CAMS

Center for Applied Mathematics and Statistics

ANNUAL REPORT

2004-2005

New Jersey Institute of Technology

TABLE OF CONTENTS

I. FROM THE DIRECTOR

Last year we had the pleasure of reporting that the Department of Mathematical Sciences was one of three NJIT programs selected to receive funding as part of a university-wide Strategic Initiative. With these funds, the Department seeks to be positioned among the top-ranked programs in applied mathematics within the next five years. The Strategic Initiative funds support the Departmental mission of research and training in the applied mathematical sciences, with particular focus in mathematical fluid dynamics and mathematical biology, which are areas of strength within the department.

This report marks the end of the first year of the Strategic Initiative, and a look through the accomplishments of DMS and CAMS that are listed here suggests that we are well on our way to achieving our goal of becoming one of the top-ranked programs in applied mathematics. We are encouraged by the attention that our efforts have received from the broader applied mathematics community. As noted by a distinguished researcher during his presentation at our second annual "Frontiers in Applied and Computational Mathematics" conference: "I visited NJIT 8 years ago, and it is amazing how the department has been built up since then. I now consider this to be one of the leading centers of applied mathematics in the country, and I congratulate the members of the Department of Mathematical Sciences."

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

- The awarding of a Major Research Instrumentation (MRI) grant from the National Science Foundation to DMS and CAMS for the purchase of a 134 processor parallel computer cluster. The cluster, online as of April 2005, is the most powerful computer on campus and one of the largest of its kind contained within a mathematics department nationwide. The projects that have been proposed for the cluster have close connection with areas of application, and illustrate the interdisciplinary strengths of CAMS. The cluster will no doubt serve as a first-rate computational tool for many years to come.

- The awarding of an Undergraduate Biology and Mathematics Training Program (UBMTP) by the National Science Foundation. This award, given to only 6 programs nationwide, marks a significant step in the Department's efforts to provide innovative training at the interface of mathematics and biology. This training program will educate undergraduate students in an environment in which mathematics and biology are intimately linked at both the curricular as well as the research level. Upon graduation, UBMTP students will be uniquely positioned to pursue doctoral studies in either mathematics or biology programs, as well as opportunities in bio-tech and pharmaceutical companies.

- The hosting of the second annual "Frontiers in Applied and Computational Mathematics" conference in May, 2005. This year's meeting attracted over 250 participants, and has become a major forum for the dissemination of new research and ideas in applied and computational mathematics.

- The addition of five new tenure-track faculty and one postdoctoral associate during the 2004-2005 academic year. Two of the faculty positions and the postdoc are funded by the Strategic Initiative. The new faculty greatly bolster DMS and CAMS research activities in scientific computing, numerical analysis, wave propagation, applied fluid dynamics, and biostatistics. For the academic year 2005-06, the Department has hired three additional tenure track faculty and one postdoctoral associate, the latter funded through the Strategic Initiative.

CAMS and DMS have established NJIT as a world center in research and education in mathematical biology, mathematical fluid dynamics, and wave propagation. The Department features one of the largest groups in Mathematical Biology in North America with ten active researchers, including six in neuroscience. Their research efforts are supported by 8 major grants from government and private organizations, covering areas such as intercellular calcium dynamics, cell-cell communication during development, and mathematical neuroscience. Departmental researchers enjoy national and international prominence and recognition in the areas of mathematical fluid dynamics and wave propagation, including electromagnetics, underwater acoustics, and nonlinear optics. The work of these researchers is supported by 15 grants from government agencies. Research activity in stochastic computing and computational geometry is supported by additional major grants from the National Science Foundation.

CAMS members also are involved in the development of innovative training programs for undergraduate students majoring in the mathematical sciences. The Department's NSF funded CAPSTONE Laboratory was set up in 1996 for the purpose of combining mathematical modeling and analysis, physical experiment, and numerical computation in a two-semester, senior-level undergraduate course. The course has been very successful over the past nine years, and we have recently submitted a proposal to NSF seeking to dramatically expand the lab's capabilities. The expanded lab, if funded, will be one of the leading facilities of its type nationwide.

The accomplishments of CAMS have been built with the support, inspiration, and dedication of many individuals. We are grateful to Fadi Deek, Dean of CSLA, Joel Bloom, Interim Provost, and Donald Sebastian, Senior Vice President for Research and Development, for encouraging CAMS through their strong support of scientific research. We are also grateful to David Ullman, Associate Provost for Information Services and Technology, David Perel, Director of Engineering Computing, and their staff for their continued support in maintaining our state-of-the-art computing facilities. We look forward to working with Provost and Sr. Vice President for Academic Affairs, Priscilla Nelson, who joined NJIT in May from her position as Senior Advisor to the Director at NSF. Finally, we thank President Robert A. Altenkirch, who has been a constant source of support for CAMS and its mission. We are sure that under his capable leadership at NJIT, CAMS will continue to prosper.

Daljit S. Ahluwalia, Director **Michael Siegel, 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 meeting, "Frontiers in Applied and Computational Mathematics," which has become a leading forum for the presentation of new research in applied mathematics and the sciences.

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

Department of Mathematical Sciences

Advisory Board - 2005

Dr. John S. Abbott	Corning Incorporated
Dr. Richard Albanese	Brooks Air Force Base
Dr. Peter E. Castro	Eastman Kodak Company
Dr. Ned J. Corron	U.S. Army AMCOM
Dr. Patrick S. Hagan	Bloomberg LP
Dr. Zahur Islam	Novartis Pharmaceuticals
Dr. James McKenna	Bell Laboratories (formerly)
Ms. Krystyna J. Monczka	Hewitt Associates
Dr. Richard Silberglitt	Rand Corporation
Dr. James W. Watson	AT&T Laboratories (formerly)
Dr. Benjamin White	Exxon Research & Engineering

III. MEMBERS AND VISITORS

Department of Mathematical Sciences

Ahluwalia, Daljit S.
Andrushkiw, Roman
Bechtold, John
Bhattacharjee, Manish
Blackmore, Denis
Booty, Michael
Bose, Amitabha
Bukiet, Bruce
Connell, Cameron
Dhar, Sunil
Dios, Rose
Elmer, Christopher
Goldberg, Vladislav
Goldman, Daniel
Golowasch, Jorge
Goodman, Roy
Horntrop, David
Jain, Aridaman
Jiang, Shidong
Kappraff, Jay
Khan, Hafiz M. R.
Kondic, Lou
Kriegsmann, Gregory A.
Luke, Jonathan
Matveev, Victor
Michalopoulou, Zoi-Heleni
Milojevic, Petronije
Miura, Robert M.
Moore, Richard
Muratov, Cyrill
Nadim, Farzan
Papageorgiou, Demetrios
Perez, Manuel
Petropoulos, Peter G.
Raymond, Christopher
Siegel, Michael
Stickler, David
Tao, Louis
Tavantzis, John
Wang, Sheldon
Yoo, Wonsuk
Young, Yuan-Nan

Visiting Members in the Department of Mathematical Sciences

Moyal, Pascal
Ozen, Ozgur

Department of Civil and Environmental Engineering

Meegoda, Jay N.

Department of Computer Science

Ma, Marc Qun

Department of Information Systems

Deek, Fadi P.

Department of Mechanical Engineering

Aubry, Nadine
Rosato, Anthony

CAMS Research Professors

Booth, Victoria	University of Michigan, Ann Arbor
Erneux, Thomas	Université Libre de Bruxelles, Belgium
Georgieva, Anna	Novartis Pharmaceuticals Corporation, East Hanover, NJ
Lott, Dawn	Delaware State University, Dover
Mauri, Roberto	Università degli Studi di Pisa, Italy
Vanden-Broeck, Jean-Marc	University of East Anglia, Norwich, England

IV. COLLOQUIA AND SEMINARS

Applied Mathematics Colloquium

September 10	**John Guckenheimer**, Cornell University *The Forced Van der Pol Oscillator*
September 17	**Hong Im**, University of Michigan *Viscosity Induced Combustion Instabilities of Premixed Flames in a Narrow Channel*
September 24	**Gregory A. Kriegsmann**, New Jersey Institute of Technology *Complete Transmission Through a Two-Dimensional Diffraction Grating*
September 29	**Harry Swinney**, The University of Texas at Austin *Emergence of Spatial Patterns in Physical, Chemical and Biological Systems*
October 8	**Jonathan Luke**, New Jersey Institute of Technology *Sedimentation Theory: Filling Gaps Between Models and Experiments*
October 12	**Tom Peters**, University of Connecticut *Computational Topology on Approximated Manifolds (with Applications in Engineering & Bioinformatics)*
October 15	**Luigi Martinelli**, Princeton University *Aerodynamic Design using Control Theory*
October 22	**John Tyson**, Virginia Tech *Network Dynamics and Cell Physiology*
October 27	**Ioannis Karatzas**, Columbia University *Convex Duality in Probability, Mathematical Statistics and Finance*
October 29	**Simon Levin**, Princeton University *Mathematical Challenges from the Environmental Life Sciences*
November 5	**Wolfgang Losert**, University of Maryland *The Memory of a Sandpile*
November 12	**Jan Martin Nordbotten**, University of Bergen, Norway *Sequestration of CO2 in Aquifers: Leakage Through Abandoned Wells*
November 19	**Jianke Yang**, University of Vermont *Nonlinear Light Propagation in Photonic Lattices*
December 3	**John Lowengrub**, University of California, Irvine *Theory and Simulation of Crystal Growth*
January 21	**Yannis Kevrekidis**, Princeton University *Equation-Free Modeling for Complex Multiscale Systems*
January 28	**Benjamin S. White**, Exxon Mobil Corporate Strategic Research *Asymptotic Theory of Electroseismic Prospecting*

February 4	**Esteban Tabak**, Courant Institute of Mathematical Sciences, New York University *The Ocean's Internal Wave Field*
February 7	**Alex Barnett**, Courant Institute of Mathematical Sciences, New York University *High-Frequency Cavity Modes: Efficient Computation and Applications*
February 10	**Peter Gordon**, University of Chicago *Propagation of Fronts in Porous Media Combustion*
February 11	**Charles Eggleton**, The University of Maryland, Baltimore County *A Three-Dimensional Model for Simulating Cellular Adhesion in Hydrodynamic Flows*
February 18	**Margaret Cheney**, Rensselaer Polytechnic Institute *Synthetic Aperture Radar*
February 25	**Wing Kam Liu**, Northwestern University *Multiscale Methods for Materials Design and Bio-Nano Interface*
March 4	**Govind Menon**, Brown University *Dynamic Scaling in Smoluchowski's Coagulation Equations*
March 11	**Marcus Grote**, University of Basel *Nonreflecting Boundary Conditions for Multiple Scattereing Problems*
April 1	**Deniz Ertas**, ExxonMobil Corporate Strategic Research *Clusters and Rheology of Dense Granular Flows*
April 8	**Alwyn Scott**, University of Arizona *A Brief History of Nonlinear Science*
April 15	**David Muraki**, Simon Fraser University *A Simple Illustration of a Spectral Cascade*
April 20	**Herman Z. Cummins**, City College - CUNY *Dynamics of Supercooled Liquids and the Liquid-Glass Transition*
April 22	**Qiang Zhang**, City University of Hong Kong *Fingering Instabilities in Fluids and Granular Materials*
April 29	**W. Edward Olmstead**, Northwestern University *Thermal Blow-up Due to a Localized Energy Source Moving Across the Surface of a Reactive-Diffusive Medium*
May 4	**Wooyoung Choi**, University of Michigan *Modeling Highly Nonlinear Wave Phenomena in the Ocean*

Statistics Colloquium

September 29	**Saurin Panya**, Cendant Corporation *Volatality of Stock Returns: Emerging and Mature Markets*
October 13	**William Rosenberger**, University of Maryland Baltimore County *Maximizing Power and Minimizing Treatment Failures in Clinical Trials*
October 27	**Ioannis Karatzas**, Columbia University *Convex Duality in Probability, Mathematical Statistics and Finance*
November 3	**Hafiz M.R. Khan**, New Jersey Institute of Technology *Predictive Distributions for Responses from the Two Parameter Exponential Life Testing Model*
November 17	**Svante Wold**, Umea University, Sweden *Chemometrics: Multivariate Modeling and Design with Chemical and Pharmaceutical Applications*
February 2	**Pascal Moyal**, Ecole Nationale Superieure des Telecommunications, Paris and Mathematical Sciences, NJIT *Queueing Impatient Customers with the EDF Service Discipline*
March 2	**Sandip Sinharay**, Educational Testing Service (ETS) *Recent Challenges in Educational Statistics*

