to the usual graduate student seminar series that runs over the summer (see below). Our students have had much recent success in finding internships, in governmental research facilities such as Center for Computational Mathematics (CCM) at the Flatiron Institute, Johns Hopkins Applied Physics Laboratory, as well as in private industries such as Merck Sharp & Dohme Corp., and Johnson & Johnson.

It is ultimately the offers our students receive after graduation that indicate the health of our programs. New positions secured by our graduates in the past two years include a faculty position at the Kohat University of Science and Technology, biostatistician positions at Bristol Myers Squibb, and postdocs at Worcester Polytechnic Institute and Mount Sinai Icahn School of Medicine. Several recent graduates have obtained exciting positions in data science. This year, a career panel session was held, where one of our past Ph.D. graduates from our department presented their career experiences and discussed and answered students’ questions.

PhDs Awarded in the Period Covered by the Report

Jimmie Adriazola
Coherent Control of Dispersive Waves
Advisor: Roy Goodman

Ryan Allaire
Modeling Dewetting, Demixing, and Thermal Effects in Nanoscale Metal Films
Advisor: Lou Kondic

Atefeh Javidialsaadi
Model Checks for Two-Sample Location-Scale
Advisor: Sundarraman Subramanian

Ruqi Pei
Periodic Fast Multipole Method
Advisor: Travis Askham and Shidong Jiang

Beibei Li
Type I Error Rates Controlling Procedures for Multiple Hypotheses Testing
Advisor: Wenge Guo

Zhongcheng Lin
Dependent Censoring in Survival Analysis
Advisor: Antai Wang

Gan Luan
Parameter Estimation and Inference of Spatial Autoregressive Model by Stochastic Gradient Descent
Advisor: Ji Meng Loh

Yixuan Sun
Modeling and Design Optimization for Membrane Filters
Advisor: Linda J. Cummings

Axel Turnuist
Numerical Methods for Optimal Transport and Optimal Information Transport on the Sphere
Advisor: Brittany Hamfeldt

Erli Wind-Anderson
Nyström Methods for High-Order Cq Solutions of the Wave Equation in Two Dimensions
Advisor: Catalin Turc and Peter Petropoulos

Publications, Presentations, & Conferences

***Not Including DMS Summer Student Talks**

Rituparna Basak

Publications

Two Approaches to Quantification of Force Networks in Particulate Systems, (with C. M. Carlevaro, R. Kozlowski, C. Cheng, L. A. Pugnaloni, M. Kramár, H. Zheng, J. E. S. Socolar, and L. Kondic), *J. Eng. Mech*, Vol. 147, 04021100 (2021)

On Intermittency in Sheared Granular Systems, (with M. Kramar, C. Cheng, and L. Kondic), *Soft Matter*, Vol. 18, 3583-3593, (2022)

Prianka Bose

Publications

Forecasting the Disturbance Storm Time Index with Bayesian Deep Learning (with Abduallah, Y., Wang, J. T. L., Zhang, G., Gerges, F., & Wang, H.), *The International FLAIRS Conference Proceedings*, 35 (2022)

Posters

Study of Beat Perception using Onset Detection Algorithm (poster),
Frontiers in Applied and Computational Mathematics,
May 20-21 2022, New Jersey Institute of Technology, Newark, NJ.

Binan Gu

Conference and Workshop Attendance

74th Meeting of Division of Fluid Dynamics, American Physical Society,
November 21-23, 2021, Phoenix, AZ.

Frontiers in Applied & Computational Mathematics (FACM '22)
May 20-21, 2022, New Jersey Institute of Technology, Newark, NJ.

Mathematical Problems in Industry (MPI) Workshop
June 13-17, 2022, Worcester Polytechnic Institute, Worcester, MA.

The 17th Northeast Complex Fluids and Soft Matter Workshop (NCS-17),
June 24th, 2022, Stevens Institute of Technology, Hoboken, NJ.

Publications

A Graphical Representation of Membrane Filtration (with L. Kondic and L. Cummings), *SIAM J. Appl. Math*, Vol. 82, 950-975 (2021).

Network-Based Membrane Filters: Influence of Network and Pore Size Variability on Filtration Performance (with L. Kondic and L. Cummings), *J. Membr. Sci*., Vol. 657, 120668 (2022)

Posters

A Graphical Representation of Membrane Filtration (poster),
Graduate Student Association Research Day,
November 30, 2021, New Jersey Institute of Technology, Newark, NJ.

Presentations

A Graphical Representation of Membrane Filtration (minisymposium talk),
74th Meeting of Division of Fluid Dynamics, American Physical Society,
November 21-23, 2021, Phoenix.

Yuexin Liu

Publications

Gait Switching and Targeted Navigation of Microswimmers via Deep Reinforcement Learning (with Z. Zou, Y. Liu, Y.-N. Young, O. S. Pak, and A. C. H. Tsang), *Communications Physics*, 5, 128, (2022)

Linear 3-Sphere Device in a Non-Stationary Environment via Reinforcement Learning Context Detection (with Z. Zou, Y. Liu, A. C. H. Tsang, Y.-N. Young, and O. S. Pak) *Manuscript*, (2022)

Artificial Microswimmers via Reinforcement Learning (Z. Zou, Y. Liu, O. S. Pak, Y.-N. Young, A. C. H. Tsang), *American Physical Society Division of Fluid Dynamics Meeting Abstracts*, Y11.00012, (2022)

Presentations

Gait Switching and Targeted Navigation of Microswimmers via Deep Reinforcement Learning (oral presentation),
Frontiers in Applied & Computational Mathematics (FACM),
May 20-21, 2022, NJIT, Newark, NJ,