Mathematical Biology Seminar

September 7	**Hide Cateau**, Center for Neural Science, New York University *Fokker-Planck Approach to Neural Phenomena*
September 14	**Ahmet Omurtag**, Bloomberg L.P., New York *The Population Approach in Modeling Large Systems and Its Applications in Computational Neuroscience*
September 15	**Alexey Kuznetsov**, Center for Biodynamics & Department of Mathematics, Boston University *Synchonization and Pattern Formation in an Ensemble of Genetic Relaxation Oscillators*
September 21	**Sheldon Wang**, Department of Mathematical Sciences, New Jersey Institute of Technology *From Immersed Boundary Method to Immersed Continuum Method: With Applications to Multi-Scale and Multi-Physics Modeling of Complex Biological Systems*
October 12	**Brent Doiron**, Center for Neural Science, New York University *Dividing with Dendrites*
October 26	**Dan Goldman**, Department of Mathematical Sciences, New Jersey Institute of Technology *Experiment-based Calculations of Oxygen Transport During Sepsis for Modeled and Measured 3D Capillary Network Geometry*

November 9	**Jonathan Dushoff**, Department of Ecology and Evolutionary Biology, Princeton University *Detecting Natural Selection from Limited Genetic Information*
November 16	**Mark Gluck**, Rutgers University (Newark) *Neurocomputational Models of the Hippocampus and Basal Ganglia: Implications for Assessing Memory Deficits in Alzheimer's and Parkinson's Disease*
November 23	**Claus Holzapfel**, Rutgers University (Newark) *On Neighborly Love, Cooperation and Playing Games: A Plant's Perspective*
November 30	**Liam Paninski**, Gatsby Computational Neuroscience Unit, University College London *Maximum Likelihood Estimation of (Semi-) Biophysical Neural Encoding Models*
December 7	**Christopher Raymond**, Department of Mathematical Sciences, New Jersey Institute of Technology *Asymptotics for Surface-Volume Reactions with Diffusive Transport*
January 27	**Avraham Mayevsky**, Faculty of Life Sciences, Bar Ilan University, Israel *Real-Time Monitoring of Brain and Other Tissues Vitality In Vivo: Theoretical, Experimental and Clinical Applications*
February 1	**Edgardo T. Farinas**, Department of Chemistry and Environmental Science, New Jersey Institute of Technology *Laboratory Evolution of a Soluble, Self-Sufficient, Highly Active Alkane Hydroxylase*
February 8	**Sergiu M. Gorun**, Department of Chemistry and Environmental Science, New Jersey Institute of Technology *Artificial Enzymes: From Cancer Therapy to Biologically Inspired Chemistry*
February 15	**Paul Miller**, Department of Physics and Volen Center for Complex Systems, Brandeis University *Memory Systems in the Brain: Modeling Short-Term and Long-Term Processes*
February 22	**Gareth Russell**, Ecology, Evolution and Environmental Biology, Columbia University *Vanishing Birds, Invading Beetles, and Other Space-Time Puzzles*
March 8	**Boris Vladimirski**, Courant Institute of Mathematical Sciences, New York University *Two Heads Are Better Than One, but a Continuum is Best: Cell-Based and Mean-Field Models of Spontaneous Episodic Activity in the Developing Spinal Cord*
March 22	**Christopher Elmer**, Department of Mathematical Sciences, New Jersey Institute of Technology *Action Potential Propagation in Nerve Axons*

March 29	**Lawrence Sirovich**, Department of Biomathematics, Mount Sinai School of Medicine *Stability and Synchrony in Neural Populations*
April 5	**Leslie Loew**, Center for Cell Analysis and Modeling, University of Connecticut Health Center *The Virtual Cell Project*
April 12	**Jorge Golowasch**, Department of Mathematical Sciences, New Jersey Institute of Technology *Electrical Coupling between Neurons: All Kinds on Non-Linear Effects*
April 19	**Barry Cohen**, Department of Computer Science, New Jersey Institute of Technology *Evidence for Natural Selection on Minimum Free Energy of Bacterial mRNA's*
April 26	**Paul Atzberger**, Department of Mathematical Sciences, Rensselaer Polytechnic Institute *A Stochastic Immersed Boundary Method for Modeling Small Length Scale Fluid Dynamics*
May 3	**Roger Traub**, Department of Physiology and Pharmacology, SUNY Downstate *Network Synchronization via Recurrent Synapses and via Electrical Coupling, in Hippocampal and Neocortical Cortices: Simulation and Electrophysiological Data*

Fluid Mechanics Seminar

September 13	**Jie Lie**, Department of Engineering, Cambridge University *Numerical Modeling of Flows with Moving Boundary*
September 27	**Michael Booty**, Department of Mathematical Sciences, New Jersey Institute of Technology *A Model for Two-Dimensional Sails in a Uniform Potential Flow*
October 11	**Silvina Tomassone**, Department of Chemical Engineering, Rutgers University, New Brunswick *A Molecular Dynamics Study of Surfactant Facilitated Spreading of Droplets on Hydrophobic Substrates*
November 1	**David Edwards**, Department of Mathematical Sciences, University of Delaware *Refining Rate Constant Estimates in the BIAcore*
November 15	**Javier Diez**, Department of Physics, Universidad Nacional de Buenos Aires *On the Contact Line Instability Under Complete and Partial Wetting Condition*
February 14	**Philip Yecko**, Department of Mathematics, MIT, and Department of Astronomy, Columbia University *Ligament and Droplet Formation in Fast Liquid Jets and Sheets*

February 28	**Jeff Morris**, Levich Institute, CCNY *Pattern Formation and Particle Migration in Free Surface Flows of Suspensions*
March 7	**Joga Rao**, Department of Mechanical Engineering, New Jersey Institute of Technology *Constitutive Modeling of the Thermo-Mechanics Associated with Crystallizable Shape Memory Polymers*
March 28	**Arup Mukherjee**, Department of Mathematics, Montclair State University *Flow Phenomena in Nematc Liquid Crystals*
April 4	**Maureen Howley**, Department of Chemical Engineering, New Jersey Institute of Technology *A Comparison of One Dimensional Traveling Waves in Inverse and Normal Fluidized Beds*
April 18	**Yongmin Zhang**, Applied Mathematics and Statistics, SUNY, Stony Brook *Modeling and Simulation of Fluid Mixing for Laser Experiments and Supernova*
April 25	**Sheldon Wang**, Department of Mathematical Sciences, NJIT *A Concurrent Multi-Scale and Multi-Physics Modeling of Biological Systems*

Waves on Wednesday Seminar Series

January 19	**Gregory Kriegsmann***,* Department of Mathematical Sciences, NJIT *The Lobachefsky Metric, Maxwell's Fish Eye, and Forty Foot Breakers at Hilo*
February 9	**Richard O. Moore**, Department of Mathematical Sciences, NJIT *Tracking Rare Events in Optical Communications*
February 23	**Peter Petropoulos**, Department of Mathematical Sciences, NJIT *EMP Propagation in the Cole-Cole Dielectric Model: Asymptotics and Numerics*
March 23	**Shidong Jiang**, Department of Mathematical Sciences, NJIT *Scattering by Open Surfaces and Generalized Poincare-Bertrand Formula*
April 6	**Roy Goodman**, Department of Mathematical Sciences, NJIT *The Two-Bounce Resonance in Solitary Wave Collisions*
April 20	**Lin Zhou***, NJIT* *Electromagnetic and Acoustic Propagation in Strip Lines and Porous Media*
April 27	**Tobias Schaefer**, The College of Staten Island *Approximating nonlinear Maxwell's Equations*

V. PUBLICATIONS, PRESENTATIONS, AND REPORTS

A. PUBLICATIONS

JOURNAL PUBLICATIONS

Roman Andrushkiw

Analysis of Malignancy-Associated DNA Changes in Interphase Nuclei of Buccal Epithelium in Patients with Breast Cancer (with N.V. Boroday, D.A. Klyushin, and Yu.I. Petunin), Experimental Oncology, Vol. 26, pp.158-160, July 2004.

Nadine Aubry

Nonlinear Vibrations of Strings and Membranes Without Tension (with Z. Bao, S. Mukherjee, and M. Roman), ASME J. Appl. Mech., Vol. 71, pp. 551-559, July 2004.

Parameters Influencing Pulsed Flow Mixing in Microchannels (with I. Glasgow and S. Lieber), Analytical Chemistry, Vol. 76, pp. 4825 - 4832, August 2004.

Aging Increases Stiffness of Cardiac Myocytes Measured by Atomic Force Microscopy Nanoindentation (with S. Lieber, J. Pain, G. Diaz, S. Kim, and S. Vatner), Am. J. Physiol. Heart. Circ. Physiol., Vol. 287, pp. H645 - H651, August 2004.

Dielectrophoresis of Nanoparticles (with J. Kadaksham and P. Singh), Electrophoresis, Vol. 25, pp. 3625-3632, November 2004.

Electroosmotic Mixing in Microchannels (with I. Glasgow and J. Batton), Lab on a Chip, Vol. 4, pp. 558-562, November 2004.

Active Control of Cylinder Wake (with Z. Chen), Communications in Nonlinear Science and Numerical Simulation, Vol. 10, pp. 205-216, March 2005.

Nonlinear Mechanics of MEMS Plates with a Total Lagrangian Approach (with Z. Bao, S. Mukherjee, and M. Roman), Computer and Structures, Vol. 83, pp. 758-768, April 2005.

Close-Loop Control of Vortex-Induced Vibration (with Z. Chen), Communications in Nonlinear Science and Numerical Simulation, Vol. 10, pp. 287-297, April 2005.

Trapping Force on a Finite-Sized Particle in a Dielectrophoretic Cage (with P. Singh), Phys. Rev. E, Vol. 72, 016602, pp. 1-5, July 2005.

John Bechtold

Cellular Instabilities of Expanding Hydrogen/Propane Spherical Flames at Elevated Pressures: Theory and Experiment (with C. K. Law and G. Jomaas), Proc. Combust. Inst., Vol. 30, pp. 159-167, January 2005.

The Role of Radiative Losses in Self-Extinguishing and Self-Wrinkling Flames (with C. Cui and M. Matalon), Proc. Combust. Inst., Vol. 30, pp. 177-184, January 2005.

Response of Spherical Diffusion Flames under Rotation with General Lewis Numbers (with S. W. Yoo, J. Qian, and C. K. Law), Combustion Theory and Modelling, Vol. 9, pp. 1-19, February 2005.

Manish Bhattacharjee

Comparison of Random Sums in Some Integral Orderings and Applications, Sankhya, Vol. 66, pp. 450-465, 2004.

Denis Blackmore

On Liouville-Arnold Integrable Flows Related to Quantum Algebras and their Poissonian Representations (with A. Samoilenko, Y. Prykarpatsky, and A. Prykarpatsky), Proc. Ukr. Acad. Sci., Vol. 50, pp. 1184-1191, July 2004.

A Geometrical Approach to Quantum Holonomic Computing Algorithms (with A. Samoilenko, Y. Prykarpatsky, U. Taneri, and A. Prykarpatsky), Math. & Computers in Simulation, Vol. 66, pp. 1-20, July 2004.

Experimental, Simulation and Nonlinear Dynamics Analysis of Galton's Board (with A. Rosato, L. Buckley, M. Johnson, and C. Oshman), Int. J. Nonlin. Sci. Num. Sim., Vol. 5, pp. 289-312, November 2004.

A Generalized Poincare-Birkhoff Theorem with Applications to Coaxial Vortex Ring Motion (with J. Champanerkar and C. Wang), Discr. & Contin. Dyn. Sys. B, Vol. 5, pp. 15-33, February 2005.

The Uniqueness of Limit Cycles for Liénard Systems (with Y. Zhou, and C. Wang), J. Math. Anal. Appl., Vol. 304, pp. 473-489, May 2005.

Mathematical Modeling of the Movement of Suspended Particles Subjected to Acoustic and Flow Fields (with N. Aboobaker and J. Meegoda), Appl. Math. Model., Vol. 29, pp. 515-532, June 2005.

Amitabha Bose

The Activity Phase of Postsynaptic Neurons in a Simplified Rhythmic Network (with Y. Manor and F. Nadim), J. Comput. Neurosci., Vol. 17, pp. 245-261, September 2004.

Two-Oscillator Model of Ventilatory Rhythmogenesis in the Frog (with T. Lewis and R. Wilson), Neurocomputing, Vol. 65-66, pp. 751-777, June 2005.

The Effect of Modulatory Neuronal Input on Gastric Mill Frequency (with C. Ambrosio and F. Nadim), Neurocomputing, Vol. 65-66, pp. 623-631, June 2005.

Bruce Bukiet

Measures of Postural Stability (with H. Chaudhry, T. Findley, K. S. Quigley, Z. Ji, T. Sims, and M. Maney), J. Rehab. Res. Devel., Vol. 41, pp. 713-720, Sept/Oct 2004.

Rose Dios

Contributions to Orthogonal Arrays of Strength Four with Two Levels (with D.V. Chopra), Congressus Numerantium, Vol. 166, 207 - 214, 2004.

Thomas Erneux

Ikeda Hopf Bifurcation Revisited (with L. Larger, M.W. Lee, and J.P. Goedgebuer), Physica D, Vol. 194, pp. 49-64, July 2004.

Stability of Injection-Locked CW-Emitting External Cavity Semiconductor Lasers (with M. Nizette), IEEE J. Selec. Topics in Quant. Electron., Vol. 10, pp. 961-967, Sept.-Oct. 2004.

The Effects of Nonlinear Gain Saturation on the Stability of Semi-Degenerate Two-Mode Semiconductor Lasers: A Case Study on VCSELs (with J. Albert, G. Van der Sande, B. Nagler, K. Panajotov, I. Veretennicoff, and J. Danckaert), Opt. Comm., Vol. 248, pp. 527-534, April 2005.

Anna Georgieva

An Integrated Approach for Inference and Mechanistic Modeling for Advancing Drug Development (with S. Aksenov, B. Church, A. Dhiman, R. Sarangapani, G. Helmlinger, and I. Khalil), FEBS Letters, Vol. 579, pp. 1878-1883, February 2005.

Pharmacodynamic Behavior of the Selective Cyclooxygenase-2 Inhibitor Lumiracoxib in the Lipopolysaccharide-Stimulated Rat Air Pouch Model (with R. Esser, R. Marendino, M, Sharr, X. Zhang, W. Porter, L. Ramos, J. Cramer, S. Zhuang, and W. Maniara), Eur. J. Pharm. Sci., Vol. 25, pp. 25-30, April 2005.

Vladislav V. Goldberg

Comments on the working paper No. 303 "Testing the Expected Utility Maximization Hypothesis with Limited Experimental Data" by James B. Cooper, Thomas Russell, and Paul A. Samuelson, Japan and the World Economy, Vol. 16, pp. 409-413, August 2004.

Webs of Maximum Rank are not Necessarily Almost Grassmannizable, Hokkaido Math. J., Vol. 33, pp. 569-583, September 2004.

Induced Connections on Submanifolds (in Russian) (with M. A. Akivis and A. V. Chakmazyan), Izv. Vyssh. Uchebn. Zaved. Mat., Vol. 2004, pp. 3-24, October 2004.

Induced Connections on Submanifolds (with M. A. Akivis and A. V. Chakmazyan), Russian Mathematics, Vol. 48, pp. 1-21, October 2004.

Linearizability of d-Webs, d >= 4, on Two-Dimensional Manifolds (with M. A. Akivis and V. V. Lychagin), Selecta Math., Vol. 10, pp. 431-451, December 2004.

Dually Degenerate Varieties and the Generalization of a Theorem of Griffiths--Harris (with M. A. Akivis), Acta Appl. Math., Vol. 86, 249-265, March 2005.

Linearizability Criterion for 3-Webs in the Plane and Blaschke's Conjecture (with V. V. Lychagin), Theses of Reports to the International Seminar "Geometry in Odesa-2005. Differential Geometry and Its Applications", Blagodiinyi fond naukovyx doslidzhen' "Nauka", Odesa, pp. 29-30, May 2005.

Daniel Goldman

Effect of Sepsis on Skeletal Muscle Oxygen Consumption and Tissue Oxygenation: Interpreting Capillary Oxygen Transport Data using a Mathematical Model (with R. M. Bateman and C. G. Ellis), Am. J. Physiol. Heart. Circ. Physiol., Vol. 287, pp. H2535-H2544, December 2004.

Roy H. Goodman

Interaction of Sine-Gordon Kinks with Defects: The Two-Bounce Resonance (with R. Haberman), Physica D, Vol. 195, pp. 303-323, August 2004.

Vector-Soliton Collision Dynamics in Nonlinear Optical Fibers (with R. Haberman), Phys. Rev. E., Vol. 71, 056605, pp. 1-16, May 2005.

Hafiz M. R. Khan

Optimizing RNA Extraction Yield from Whole Blood for Microarray Gene Expression Analysis (with J. Wang, J.F. Robinson, D.E. Carter, J. McKinney, B.A. Miskie, and R.A. Hegele), J. Clinical Biochemistry, Vol. 37, pp. 741-744, September 2004.

Genetic Variation in PPARG Encoding Peroxisome Proliferator-Activated Receptor Gamma Associated with Carotid Atherosclerosis (with K. Al-Shali, A.A. House, A. J.G. Hanley, S.B. Harris, B. Zinman, M. Mamakeesick, A. Fenster, J.D. Spence, and R.A. Hegele), Stroke, Vol. 35, pp. 2036-2040, September 2004.

Venn Analysis as Part of a Bioinformatic Approach to Prioritize Expressed Sequence Tags from Cardiac Libraries (with J.L. McKinney, D.J. Murdoch, J. Wang, J. Robinson, C. Biltcliffe, P.M. Walker, J. Savage, I. Skerjanc, and R.A. Hegele), Journal of Clinical Biochemistry, Vol. 37, pp. 953-960, November 2004.

Predictive Inference for Future Responses from Two Component Systems (with M. S. Haq and S. B. Provost), Pakistan J. Statistics, Vol. 21, pp. 27-42, January 2005.

Differences Between Carotid Wall Morphological Phenotypes Measured by Ultrasound in One, Two and Three Dimensions (with K. Al-Shali, A.A. House, A.J.G. Hanley, S.B. Harris, B. Zinman, M. Mamakeesick, A. Fenster, J.D. Spence, and R.A. Hegele), Atherosclerosis, Vol. 178, pp. 319-325, February 2005.

Lou Kondic

On Flooding and Undercompressive Shocks in Countercurrent Two-Layer Flow (with T. Segin and B. Tilley), J. Fluid. Mech., Vol. 532, pp. 217-242, June 2005.

Velocity Profiles in Repulsive Glassy and Athermal Systems under Shear (with N. Xu and C. O'Hern), Phys. Rev. Lett., Vol 94, 016001, pp. 1-4, January 2005.

Spreading of a Thin Two-Dimensional Strip of Fluid on a Vertical Plane: Experiments and Modeling (with A. G. Gonzalez, J. Diez, J. Gomba, and R. Gratton), Phys. Rev. E, Vol. 70, 026309, pp. 1-18, November 2004.

Instabilities in the Flow of Thin Films on Inhomogeneous Surfaces (with J. Diez), Phys. Fluids, Vol. 16, pp. 3341-3360, September 2004.

Elastic Energy, Fluctuations and Temperature for Granular Materials (with R. P. Behringer), Europhys. Lett., Vol. 67, pp. 205-211, July 2004.

Gregory A. Kriegsmann

Complete Transmission Through a Two-Dimensional Diffraction Grating, SIAM J. Appl. Math., Vol. 65, pp. 24-42, January 2005.

Marc Q. Ma

ProtoMol, An Object-Oriented Framework for Prototyping Novel Algorithms for Molecular Dynamics (with T. Matthey, T. Cickovski, S. Hampton, A. Ko, M. Nyerges, T. Raeder, T. Slabach, and J. Izaguirre), ACM Trans. Math. Soft. (TOMS), Vol. 30, pp. 237-265, Sep. 2004.

Jay N. Meegoda

Estimation of Diffusion Coefficient of Chromium in Colloidal Silica using an Optical Method (with Netnapid Tantemsapya), Environmental Science and Technology J., Vol. 38, pp. 3950-3957, July 2004.

Strategies to Mitigate Salt Runoff from Salt Storage and Salt Truck Maintenance Facilities (with T. Marhaba and P. Ratnaweera), ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol. 8, pp. 247-252, October 2004.

Multimedia Model for Analysis of Contaminant Releases in the Passaic River Watershed (with L. Coulibaly and M. E. Labib), ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol. 8, pp. 220-227, October 2004.

NJTxtr - A Computer Program Based on LASER to Monitor Asphalt Segregation (with G. M. Rowe, A. Jumikis, M. J. Sharrock, N. Bandara, and C. H. Hettiarachchi), ASCE Journal of Construction Engineering and Management, Vol. 130, pp.924-934, December 2004.

Micro-Mechanical Simulations of Soils using Massively Parallel Supercomputers (with D. Washington), Journal of Systemics, Cybernetics and Informatics, Vol. 2, pp. 57-63, December 2004.

Feasibility Study of using Centrifuge for Investigating LNAPL Migration in Unsaturated Soils (with I. M.-C. Lo and L. Hu), Soil and Sediment Contamination: an International Journal, Vol. 14, pp. 85-103, January 2005.

Towards a Fundamental Model to Predict the Settlements in Bioreactor Landfills (with C. H. Hettiarachchi and J. P. Hettiaratchi), Waste Containment and Remediation ASCE Geotechnical Special Publication, No. 142, ISBN # 078440769X, January 2005.

Mathematical Modeling of the Movement of Suspended Particles Subjected to Acoustic and Flow Fields (with N. Aboobaker and D. Blackmore), Applied Math. Modeling, Vol. 29, pp. 515-532, May 2005.

Zoi-Heleni Michalopoulou

Gibbs Sampling for Time-Delay and Amplitude Estimation in Underwater Acoustics (with M. Picarelli), J. Acoust. Soc. Am., Vol. 117, pp. 799-808, February 2005.

Richard O. Moore

Computing Large Signal Distortions and Bit-Error Ratios in DPSK Transmission Systems, (with E. T. Spiller, W. L. Kath, and C. J. McKinstrie), IEEE Phot. Tech. Lett., Vol. 17, pp. 1022-1024, May 2005.

Renormalization Group Reduction of Pulse Dynamics in Thermally Loaded Optical Parametric Oscillators (with K. Promislow), Physica D, Vol. 206, pp. 62-81, June 2005.

Cyrill Muratov

Signal Propagation and Failure in Discrete Autocrine Relays (with S. Y. Shvartsman), Phys. Rev. Lett., Vol. 93, 118101, pp, 1-4, September 2004.

A Global Variational Structure and Propagation of Disturbances in Reaction-Diffusion Systems of Gradient Type, Discrete Cont. Dyn. Sys., Ser. B, Vol. 4, pp. 867-892, November 2004.

Farzan Nadim

Dynamic Interaction of Oscillatory Neurons Coupled with Reciprocally Inhibitory Depressing Synapses Acts to Stabilize the Rhythm Period (with A. Mamiya), J. Neurosci., Vol. 24, pp. 5140-5150, July 2004.

Inter-Circuit Control via Rhythmic Regulation of Projection Neuron Activity (with D. Wood, Y. Manor, and M.P. Nusbaum), J. Neurosci., Vol. 24, pp. 7455-7463, August 2004.

The Activity Phase of Postsynaptic Neurons in a Simplified Rhythmic Network (with A. Bose and Y. Manor), J. Comput. Neurosci., Vol. 17, pp. 245-261, September 2004.

The Effect of Modulatory Neuronal Input on Gastric Mill Frequency (with C. Ambrosio and A. Bose), Neurocomputing, Vol. 65-66, pp. 623-631, June 2005.

Demetrios T. Papageorgiou

Generation of Interfacial Instabilities in Charged Electrified Viscous Liquid Films (with P.G. Petropoulos), J. Eng. Math., Vol. 50, pp. 223-240, November 2004.

A Mathematical Model of Core Annular Flow with Surfactant (with S. Kas-Danouche and M. Siegel), Divulgaciones Matimaticas, Vol. 12, pp. 117-138, December 2004.

Antisymmetric Capillary Waves in Electrified Fluid Sheets (with J.-M. Vanden-Broeck), European Journal of Applied Mathematics, Vol. 15, pp. 609-623, December 2004.

Absolute and Convective Instability for Evolution PDEs on the Half-Line (with A.S. Fokas), Studies Appl. Math., Vol. 114, pp. 95-114, January 2005.

Peter G. Petropoulos

Generation of Interfacial Instabilities in Charged Electrified Viscous Liquid Films (with D. T. Papageorgiou), J. Eng. Math., Vol. 50, pp. 223-240, November 2004.