Gait Switching and Targeted Navigation of Microswimmers via Deep Reinforcement Learning (oral presentation),
Northeast Complex Fluids & Soft Matter (NCS) Workshop,
Jan 14, 2022

Mechanical Rotation at Low Reynolds Number via Reinforcement Learning (oral presentation),
Northeast Complex Fluids & Soft Matter (NCS) Workshop,
Aug 20, 2021

Connor Robertson

Presentations

Data-Driven Continuum Modeling of Active Nematics via Sparse Identification of Nonlinear Dynamic (talk)
APS March
March 14-18, 2022, Chicago, Il

Soheil Saghafi

Publications

The Emergence of Polyglot Entrainment Responses to Periodic Inputs in Vicinities of Hopf Bifurcations in Slow-Fast Systems (with E. Khan, S. Saghafi, C. O. Diekman, and H. G. Rotstein) *Chaos: An Interdisciplinary Journal of Nonlinear Science*

Posters

Deep Hybrid Modeling of Neuronal Dynamics using Generative Adversarial Networks,
Dana Knox Student Research Showcase
April 20, 2022, New Jersey Institute of Technology, Newark, NJ.

Deep Hybrid Modeling of Neuronal Dynamics using Generative Adversarial Networks.
Frontiers in Applied & Computational Mathematics (FACM)
May 20-21, 2022, New Jersey Institute of Technology, Newark, NJ.

Presentations

A Markov Chain Monte Carlo Version of the Genetic Algorithm Differential Evolution: Easy Bayesian Computing for Real Parameter Spaces.
Machine Learning and Optimization Seminar,
April, 2022, New Jersey Institute of Technology, Newark, NJ.

Moshe Silverstein

Posters

"Understanding Population-Level Activity in Large Neural Networks of Balanced Excitation and Inhibition (poster),
Frontiers in Applied and Computational Mathematics,
May 20-21, 2022, New Jersey Institute of Technology, Newark, NJ.

Presentations

Model Reduction of Large Random Networks (talk),
International Conference on Mathematical Neuroscience,
July 6-8, Online

Balanced Neural Fields (talk),
SIAM Conference on the Life Sciences,
July 11-14, Pittsburg, PA

Zheng Zhang

Conference and Workshop Attendance

2022 Workshop on Statistical Network Analysis & Beyond (SNAB 2022) at NYU, Aug 3-5, 2022, NY

Awards

Binan Gu

College of Science & Liberal Arts, Outstanding Graduate Student Award, Spring 2021

SIAM Student Chapter Certificate of Recognition, Spring 2021

Best Oral Presenter Award, Graduate Student Association Research Day, Fall 2021

Moshe Silverstein

Travel Award for the SIAM Conference on the Life Sciences 2022

Student Talks - Summer 2022

Thursday, June 2, **David Mazowiecki**
Numerical Simulation of Particles Undergoing Quincke Rotation

Tuesday, June 21, **Connor Robertson**
Data-driven Continuum Modeling and Simulation of Active Nematics via Sparse Identification of Nonlinear Dynamics

Tuesday, June 21, **Lauren Barnes**
Modeling Phase Separation of Colloid-Polymer Mixtures in Microgravity

Thursday, June 23, **Souaad Lazergui**t
High Frequency Asymptotic Expansion of the Helmholtz Equation Solutions Using Neumann to Dirichlet and Robin to Dirichlet Operators

Thursday, June 23, **Nicholas Dubicki**
A Micromagnetic Study of Skyrmions in Thin Film Ferromagnetic Bilayers

Tuesday, June 28, **Samantha Evans**
Towards a Boundary Integral Numerical Method for Two Phase Flow with Soluble Surfactant

Tuesday, June 28, **Yuexin Liu**
Low-Reynolds-Number Locomotion via Reinforcement Learning

Thursday, June 30, **Soheil Saghafi**
Stochastic Inverse Problem with Markov Chain Monte Carlo Version of the Genetic Algorithm Differential Evolution

Thursday, June 30, **Philip Zaleski**
Variational Models of Charged Drops: The Effect of Charge Discreteness

Tuesday. July 5, **Diego Rios**
Geoacoustic Inversion and Sediment Classification using Sound Waves

Thursday, July 7, **Jake Brusca**
Numerical Methods for the Monge-Ampère equation and Optimal Transport

Thursday, July 14, **Joseph D'Addesa**
Phase Separation of Two-Fluid Mixtures using Surface Acoustic Waves

Thursday, July 14, **Connor Greene**
Function Extension Methods for Solving PDEs

Tuesday, July 19, **Mark Fasano**
Modeling Phase Separation in Oil-Water Mixtures Atop a Substrate Vibration

Tuesday, July 19, **Binan Gu**
Stochastic Modeling of Flows in Membrane Pore Networks

Thursday, July 21, **Rituparna Basak**
Application of Computational Topology to Analysis of Granular Material Force Networks in the Stick-Slip Regime

Thursday, July 21, **Prianka Bose**
Rhythm Detection and Generation of New Tabla Composition using RNN

Thursday, July 21, **Nicholas Harty**
Multiple Scattering in Chaff Clouds

Tuesday, July 26, **Zhiwen Wang**
Something About Spatial Analysis

Tuesday, July 26, **Michael Luo**
Modeling Action Potentials in Diurnal Rodent Species

Thursday, July 28, **Zheng Zhang**
Information-Theoretic Limits for Testing Community Structure of Bipartite Network

Thursday, July 28, **Jose Pabon**
On the Study of the Role of Hydrodynamic Interactions in the Collective Motion of Swarms of Active Matter

Thursday, July 28, **Nastaran Rezaei**
Interfacial Instability of Two-Layer Flows

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/