Anthony D. Rosato

Analysis of Instantaneous Dynamic States of Vibrated Granular Materials (with N. Zhang), Mech. Res. Comm., Vol. 31, pp. 525-544, February 2004.

Experimental, Simulation and Nonlinear Dynamics Analysis of Galton's Board (with D. L. Blackmore, L. Buckley, C. Oshman, and M. Johnson), Int. J. Nonlinear Science and Numerical Simulation, Vol. 5, pp. 289-332, November 2004.

Migration of an Intruder in a Boundary Driven Granular Flow (with J. Liu), J. Cond. Matter Physics, Vol. 17, pp. 1-14, May 2005.

Michael Siegel

A semi-analytic approach to Euler singularities (with R. E. Caflisch), Methods and Applications of Analysis, Vol. 11, pp. 423-430, September 2004.

Global Existence, Singular Solutions and Ill-Posedness for the Muskat Problem (with R. E. Caflisch and S. D. Howison), Comm. Pure Appl. Math., Vol. 57, pp. 1374-1411, October 2004.

A Mathematical Model of Core Annular Flow with Surfactant (with S. Kas-Danouche and D. Papageorgiou), Divulgaciones Matimaticas, Vol. 12, pp. 117-138, December 2004.

The Evolution of a Slender Non-Axisymmetric Drop in an Extensional Flow (with P. D. Howell), J. Fluid Mech., Vol. 521, pp. 155-180, December 2004.

Exact Solutions for the Evolution of a Bubble in Stokes Flow: A Cauchy Transform Approach (with D. Crowdy), SIAM J. Appl. Math., Vol. 65, pp. 941-963, March 2005.

Louis Tao

An Embedded Network Approach for Scale-Up of Fluctuation-Driven Systems with Preservation of Spike Information (with D. Cai and D. McLaughlin), Proc. Natl. Acad. Sci., Vol. 101, pp. 14288-14293, September 2004.

Jean-Marc Vanden-Broeck

Two Layer Hydraulic Falls over an Obstacle (with F. Dias), Eur. J. Mech. B/Fluids, Vol. 23, pp. 879-898, November 2004.

Nonlinear Capillary Free-Surface Flows, J. Eng. Math., Vol. 50, pp. 415-426, December 2004.

Sheldon Wang

Coupling of Navier-Stokes Equations with Protein Molecular Dynamics and Its Application to Hemodynamics (with Y. Liu, L. Zhang, X. Wang, and W.K. Liu), Int. J. Num. Meth. Fluids, 46, pp. 1237-1252, December 2004.

Yuan-Nan Young

Registration-Based Morphing of Active Contours for Segmengation of CT Scans, (with D. Levy), Mathematical Biosciences and Engineering, Vol. 2, pp. 79-96, January 2005.

Stratified Kolmogorov Flow. Part 2, (with N. J. Balmforth), J. Fluid Mech., Vol. 528, pp. 23-42, March 2005.

BOOKS AND BOOK CHAPTERS

Manish Bhattacharjee

Adaptive Economic Choices under Recurrent Disasters: A Bayesian Perspective, in Handbook of Beta Distribution and Its Applications, A.K. Gupta and S. Nadarajah (eds.), Mercel Dekker Inc., pp. 457-484, 2004.

Denis Blackmore

Periodic and Quasiperiodic Motion of Point Vortices (with J. Champanerkar), in Vortex Dominated Flows, D. Blackmore, E. Krause and C. Tung (eds.), World Scientific, Singapore, pp. 21-42, June 2005.

Robert M. Miura

Nonlinear Toys (with M. Toda), Encyclopedia of Nonlinear Science, A.C. Scott (ed.), Routledge, Taylor and Francis, New York, pp. 645-647, 2005.

Richard O. Moore

Harmonic Generation, in Encyclopedia of Nonlinear Science, Alwyn Scott (ed.), Routledge, pp. 394-396, November 2004.

PROCEEDINGS PUBLICATIONS

Roman Andrushkiw

Diagnosis of Colon Cancer and Cancer of the Esophagus Based on Blood Mechanoemission (with V.E. Orel, D.A. Klyushin, A.V. Romanov, and Yu.I. Petunin), Proceedings of the International Conference on Mathematics and Engineering Techniques in Medicine and Biological Sciences, Vol. 1, pp 47-51, F.Valafar and H. Valafar (eds.), CSREA Press, July 2004.

Retrospective Cohort Investigation of Risk Factors in Breast Cancer (with N.V. Boraday, D.A. Klyushin, Yu.I. Petunin, and F. Miropolska), Proceedings of the International Conference on Mathematics and Engineering Techniques in Medicine and Biological Sciences, Vol. 1, pp.385-390, F.Valafar and H. Valafar (eds.), CSREA Press, July 2004.

Equations of Interface Dynamics for Quasi-Stationary Stefan Problem (with V. Gafiychuk), Proceedings of the Fourth International Conference on Dynamic Systems and Applications, Vol. 4, pp 571-580, G.S. Laddle, N.G. Medhin and M. Sambandham (eds.), Dynamic Publishers, Atlanta, December 2004.

Nadine Aubry

Direct Simulation of Electrorheological Suspensions (with P. Singh), ASME Paper Number IMECE2004-61527, New York Society of Mechanical Engineers, 5 pages, November 2004.

Dielectrophoresis of Nanoparticles (with P. Singh and J. Kadaksham), ASME Paper Number IMECE2004-61529, New York Society of Mechanical Engineers, 8 pages, November 2004.

John Bechtold

On Transition to Cellularity in Expanding Spherical Flames: Experiment and Theoretical Comparison (with G. Jomaas and C. K. Law), AIAA 2005-0713, 43rd Aerospace Sciences Meeting & Exhibit, pp. 1-13, January 2005.

Nonlinear Analysis of Pulsating Instabilities in Diffusion Flames (with H. Y. Wang and C. K. Law), AIAA 2005-0544, 43rd Aerospace Sciences Meeting & Exhibit, pp. 1-17, January 2005.

Forced Oscillations in Diffusion Flames Near Resonance (with H. Y. Wang and C. K. Law), 4th Joint Meeting of the US Section of the Combustion Institute, paper #1646, pp. 1-6, March 2005.

Denis Blackmore

Complexity Measures for Ecological Assemblages (with J. Champanerkar, and M. Levandowsky), Proc. Int. Conf. on Complex Systems (ICCS'04), pp. 220-228, Boston, MA, July 2004.

Perturbed Three Point Vortex Problems (with L. Ting, and O. Knio), Proc. 3nd MIT Conf. on Computational Fluid and Solid Mechanics, Vol. 1, pp. 594-597, K.J. Bathe, ed., Elsevier, Amsterdam, June 2005.

Thomas Erneux

Bifurcations of Injection-Locked Semiconductor Lasers Subject to Optical Feedback (with M. Nizette), in Semiconductor Lasers and Laser Dynamics, D. Lenstra, G. Morthier, T. Erneux, M. Pessa (eds.), Proc. Of SPIE 5452 (SPIE, Bellingham, WA 2004), pp. 105-116, 2004.

The Injection Laser Limit of Lasers Subject to Optical Feedback (with G. Hek, M. Yousefi, and D. Lenstra), in Semiconductor Lasers and Laser Dynamics, D. Lenstra, G. Morthier, T. Erneux, M. Pessa (eds.), Proc. Of SPIE 5452 (SPIE, Bellingham, WA 2004), pp. 303-311, 2004.

Analytical Theory of External Cavity Modes of a Semiconductor Laser with Phase Conjugate Feedback (with A. Gavrielides, K. Green, and B. Krauskopf), in Semiconductor Lasers and Laser Dynamics, D. Lenstra, G. Morthier, T. Erneux, M. Pessa (eds.), Proc. Of SPIE 5452 (SPIE, Bellingham, WA 2004), pp. 263-272, 2004.

Equations a Retard et Leurs Applications, Bull. Class des Sciences XV, Vol. 1-6, pp. 7-21, 2004.

David J. Horntrop

Mesoscopic Simulation for Self-Organization in Surface Processes, Computational Science-ICCS 2005: 5th International Conference, Proceedings, Part I, Lecture Notes in Computer Science, V. Sunderam, G. van Albada, P. Sloot, and J. Dongarra (eds.), Springer, Berlin, Vol. 3514, pp. 852-859, May 2005.

Lou Kondic

Extended Granular Temperature (with R. P. Behringer), Proceedings of the XXI International Congress on Theoretical and Applied Mechanics, ISBN 83-89697-10-1, pp. 1-2, Warsaw, Poland, August 2004.

Zoi-Heleni Michalopoulou

Optimizing Matched-Field Inversion using Tabu Search, Proceedings of the 7th Conference on Underwater Acoustics, Dick Simmons (ed.), Vol. 2, pp. 653-658, Delft, The Netherlands, July 2004.

Wonsuk Yoo

Variable Selection of Bayesian Hierarchical Changepoint Model for Longitudinal Biomarkers of Prostate Cancer (with E. Slate), Proceedings of the American Statistical Association, Section on Bayesian Statistical Science, Alexandria, VA, pp. 223-247, August 2004.

B. PRESENTATIONS

Roman Andrushkiw

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
On the Spectral Theory of Operator-Valued Functions.

June 2005: International Conference on Information Technology Interfaces (ITI-2005), University of Zagreb, Croatia
The Exact Confidence Limits for Unknown Probability in Bernoulli Models.

Nadine Aubry

November 2004: 2004 ASME International Mechanical Engineering Congress and R&D Expo, Anaheim, CA
1) Direct Simulation of Electrorheological Suspensions;
2) Dielectrophoresis of Nanoparticles.

November 2004: 57th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Seattle, Washington
Electrorheological Suspensions of Brownian Particles

March 2005: ONR Kick-Off Meeting, Philadelphia, PA
Electro-Hydrodynamic Filtration.

John Bechtold

July 2004: Thirtieth International Symposium on Combustion, Chicago, IL
1) The Role of Radiative Losses in Self-Extinguishing and Self-Wrinkling Flames;
2) Cellular Instabilities of Expanding Hydrogen/Propane Spherical Flames at Elevated Pressures: Theory and Experiment.
March 2005: 4th Joint Meeting of the US Section of the Combustion Institute, Philadelphia, PA
Forced Oscillations in Diffusion Flames Near Resonance.

Manish Bhattacharjee

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Strong Versions of the DFR Property and Applications.

Denis Blackmore

August 2004: ICTAM Congress on Fluid Mechanics, Warsaw, Poland
Perturbations of Point and Ring Vortex Dynamics.

October 2004: Physics Seminar, Wesleyan University, New Haven, CT
Vortex Dynamics: Past, Present, and Future.

November 2004: Topology and Group Theory Seminar, CUNY
Computational Topology: Where is the Topology?

December 2004: Computer Science Colloquium, CUNY Graduate Center
Opportunities for Computer Science and Mathematics Synergy in the Representation of Geometric Objects.

May 2005: NSF/DARPA Grantees Workshop, Santa Fe, NM
1) Computational Topology, Swept Volumes and Applications: New Results;
2) Homological Interrogation of Tangent Intersections.

Victoria Booth

July 2004: International Conference for Mathematics in Biology and Medicine, Annual Meeting for the Society for Mathematical Biology, Ann Arbor, MI
Multistability in Inhibitory Networks with Depressing Synapses.

Michael Booty

July 2004: SIAM National Meeting, Portland, Oregon
Interaction of a Pair of Two-Dimensional Sails in a Uniform Potential Flow.

January 2005: Greater Philadelphia AIAA/ASME Inaugural, Aerospace/Mechanical Engineering Minisymposium, Philadelphia, PA
Microwave Heat-Processing of a Narrow Cylinder or Fiber.

Amitabha Bose

July 2004: SIAM Conference on Life Sciences, Portland, OR
Two-Oscillator Model of Ventilatory Rhythmogenesis in the Frog.

July 2004: Computational Neuroscience Conference, Baltimore, MD
1) Two-Oscillator Model of Ventilatory Rhythmogenesis in the Frog;
2) Multistability in Mutually Inhibitory Networks with Depression;
3) Localized Activity Patterns in Excitatory Neuronal Networks.

December 2004: Department of Mathematics, Lehigh University, PA
Role of Synaptic Plasticity in Neuronal Networks.

February 2005: Department of Mathematics, University of Pittsburgh, PA
Role of Synaptic Plasticity in Neuronal Networks.

April 2005: Department of Biomedical Engineering, Georgia Institute of Technology, GA
Role of Synaptic Plasticity in Neuronal Networks.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Localized Activity Patterns in Excitatory Neuronal Networks.

May 2005: SIAM Conference on Dynamical Systems, Snowbird, UT
The Role of Feedback on the Pacemaker Unit of a CPG.

Bruce Bukiet

September 2004: Honors Colloquium Lecture Series, Newark Bears Stadium, Newark, NJ
The Statistics of Baseball.

October 2004: Institute for Operations Research and Management Science (INFORMS) Annual Meeting, Denver, CO
Modelling One-Day Cricket Batting Orders.

Sunil K. Dhar

December 2004: International Conference on the Future of Statistical Theory Practice and Education, Indian School of Business, Hyderabad, Andhra Pradesh, India
Computations of Tests to Evaluate Randomness.

January 2005: Biometric US&CDMA Staff Meeting, Novartis Pharmaceuticals Corporation, East Hanover, NJ
Appropriate Specifications of SAS Codes for a Repeated Measure Analysis.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT
1) Improved Methods for Establishing Noninferiority in Clinical Trials;
2) On the Characterization of a Bivariate Geometric Distribution.

Thomas Erneux

November 2004: Workshop on Functional Differential Equations, Banff, Canada
Multiple Time-Scale Techniques Applied to Delay Differential Equations Modeling Lasers and Mechanical Systems.

March 2005: Rencontre du Nonlineaire 2005, Paris, France
Dynamique Nonlineaire a Retard.

March 2005: Universite Libre de Bruxelles, Brussels, Belgium
Nonlinear Dynamics with Delay, Nonlinearity, Fluctuations, and Complexity.

March 2005: Physics and Applications of Semiconductor Lasers, Metz, France
Frequency Locked Pulsating Regimes of Semiconductor Lasers Subject to Optoelectronic Feedback.

May 2005: Nonlinear Dynamics in Photonics, WIAS, Berlin, Germany
Frequency Locked Pulsating Regimes of Semiconductor Lasers Subject to Optoelectronic Feedback.

Anna Georgieva

May 2005: Frontiers in Applied and Computational Mathematics (FACM 2005), Newark
Mechanistic Systems Biology Modeling Applied to the Pre-Clinical Cardiac Safety Assessment of Pharmaceutical Compounds: From Channels to Cells to Tissue.

Vladislav V. Goldberg

December 2004: Seminar on Complex Analysis, Mathematical Institute, University Paris-6, France
Linearizability Criterion for d-Webs, d > 3, in the Plane and the Blaschke Conjecture.

May 2005: Workshop on Differential Geometry and Its Applications, Odessa, Ukraine
Linearization Problems for Planar Webs.

June 2005: Mile High Conference on Quasigroups, Loops and Nonassociative Systems, Denver, CO
1) Local Algebras of a Differentiable Quasigroup;
2) On the Existence of Irreducible n-Quasigroups (Solution of Belousov's Problem).

Daniel Goldman

October 2004: Biomedical Engineering Society Meeting, Philadelphia, PA
Simulations of Skeletal Muscle Oxygen Transport During Sepsis using Measured Capillary Hemodynamics, Oxygen Saturation, and 3D Network Geometry.

April 2005: Experimental Biology/Microcirculatory Society Meeting, San Diego, CA
A Theoretical Study of Preferential Capillary Loss and Oxygen Transport During Sepsis.

Jorge Golowasch

September 2004: The II International Congress on Neuroregeneration, Rio de Janeiro, Brasil
Is Neuronal Rhythmic Activity Dependent on Network Activity Itself?

November 2004: STG Meeting, San Diego, CA
1) Gap Junction Conductance Between Passive Cables: Existence of an Optimal Cable Diameter for Signal Transfer;
2) Modeling Rhythmic Activity Recovery after Decentralization of a Neuronal Network.

November 2004: Annual Meeting of the Society for Neuroscience, San Diego, CA
1) Long-Term Regulation of Rhythmic Neural Networks by GABA;
2) Regulation of Rhythmic Activity in Cultured Neurons by Patterned Electrical Activity.

April 2005: 31th Annual East Coast Nerve Net, Woods Hole, MA
1) Gap-Junction Conductance Determines an Optimal Coupling Diameter in Passive Fibers;
2) Modeling Recovery of Rhythmic Activity: Hypothesis for the Role of a Calcium Pump;
3) Long-Term Regulation of Crab Pyloric Network by GABA;
4) Effect of Electrical Coupling on Ionic Current Measurements;
5) Convergence of Neuronal Activity Phenotype in Adult Isolated Neurons Result from Spontaneous or Induced Activity via a Common Ionic Mechanism.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
1) Gap-Junction Conductance Determines an Optimal Coupling Diameter in Passive Fibers;
2) Modeling Recovery of Rhythmic Activity: Hypothesis for the Role of a Calcium Pump.

Roy H. Goodman

August 2004: Workshop on Mathematical Ideas in Nonlinear Optics: Guided Waves in Inhomogenous Nonlinear Media, International Center for Mathematical Sciences, Edinburgh, Scotland
The 2-Bounce Resonant in Soliton-Soliton and Soliton-Defect Interactions.

October 2004: SIAM Conference on Nonlinear Waves and Coherent Structure, Orlando, FL
Asymptotic Analysis of Collective Coordinate Models.

October 2004: Conference in Honor of 60th Birthday of D. McLaughlin, Chapel Hill, NC
The Two-Bounce Resonance Phenomenon.

April 2005: IMACS Conference on Theory and Computation for Nonlinear Waves, University of Georgia, Athens, GA
The Two-Bounce Resonance in Solitary Wave Collisions.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Heads Up! A Capstone Applied Math Course in the Mechanics of Coin Flipping.

May 2005: SIAM Conference on Applications of Dynamical Systems, Snowbird, UT
Stability of Nonlinear Defect Modes in Bragg Grating Fibers.

David J. Horntrop

July 2004: SIAM Annual Meeting, Portland, OR
Mesoscopic Simulation for Surface Processes.

February 2005: SIAM Conference on Computational Science and Engineering, Orlando, FL
Mesoscopic Simulation of Domain Coarsening in Surface Processes.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Mesoscopic Simulation of Domain Coarsening in Surface Processes.

May 2005: Fifth IMACS Conference on Monte Carlo Methods, Tallahassee, FL
Mesoscopic Simulation for Ostwald Ripening.

May 2005: International Conference on Computational Science 2005, Atlanta, GA
Mesoscopic Simulation for Self-Organization in Surface Processes.

Shidong Jiang

June 2005: Beijing International Workshop
Fast Integral and Symplectic Methods.

Hafiz M. R. Khan

November 2004: Department of Mathematical Sciences, NJIT
Predictive Distributions for Responses from the Two Parameter Exponential Life Testing Model.

February 2005: Department of Epidemiology and Biostatistics, Florida International University
Model Adequacy in Atherosclerosis Phenotypes and RNA Indicators using Different Regression Models and Bayesian Approach.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Predictive Distributions for Responses from the Weibull Life Testing Model.

Lou Kondic

August 2004: XXI International Congress of Theoretical and Applied Mechanics, Warsaw, Poland
Extended Granular Temperature.

September 2004: International Workshop on Pattern Formation through Instabilities in Thin Liquid Films: From Fundamental Aspects to Applications, Dresden, Germany
1) Dynamics of Thin Liquid Films;
2) Spreading of a Thin Two-Dimensional Strip of Fluid on a Vertical Plane.

November 2004: American Physical Society-Division of Fluid Dynamics Annual Meeting, Seattle, WA
1) Simulations of Sheared Granular Flow of Intermediate Volume Fraction with Realistic Boundary Conditions;
2) Statistical Approach to Dense Granular Flows;
3) Long-Wave Stability of Thin Liquid Films: Compressible Gas Effects.

December 2004: Courant Institute of Mathematical Sciences, NYU, New York City, NY
Instabilities in the Flow of Thin Liquid Films.

February 2005: Workshop on Granular Materials in Lunar and Martian Exploration, Kennedy Space Center, FL
Velocity Profiles and Stresses of Sheared Granular Systems Under Gravity.

April 2005: 1005th American Mathematical Society Meeting, Newark, DE
Thin Liquid Films with Contact Lines: Instabilities, Coalescence and Rupture.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Thin Liquid Films with Contact Lines: Instabilities, Coalescence and Rupture.

June 2005: Granular Physics Workshop, Kavli Institute for Theoretical Physics, UCSB, Santa Barbara, CA
Temperature for Dense Granular Systems.

Gregory A. Kriegsmann

September 2004: Department of Mathematical Sciences, NJIT
Complete Transmission Through a Two-Dimensional Diffraction Grating.

April 2005: Department of Mathematical Sciences, University of Delaware
Electromagnetic Wave Propagation in Periodic Porous Media.

Dawn A. Lott

August 2004: Mathematical Association of American (MAA) MathFest 2004, Providence, RI
Mathematical Predictions and Aneurysm Treatment.

October 2004: 8th Annual Philadelphia AMP Research Symposium and Mentoring Conference, Philadelphia, PA
Algorithms of an African American Female Mathematician.

January 2005: AWM Workshop for Graduate Students and Recent Ph.D.'s, Joint Mathematics Meeting, Atlanta, GA
Shaping a Career in Mathematics (Panel).

April 2005: The Alliance for the Production of African American Ph.D.'s in the Mathematical Sciences, Jackson State University, Jackson, MI
Algorithms of an African American Female Mathematician.

Jonathan Luke

November 2004: The APS Division of Fluid Dynamics, Seattle
On Large-Scale Motions in Random Suspension in Large Containers.

July 2004: SIAM Annual Meeting, Portland
Simulated Evolution of Large-Scale Density Fluctuations in a Sedimenting Suspension.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
An Effective Fluid Model for the Day of Velocity Fluctuations in a Sedimenting Suspension.

Marc Q. Ma

Oct. 2004: Department of Chemistry and Environmental Science, NJIT
Molecular Dynamics for Biomolecules and Nano Systems.

Feb. 2005: Department of Computer Science, NJIT
Classical Molecular Dynamics for the Study of Biological Systems.

Mar. 2005: College of Computing Sciences, NJIT
Computational Biology using Molecular Dynamics Simulations.

May 2005: Institute for Mathematics and its Applications, U. Minnesota, MN
Molecular Dynamics Simulations: Stability, Multiscale Approaches and the Art of Trajectory Analysis.

Victor Matveev

July 2004: Annual Meeting for the Society for Mathematical Biology, Ann Arbor, MI
Synaptic Facilitation through Saturation of Endogenous Calcium Buffers.

July 2004: Cellular and Subcellular Models of Excitable Cells Workshop, Computational Neuroscience Meeting, Baltimore, MD
Synaptic Facilitation through Saturation of Calcium Buffers: a Computational Study.

March 2005: First Young Investigator Workshop, Mathematical Biosciences Institute, Columbus, OH
A Bound Calcium Mechanism of Synaptic Facilitation Revisited.

April 2005: Department of Pharmacology and Physiology Seminar, UMDNJ, Newark, NJ.
Mechanisms of Short-Term Synaptic Facilitation: Buffer Saturation and Beyond.

Jay N. Meegoda

November 2004: INFPRA, Montreal, Quebec, Canada
Inspection, Cleaning, Condition Assessment and Prediction of Remaining Service Life of CSCPs.

January 2005: TRB Conference, Washington, DC
A Framework for Inspection, Maintenance and Replacement of Corrugated Steel Culvert Pipes.

March 2005: Meeting of the Asia-Link Project: Geo-Environmental Engineering Training Program in China, Tsinghua University, Beijing, China
Future of Geo-Environmental Engineering.

May 2005: WasteEng05, Albi, France
Numerical Model to Predict Settlements Coupled with Landfill Gas Pressure in Bioreactor Landfills.

Zoi-Heleni Michalopoulou

July 2004: 7th European Conference on Underwater Acoustics, Delft, The Netherlands
Optimizing Matched-Field Inversion using Tabu Search.

November 2004: 148th Meeting of the Acoustical Society of America, San Diego, CA
Time Delay Estimation in Underwater Acoustics: A Global Optimization Approach.

March 2005: Women in Technology Leadership Awards, NJIT, Newark, NJ
Applied Mathematics in Underwater Acoustics.

Petronije S. Milojevic

May 2005: Frontiers in Applied and Computational Mathematics, Department of Mathematical Sciences, NJIT, Newark, NJ
Fredholm Theory for Hammerstein Equations.

Robert M. Miura

July 2004: SIAM Conference on the Life Sciences, Portland, Oregon
Solitary and Multiple Waves in Models of Spreading Cortical Depression.

July 2004: International Conference for Mathematics in Biology and Medicine and Annual Meeting for the Society for Mathematical Biology, University of Michigan, Ann Arbor, Michigan
Mathematical Modelling of Spreading Cortical Depression.

September 2004: 7th International Meeting of the Microarray Gene Expression Data Society, Toronto
Kinetic Model-Based Analysis of Microarray Data.

November 2004: Department of Biomedical Engineering, Columbia University, New York
Spreading Cortical Depression: An Enigma.

February 2005: COE Conference on Nonlinear Integrable Systems and Their Real World Applications, University of Tokyo, Tokyo
Modeling Nonlinear Waves of Spreading Depression.

February 2005: Research Institute for Applied Mechanics, Kyushu University, Fukuoka, Japan
Solitons and the Inverse Scattering Method: An Historical View.

March 2005: Mathematics Colloquium, University of Maryland, Baltimore County, Baltimore
Modeling Nonlinear Waves of Spreading Depression.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Modeling Nonlinear Waves of Spreading Depression.

Richard O. Moore

August 2004: Workshop on Mathematical Ideas in Nonlinear Optics, Edinburgh, Scotland
Pulse Dynamics in Thermally Loaded Optical Parametric Oscillators.

October 2004: SIAM Conference on Nonlinear Waves and Coherent Structures, Orlando, FL
Computing Random Soliton Fluctuations with Importance Sampling.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Thermally Induced Dynamics and Pattern Formation in Optical Parametric Oscillators.

May 2005: SIAM Conference on Applications of Dynamical Systems, Snowbird, UT

Thermally Induced Dynamics and Pattern Formation in Optical Parametric Oscillators.

Cyrill Muratov

July 2004: SIAM Conference on Life Sciences, Portland, OR
Signal Transmission by Autocrine Cells in Model Epithelial Layers.

July 2004: SIAM Annual Meeting, Portland, OR
Pseudodifferential Operators, Optimal Grids, and Nonlinear Evolution Equations: The Case Study for Micromagnetics.

October 2004: SIAM Conference on Nonlinear Waves and Coherent Structures, Orlando, FL
Eggshell Patterning in Drosophila Oogenesis: Modeling, Analysis, Experiments.

October 2004: BioMaPS Seminar in Quantitative Biology, Rutgers University, New Brunswick, NJ
Signal Transmission by Autocrine Cells in Model Epithelial Layers.

December 2004: SIAM Conference on PDEs, Houston, TX
Phase Transformation Kinetics in Ginzburg-Landau-Type Theories.

January 2005: CAMP/Nonlinear PDEs Seminar, University of Chicago, Chicago, IL
Traveling Wave Solutions and Propagation Phenomena in Gradient Reaction-Diffusion Systems.

February 2005: Special PDEs Seminar, Department of Mathematics, University of Tokyo, Tokyo, Japan
Traveling Wave Solutions and Propagation Phenomena in Gradient Reaction-Diffusion Systems.

February 2005: 50th NIBB Conference, Structure and Dynamics of Complex Biological Networks, Okazaki, Japan
Transmission of Autocrine Signals in Epithelial Layers: Modeling and Analysis.

February 2005: Applied Mathematics Colloquium, Department of Computational and Applied Mathematics, Rice University, Houston, TX
Transmission of Autocrine Signals in Epithelial Layers: Modeling and Analysis.

March 2005: Analysis and PDEs Seminar, Department of Mathematics, University of Marseille, Marseille, France
Traveling Wave Solutions and Propagation Phenomena in Gradient Reaction-Diffusion Systems.

May 2005: SIAM Conference on Application of Dynamical Systems, Snowbird, UT
1) A Variational Approach to Traveling Waves in Gradient Reaction-Diffusion Systems;
2) Signal Transmission by Autocrine Cel ls in Model Epithelial Layers.

June 2005: Applied Mathematics Seminar, Department of Mathematics, University of Pisa, Pisa, Italy
Pseudodifferential Operators, Optimal Grids, and Nonlinear Evolution Equations: The Case Study for Micromagnetics.

Farzan Nadim

August 2004: The 7th Congress of the International Society for Neuroethology, Nyborg, Denmark
Complex Synaptic Control of Timing of Neuronal Activity in a Rhythmic Network.

October 2004: Dynamical Neuroscience Satellite Symposium XII: Closing the Loop, San Diego, CA
Synaptic Depression Mediates Bistability in Neuronal Networks with Feedback Inhibition.

October 2004: Soc. Neurosci. Ann. Meeting. San Diego, CA

1) Modeling Electrically Coupled Pacemaker Neurons With Distinct Intrinsic Properties;
2) A Detailed Analysis Of The Distinct Intrinsic Properties Of The Electrically Coupled Pacemaker Neurons In A Rhythmic Network;
3) Using The Dynamic Clamp To Elucidate Actions Of Neuromodulators In A Rhythmically Active Network;
4) The Interaction Between Short-Term Facilitation And Depression In An Oscillatory Network;
5) Proctolin Enables A Shift In Synaptic Dynamics From Depression To Facilitation Due To The Presynaptic Waveform Amplitude In A Rhythmic Network;
6) Dopamine Modifies Firing Phase In A Rhythmic Network Through Synaptic Sign Reversal and Activation Of Silent Synapses.

April 2005: 31st Annual East Coast Nerve Net, Woods Hole, MA
1) Sensory Regulation of Rhythmic Motor Activity Via Presynaptic Inhibition;
2) Synaptic Resonance in the Stomatogastric Ganglion;
3) Effect of Electrical Coupling on Ionic Current Measurments;
4) Interaction of Short-Term Dynamics of Spike-Mediated and Graded Transmission in a Single Synapse.

Ozgur Ozen

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
1) Generation of Interfacial Instabilities in Charged Electrified Viscous Liquid Films;
2) Electrohydrodynamic Instability of the Interface of a Two-Fluid Flow in a Channel-Theory and Experiments.

Demetrios T. Papageorgiou

October 2004: Otto H. York Department of Chemical Engineering Seminar Series, NJIT, Newark, NJ
Theoretical and Experimental Aspects of Liquid Jet Breakup.

November 2004: American Physical Society, 57th Annual Meeting of the Division of Fluid Dynamics, Seattle, Washington
1) Electrohydrodynamic Stability in a Microfluidic Channel;
2) Singularity Formation in Vortex Sheets in a Channel.

March 2005: Gesellschaft fur Angewandte Mathematik und Mechanik (GAMM), 76th Meeting, Luxembourg
Nonlinear Waves in Electrified Liquid Films.

April 2005: 105th American Mathematical Society Meeting, University of Delaware, Newark, Delaware
Mathematical Problems in Electrified Falling Film Problems.

April 2005: Mathematical Sciences Colloquium, Worcester Polytechnic Institute
Nonlinear Electrohydrodynamics of Liquid Films.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
A Mathematical Model for Core-Annular Flows with Surfactant and No Basic Flow.

Peter G. Petropoulos

July 2004: EUROEM 2004 International Conference, Magdeburg, Germany
Modeling Propagation of Time-Domain Pulses in Cole-Cole Dielectrics.

January 2005: AFOSR Annual Electromagnetics Workshop, San Antonio, TX
A Numerical Method for Solving Maxwell's Equations Coupled to Fractional-Order Differential Equations.

April 2005: 1005th AMS Meeting, University of Delaware, Newark, DE
Asymptotics and Numerics of Pulse Propagation in Dielectrics Exhibiting Fractional Relaxation.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Chemical Oscillations & Waves: the Belousov-Zhabotinskii Reaction.

June 2005: Seventh International Conference on Mathematical and Numerical Aspects of Wave Propagation, Brown University, Providence, RI
Asymptotics and Numerics of Hyperbolic Systems Coupled to Fractional-Order Differential Equations.

Christopher Raymond

July 2004: SIAM Annual Meeting, Portland OR
Asymptotics for Surface-Volume Reactions with Diffusive Transport.

December 2004: Mathematical Biology Seminar, NJIT, DMS, Newark NJ
Asymptotics for Surface-Volume Reactions with Diffusive Transport.

April 2005: AMS Eastern Section Meeting, Newark, DE
Asymptotics for Certain Biochemical Surface-Volume Reactions.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Effect of Reversible Chemistry on Immunocolloid Labeling.

Anthony D. Rosato

July 2004: Tsang Lecture, Department of Physics, University of Manchester, UK
Segregation: Brazil Nuts Versus Convection.

March 2005: Levich Institute, City University of New York
General Features of Granular Couette Flow and Intruder Dynamics.

Michael Siegel

December 2004: SIAM Conference on Partial Differential Equations, Houston, TX
Global Existence, Singular Solutions and Ill-posedness for the Muskat Problem.

March 2005: Applied Mathematics Seminar, University of Delaware, Newark, DE
The Breakup of a Fluid Thread Surrounded by a More Viscous Liquid.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Steady Deformation, Tipstreaming, and Breakup of Inviscid Bubbles and Jets in Extensional Flow.

June 2005: Third M.I.T. Conference on Computational Fluid and Solid Mechanics, Boston, MA
Numerical Study of the Breakup of a Fluid Thread Surrounded by a More Viscous Fluid.

Louis Tao

October 2004: Annual Neuroscience Meeting, San Diego, CA
Ensemble Activity in a Large-Scale Neuronal Network of Macaque Primary Visual Cortex.

October 2004: Dmac Fest, Chapel Hill, NC
Visual Cortex Network Dynamics, with Application to Simple and Complex Cells in a Large-Scale Neuronal Network Model.

March 2005: Universitat Polytecnica de Catalunya, Barcelona, Spain
Orientation Selectivity by Fluctuation-Driven Critical States.

March 2005: Universitat Autonoma, Barcelona, Spain
Lecture Series on Visual Cortex: Physiology and Modeling.

March 2004: Rensselaer Polytechnic Institute, Department of Mathematical Sciences, Troy, NY
Orientation Selectivity by Fluctuation-Driven Critical States.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Orientation Selectivity by Fluctuation-Driven Critical States.

May 2004: SIAM Dynamical Systems, Snowbird, UT
Orientation Selectivity by Fluctuation-Driven Criticality.

Jean-Marc Vanden-Broeck

August 2004: ICTAM04, Warsaw, Poland
Nonlinear Capillary Waves with Electric Fields.

September 2004: Third International Conference on Boundary Integral Equation Methods, Reading, UK
Nonlinear Two and Three Dimensional Free Surface Flows.

February 2005: Mathematics Department, The University of Reading, UK
Two Layer Flows Past Submerged Obstacles.

March 2005: GAMM Conference, Luxembourg
Nonlinear Free Surface Flows in Presence of Electric Fields.

April 2005: BAMC, Liverpool, UK
Magnetic Shaping of a Liquid Metal Column and Deformation of a Bubble in a Vortex Flow.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Nonlinear Capillary Waves in Electrified Fluid Sheets.

Sheldon Wang

November 2004: APS Fluid Dynamics Meeting, Seattle, WA
From Imersed Boundary Method to Immersed Continuum Methods.

February 2005: NJIT Mechanical Engineering Seminar
An Overview of Immersed Methods.

April 2005: NJIT Computer Science presentation
Concurrent Multiscale Methods.

Wonsuk Yoo

August 2004: Joint Statistical Meeting 2004, Toronto, Canada
Bayesian Hierarchical Modelling of Longitudinal Biomarkers for Early Detection of Prostate Cancer.

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Bayesian Changepoint Model using Reversible Jump MCMC Algorithm for Early Detection of Prostate Cancer.

May 2005: Conference on Korean American Society in Biotech and Pharmaceutical Industry
Biostatistics: Role and Responsibility in Clinical Research.

Yuan-Nan Young

October 2004: Mechanical Engineering Seminar, NJIT
Drop Size Distribution in Turbulent Two-Phase Flows.
November 2004: APS Division of Fluid Dynamics, Seattle
Drop Size Distribution in Turbulent Two-Phase Flows.

May 2005: SIAM Conference on Dynamical Systems, Snowbird, Utah
Mean Flow in Rotating Non-Boussinesq Convection.

C. TECHNICAL REPORTS

REPORT 0405-1: D. A. Lott, M. Li, and J. R. Berlin
Effectiveness of Numerical Techniques for Calculating the Quantity of Calcium Ion Species During Calcium Sparks in Heart Muscle

REPORT 0405-2: Zoi-Heleni Michalopoulou and Michele Picarelli
Time Delay and Amplitude Estimation in Underwater Acoustics: A Gibbs Sampling Approach

REPORT 0405-3: M. Lucia, C. B. Muratov, and M. Novaga
Existence of Traveling Wave Solutions for Ginzburg-Landau-Type Problems in Infinite Cylinder

REPORT 0405-4: T. M. Segin, B. S. Tilley, and L. Kondic
On Undercompressive Shocks and Flooding in Countercurrent Two-Layer Flows

REPORT 0405-5: Amitabha Bose and Victoria Booth
Bursting in 2-Compartment Neurons: A Case Study of the Pinsky-Rinzel Model

REPORT 0405-6: Vladislav V. Goldberg and Valentin V. Lychagin
On the Blaschke Conjecture for 3-Webs

REPORT 0405-7: Cristina Soto-Treviño, Pascale Rabbah, Eve Marder, and Farzan Nadim
A Computational Model of Electrically Coupled, Intrinsically Distinct Pacemaker Neurons

REPORT 0405-8: Pascale Rabbah, Jorge Golowasch, and Farzan Nadim
Effect of Electrical Coupling on Ionic Current and Synaptic Potential Measurements

REPORT 0405-9: Akira Mamiya and Farzan Nadim
Target-Specific Short-Term Dynamics are Important for the Function of Synapses in an Oscillatory Neural Network

REPORT 0405-10: Hans Chaudhry, Thomas Findley, Karen S. Quigley, Zhiming Ji, Miriam Maney, Tiffany Sims, Bruce Bukiet, and Richard Foulds
Postural Stability Index is a More Valid Measure of Stability Than Equilibrium Score

REPORT 0405-11: Hans Chaudhry, Thomas Findley, Zhiming Ji, Bruce Bukiet, Richard Foulds, and Miriam Maney
Relationship Among Postural Stability, Weight, Height and Moment of Inertia of Normal Adults

REPORT 0405-12: Christina Ambrosio, Farzan Nadim, and Amitabha Bose
The Effects of Varying the Timing of Inputs on a Conditional Oscillator

REPORT 0405-13: Hafiz M. R. Khan, M. Safiul Haq, and Serge B. Provost
Predictive Inference for Future Responses Given a Doubly Censored Sample from a Two Parameter Exponential Distribution

REPORT 0405-14: Hafiz M. R. Khan, M. Safiul Haq, and Serge B. Provost
Predictive Inference for Future Responses from Two Component Systems

REPORT 0405-15: Zoi-Heleni Michalopoulou, Sima Bagheri, and Lisa Axe
Matching Reflectances for the Estimation of Inherent Optical Properties

REPORT 0405-16: Roy H. Goodman and Richard Haberman
Vector-Soliton Collision Dynamics in Nonlinear Optical Fibers

REPORT 0405-17: Hafiz M. R. Khan, M. Safiul Haq, and Serge B. Provost
Bayesian Prediction for the Log-Normal Model Under Type II Censoring

REPORT 0405-18: M.C. Bhattacharjee
Strong Versions of the DFR Property

REPORT 0405-19: Wonsuk Yoo and Elizabeth H. Slate
A Simulation Study of a Bayesian Hierarchical Changepoint Model with Covariates

REPORT 0405-20: Shidong Jiang and Minzhong Xu
Hyperpolarizabilities for the One-Dimensional Infinite Single-Electron Periodic Systems: I. Analytical Solutions Under Dipole-Dipole Correlations

REPORT 0405-21: Minzhong Xu and Shidong Jiang
Hyperpolarizabilities for the One-Dimensional Infinite Single-Electron Periodic Systems: II. Dipole-Dipole Versus Current-Current Correlations

REPORT 0405-22: Minzhong Xu and Shidong Jiang
Breaking of the Overall Permutation Symmetry in Nonlinear Optical Susceptibilities of Periodic Systems

REPORT 0405-23: Dean Bottino, Chrstian Penland, Andrew Stamps, Martin Traebert, Berengere Dumotier, Anna Georgieva, Gabriel Helmlinger, and Scott Lett
Preclinical Cardiac Safety Assessment of Pharmaceutical Compounds Using an Integrated Systems-Based Computer Model of the Heart

REPORT 0405-24: P.S. Milojevic
Some Generalizations of the First Fredholm Theorem to Hammerstein Equations and the Number of Solutions

REPORT 0405-25: R.I. Andrushkiw, D.A. Klyushin, Yu.I. Petunin, and M.Yu. Savkina
The "Exact" Confidence Limits for Unknown Probability in Bernoulli Models

REPORT 0405-26: David Cai, Louis Tao, and David McLaughlin
An Embedded Network Approach for Scale-Up of Fluctuation-Driven Systems with Preservation of Spike Information

REPORT 0405-27: Louis Tao, David Cai, David McLaughlin, Robert Shapley, and Michael Shelley
Orientation Selectivity in Visual Cortex by Fluctuation-Controlled Criticality

REPORT 0405-28: N. J. Balmforth and Y.-N. Young
Stratified Kolmogorov Flow. Part 2.

REPORT 0405-29: Y.-N. Young and D. Levy
Registration-Based Morphing of Active Contours for Segmentation of CT Scans

REPORT 0405-30: Tetyana M. Segin, Lou Kondic, and Burt S. Tilley
Long-Wave Linear Stability Theory for Two-Fluid Channel Flow

REPORT 0405-31: Ning Xu, Corey S. O'Hern, and Lou Kondic
Velocity Profiles in Repulsive Athermal Systems Under Shear

REPORT 0405-32: Bruce R. Johnson, Lauren Schneider, Farzan Nadim, and Ronald M. Harris-Warrick
Dopamine Modulation of Phasing of Activity in a Rhythmic Motor Network: Contribution of Synaptic and Intrinsic Modulatory Actions

REPORT 0405-33: Kai Zhang, Marc Q. Ma, Hui-Yun Wang, Yu Wang, and Frank Shih
Integrated Data Analysis for Genotyping Microarrays

REPORT 0405-34: Yu Wang, Kentaro Sugino, Marc Q. Ma, and Annie V. Beuve
Modeling and Simulation of Soluble Guanylyl Cyclase

REPORT 0405-35: Wonsuk Yoo and Elizabeth H. Slate
Variable Selection of a Bayesian Hierarchical Changepoint Model for Longitudinal Biomarkers of Prostate Cancer

REPORT 0405-36: Farzan Nadim and Jorge Golowasch
Signal Transmission Between Gap-Junctionally Coupled Passive Cables Occurs at an Optimal Cable Diameter

REPORT 0405-37: Yiming Cheng and Robert M. Miura
Analysis of Equivalent Distorted Ratchet Potentials

VI. EXTERNAL ACTIVITIES AND AWARDS

A. FACULTY ACTIVITIES AND AWARDS

Daljit S. Ahluwalia

Chair, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Editorial Board member, Mathematical Sciences Research Hot-Line International Journal

Nadine Aubry

Member-at-large (one of six), US National Committee on Theoretical and Applied Mechanics (USNC/TAM), 2001 - 2005 (two terms).

Vice Chair, US National Committee on Theoretical and Applied Mechanics (USNC/TAM), 2004 - 2006.

Member of the USNC/TAM Publications Committee, Research Publications and Communications, 2003-2004, Chair (2005).

Member of the APS/DFD (American Physical Society/Division of Fluid Dynamics) Publications Committee.

Chair (12/01/04-11/30/05) and Vice Chair (12/1/03-11/30/04) of the American Physical Society (APS), Division of Fluid Dynamics (DFD) Nominating Committee.

Chair of the USNC/TAM Ad Hoc Committee on USNC/TAM Society Memberships.

NASA Human Support Technology Interfacial Phenomena Panel, Washington, DC, December 14-16, 2004.

National Science Foundation (NSF) Panel for Graduate Fellowship Program (GRP) (Mechanical and Aeronautical Engineering Panel), Arlington, VA, February, 2005.

National Science Foundation (NSF) FY 2005 Turbulence and Flow Control Unsolicited Proposal Review Panel, Arlington, VA, April 2005.

National Science Foundation (NSF), Nanotechnology Sciene and Engineering Technology (NSEC) Site Visit 2005, Ohio State University, Cincinnati, OH, April 2005.

John Bechtold

Outstanding Service to Undergraduate Education Award, CSLA, NJIT, April 2005.

Manish Bhattacharjee

Elected Member: International Statistical Institute, The Hague, The Netherlands.

Editorial Board Calcutta Statistical Association.

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Denis Blackmore

Editorial Board, ACS Journal of Chemical Information and Modeling (since 2003).

Editorial Board, Mechanics Research Communications (since 2005).

Co-Editor of book on Vortex Dominated Flows for World Scientific, June 2005.

Co-Organizer (Invited) of minisymposium on Vortex Dominated Flows at the Third MIT Conference on Computational Fluid and Solid Mechanics, MIT, June 14-17, 2005.

NSF Panelist for Division of Mathematical Sciences.

NSF Panelist for Division of Computer Science.

Reviewed World Scientific book on Quantum Field Theory.

Reviewed Springer manuscript on Calculus.

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Amitabha Bose

Organized a Minisymposium on the Dynamics of Central Pattern Generators at the SIAM Conference on Dynamical Systems, May 2005

Invited to participate in the Research Program in Mathematical Biology at the Park City Mathematics Institute, Park City, UT, June, 2005

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Sunil Dhar

Chair of invited session on Nonparametric Inference II: International Conference on the Future of Statistical Theory Practice and Education, Indian School of Business, Hyderabad, Andhra Pradesh, India, (December 2004).

Received a recognition award, "Above & Beyond" from the Head of Biometrics US CD&MA, Novartis Pharmaceuticals Corporation, East Hanover, NJ, for teaching series of courses: "Statistics for Non-Statisticians".

Vladislav V. Goldberg

Editorial Board Member, Webs and Quasigroups (Tver, Russia).

Editorial Board Member, Rendiconti del Seminario Matematica di Messina.

Jorge Golowasch

Invited Faculty at the Marine Biological Laboratories, Woods Hole, MA, Neural Systems and Behavior course (July 2004).

Co-Director and Faculty at the Marine Biological Laboratories, Woods Hole, MA. Neural Systems and Behavior course (June-July 2005).

David J. Horntrop

National Science Foundation Panelist for Division of Mathematical Sciences.

Lou Kondic

Named Fulbright Scholar, March 2005.

Named KITP Scholar 2006-2008 by The Kavli Institute for Theoretical Physics, University of Santa Barbara, CA.

Invited Granular Workshop participant, The Kavli Institute for Theoretical Physics, University of Santa Barbara, CA, May 23-June 24, 2005.

Gregory A. Kriegsmann

Vice President of SIAM Publications.

Associate Editor for the SIAM Journal of Applied Math., the IMA Journal of Appl. Math., Wave Motion, the Journal of Engineering Math., and the Journal of Math and Applications.

Fellow of The Acoustical Society of America (since 1991).

Fellow of the Institute for Mathematics and Its Applications (since 1992).

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Dawn A. Lott

Greater Philadelphia Region Louis Stokes Alliance for Minority Participation Appreciation Award, Oct 2004.

National Association of Mathematicians Award of Appreciation, Aug 2004.

Jonathan Luke

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Robert M. Miura

Fellow of the Royal Society of Canada (since 1995).

Member, Organizing Committee for the Third Pacific Rim Conference on Mathematics, August 17-21, 2005, Shanghai, China (since 2001).

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Co-Organizer and Participant, Focused Research Group on Analysis, Computations, and Experiments on Pinch-off in Liquid Jets, Banff International Research Station, Banff, Alberta, March 12-26, 2005.

Co-Editor-in-Chief, Analysis and Applications (World Scientific, publisher) (since 2000).

Editorial Board, Integrative Neuroscience (World Scientific, publisher) (since 1999).

Editorial Board, Canadian Applied Mathematics Quarterly (since 1991).

Scientific Advisory Panel (since 2002) and Scientific Nominating Committee (since 2003), Fields Institute for the Mathematical Sciences, Toronto, Canada.

Elected Vice Chair of the Society for Industrial and Applied Mathematics (SIAM) Activity Group on Life Sciences.

Richard O. Moore

Participant, Mathematical Problems in Industry, Worcester Polytechnic Institute, June 13-17, 2005.

Organizer, Waves Seminar Series, Department of Mathematical Sciences, New Jersey Institute of Technology, September 2004 - May 2005.

Cyrill Muratov

Co-Organizer of Minisymposium, Towards Integrated Models of Tissue Development and Homeostasis, SIAM Conference on Life Sciences, Portland, OR, July 2004.

Co-Organizer of Minisymposium, Mathematical Aspects of Ginzburg-Landau Theories, SIAM Conference on PDEs, Houston, TX, December 2004.

Co-Organizer of Two-Part Minisymposium, Propagation By Reaction and Diffusion: Theory and Applications, SIAM Conference on Applications of Dynamical Systems, Snowbird, UT, May 2005.

Farzan Nadim

Cycle Director, Stomatogastric Nervous System Cycle, Neural Systems and Behavior Course, Marine Biological Laboratory, Woods Hole, MA.

Associate Editor, Journal of Neuroscience.

Demetrios T. Papageorgiou

Co-Editor in-Chief, IMA Journal of Applied Mathematics.

Editorial Board Member, SIAM Journal on Applied Mathematics.

Fellow of the Institute of Mathematics and its Applications.

Co-Organizer of a Focused Research Group on Analysis, Computations and Experiments on Pinchoff in Liquid Jets, Banff International Research Station, March 12-26, 2005. (Co-organized with H. Huang, R. Miura and M. Siegel).

Member, Organizing Committee for the Frontiers in Applied and Computational Mathematics Conference (FACM'05), May 13-15, 2005, NJIT.

Peter G. Petropoulos

Organized a Mini-Symposium at the May 2005 Frontiers in Applied and Computational Mathematics Conference, entitled: Computational Electromagnetics, New Jersey Institute of Technology, Newark, NJ.

Constructed and Presented an Exhibit on Applied Mathematics at the 17th Annual Super Science Saturday event organized by Ridgewood High School, Ridgewood, NJ.

Michael Siegel

Member, Organizing Committee for Frontiers in Applied and Computational Mathematics, (FACM’05), May 13-15, 2005, NJIT.

Organizer, with H. Huang (York University), R. Miura (NJIT), and D. Papageorgiou (NJIT), Focused Research Group on Analysis, Computations, and Experiments on Pinch-off in Liquid Jets, March 2005, Banff International Research Station, Banff, Alberta, Canada.

Minisymposium Organizer: Rigorous Results for Partial Differential Equations from Interfacial Fluid Dynamics, December 2004, SIAM Conference on PDE, Houston, TX.

Louis Tao

Organizer of the Minisymposium Waves and Coherent Structures in Neural Systems at SIAM Conference on Dynamical Systems and Its Applications, Snowbird, UT, May 2005.

Jean-Marc Vanden-Broeck

Wrote the Lighthill Memorial Paper for the Journal of Engineering Mathematics.

Plenary speaker at the Third International Conference on Boundary Integral Equation Methods in Reading, UK, September 2004.

Associate Editor for the ANZIAM Journal and the Quarterly Journal of Mechanics and Applied Mathematics.

Fellow of the Institute of Mathematics and its Applications in the UK.

Wonsuk Yoo

Selected for the SIE Young Investigator Award for 2005 by the American Statistical Association (ASA) Section on Statistics in Epidemiology.

Yuan-Nan Young

Visiting Staff, Geophysical Fluid Dynamics Summer Program, Woods Hole Oceanographic Institute, 2005.

B. CONFERENCE ON FRONTIERS IN APPLIED AND COMPUTATIONAL MATHEMATICS (FACM '05)

On May 13-15, 2005, the New Jersey Institute of Technology (NJIT) played host to more than 250 leading experts in applied mathematics. The researchers poured onto campus for a three-day conference to discuss the frontiers of applied and computational mathematics. The conference was the second in a series of events to enhance the visibility and reputation of the Department of Mathematical Sciences.

The National Science Foundation (NSF) and the Air Force Office of Scientific Research (AFOSR) provided funding. Other sponsors were NJIT, the Society for Mathematical Biology, and the Mathematical Biosciences Institute. NJIT's Department of Mathematical Sciences and Center for Applied Mathematics and Statistics organized the event.

"The conference offered mathematical researchers an opportunity to present their work in applied mathematics and statistics," said Daljit S. Ahluwalia, PhD, Acting Dean of NJIT's College of Computing Sciences, Director of CAMS, and former Chairman of the Department of Mathematical Sciences. Among the topics covered were mathematical biology, nonlinear waves and electromagnetics, fluid mechanics, and applied statistics.

Joseph B. Keller, described by Ahluwalia as "Mr. Applied Mathematics of the USA," was a featured speaker. Keller is a member of the National Academy of Sciences and recipient of the National Medal of Science. Avner Friedman (Ohio State University), a member of the National Academy of Sciences, provided the keynote speech. Other plenary speakers included Larry Abbott (Brandeis University), Martin Golubitsky (University of Houston), Leo Kadanoff (University of Chicago), William Kath (Northwestern University), and John Ockendon (Oxford University).

Joseph Keller spoke on the problem of how an animal determines the location of a source of sound. His mathematical treatment relied on formulating the question as an inverse problem. Keller explained how differences of acoustic pressure phases in the two ears are processed to determine the direction of the source.

Avner Friedman discussed new challenges in applied mathematics arising from the biosciences, where tremendous amounts of experimental data are currently being generated. He explored the usefulness of mathematical modeling through examples from his experiences at the Mathematical Biosciences Institute.

Larry Abbott considered the adaptation of neuronal responses to stimuli. Abbott discussed new ways of modeling and thinking about adaptation and examined the implications for sensory processing.

Martin Golubitsky discussed coupled cell models. These models assume the output from each cell is important and that signals from two or more cells can be compared so that patterns of synchrony can emerge.

Leo Kadanoff talked about effective scientific simulations. He questioned the effectiveness of simulations in the generation of scientific knowledge, and gave examples of very successful simulations, and those which were quite the opposite. The examples included studies of solar neutrino production, the early history of the universe, sonoluminescence, "cold fusion", and mechanisms for mixing in novae, supernovae, and other turbulent flows.

William Kath of Northwestern spoke about simulating rare events in lightwave communications systems. Lightwave communications systems transmit information at extremely high rates, and are designed to have extremely small error rates. Since system performance is determined by these rare events, accurate modeling remains a mathematical and computational challenge. Kath talked about recent work on overcoming the difficulties.

John Ockendon of Oxford described some industry-driven problems that pose interesting open questions in mathematical modeling and analysis. The problems included: the dynamics of a shaped charge jet as it penetrates a target, the effect of small dust particle on the flow of a cold plasma, and high-frequency asymptotics in the aircraft industry.

Several sessions of invited talks were devoted to Mathematical Biology. Speakers included Jonathan Bell, University of Maryland Baltimore County, Richard Bertram, Florida State University, Lora Billings, Montclair State University, Victoria Booth, University of Michigan, Stephen Childress, New York University, Herbert Levine, University of California at San Diego, Philip Holmes, Princeton University, Thomas Kepler, Duke University, Vittorio Cristini, University of California at Irvine, Arthur Sherman, National Institutes of Health, John Rinzel, New York University, Masayasu Mimura, Meiji University, John Pearson, Los Alamos National Laboratory, Anna Georgieva, Novartis Pharmaceuticals Corp., Frank Hoppensteadt, New York University, and Johan Paulsson, Cambridge University. Topics included neuroscience, disease modeling, flapping flight, tumor growth, cardiac electrophysiology, insect locomotion, networks of oscillators, immune system modeling, intracellular calcium signaling, self-organized patterns in bacterial colonies, and ion channel kinetics.

There were also a number of sessions in Fluid Dynamics. Speakers included Michael Siegel, New Jersey Institute of Technology, Kate Stebe, Johns Hopkins University, Z. Jane Wang, Cornell University, Howard Stone, Harvard University, Paul Steen, Cornell University, André Nachbin, IMPA, Brazil, Anette (Peko) Hosoi, Massachusetts Institute of Technology, Andrew Belmonte, Pennsylvania State University, Michael Shelley, New York University, Russell Caflisch, University of California at Los Angeles, Monika Nitsche, University of New Mexico, Jean-Marc Vanden-Broeck, University of East Anglia, Wendy Zhang, University of Chicago, Hillary Ockendon, Oxford University, L. Pamela Cook, University of Delaware, Bernard Matkowsky, Northwestern University, Ashwani K. Kapila, Rensselaer Polytechnic Institute, and D. Scott Stewart, University of Illinois at Urbana-Champaign. Topics covered in these sessions included wormlike micellar fluids, singularities in incompressible fluid dynamics, applications of thin film theory to crawling snails, combustion and detonations, regularizations of vortex sheet models, turbulent flow in long thin channels, swimming worms, droplet switches, dragonfly flight, the mobility of membrane trapped particles, electrified fluid sheets, singular liquid spouts, and surfactant effects in bubble dynamics.

Speakers in the sessions on Computational Electro-Magnetics and Waves included Jan Hesthaven, Brown University, Fernando Reitich, University of Minnesota, Fioralba Cakoni, University of Delaware, Miguel Visbal, U.S. Air Force Research Laboratory, Arnd Scheel, IMA, University of Minnesota, Richard Haberman, Southern Methodist University, Jared Bronski, University of Illinois at Urbana-Champaign, J. Nathan Kutz, University of Washington, Clyde Scandrett, Naval Postgraduate School, John Harris, Northwestern University, and Andy Norris, Rutgers University. Topics included new methods for time-domain computational electromagnetics and the solution of wave scattering problems, soliton collision dynamics in nonlinear optical fibers, and coupled elastic waveguide modes.

There were also sessions in Applied Statistics, Biostatistics and Genomics. Speakers included Javier Cabrera, Rutgers University, Dipak Dey, University of Connecticut, Nilanjan Chatterjee, National Institutes of Health, Shelby Haberman, Educational Testing Service, W. Jackson Hall, University of Rochester, Pranab K. Sen, University of North Carolina at Chapel Hill, and William Sallas, Novartis Pharmaceuticals Corp. Topics in these sessions included statistical analysis of DNA microarray data, dimensionality in genomics, and estimating insulin secretion in patients with diabetes.

In addition to the plenary lectures, minisymposia, and poster session, Dr. Arje Nachman of the Air Force Office of Scientific Research (AFOSR) and Dr. Henry Warchall (National Science Foundation) made excellent presentations outlining potential funding opportunities.

Graduate students and postdocs from universities nationwide presented posters. “We saw a number of high quality poster presentations,” said Ahluwalia. “We were particularly gratified that graduate students participated in the conference and widened their research horizons by interacting with leading experts in their fields."

"The conference brought together some of the best minds in applied mathematics from around the nation and world," said Robert M. Miura, PhD, Professor of Mathematics and Acting Chairman of NJIT's Department of Mathematical Sciences. Among attendees were foreign researchers from the United Kingdom, Spain, and Japan; mathematicians and statisticians from Novartis and Merck; and top researchers from federal laboratories, such as Lawrence Livermore, Los Alamos and others.

"The future of our profession depends on doctoral students and post-docs having access to this kind of collegial exchange," said Ahluwalia. "I am happy to report that 60 junior researchers received travel subsidies and/or conference fee waivers to attend and at least 40 junior researchers were from institutions other than NJIT."

The conference's modest $100 registration fee included breakfasts and lunches plus a Saturday night banquet. The banquet was held in the beautiful glass-enclosed atrium of the new NJIT Campus Center. Find more information about this second annual event, plus forthcoming details about next year at http://m.njit.edu.

The conference organizers were Daljit S. Ahluwalia (Chair), Manish Bhattacharjee, Denis Blackmore, Amitabha Bose, Gregory A. Kriegsmann, Jonathan Luke, Robert M. Miura, Demetrios Papageorgiou, and Michael Siegel.

Conference Announcement:

New Jersey Institute of Technology

FRONTIERS IN APPLIED AND COMPUTATIONAL MATHEMATICS

FACM

May 13-15, 2005

OVERVIEW: Recent advances in mathematical biology, mathematical fluid dynamics, nonlinear waves & electromagnetics, applied statistics, and other areas of the mathematical sciences

KEYNOTE, PLENARY, AND INVITED SPEAKERS (Partial List):

L. Abbott (Brandeis)
V. Booth (Michigan)
J. Bronski (Univ. of Illinois)
R. Caflisch (UCLA)
S. Childress (Courant, NYU)
P. Cook (Delaware)
D. Dey (Connecticut)
A. Friedman (MBI, Ohio State)
M. Golubitsky (Univ. of Houston)
R. Haberman (SMU)
S. Haberman (ETS, Princeton)
P. Holmes (Princeton Univ.)
F.C. Hoppensteadt (Courant, NYU)
A. Hosoi (MIT)
L. Kadanoff (Univ. of Chicago)
A. Kapila (RPI)
W. Kath (Northwestern)
J.B. Keller (Stanford)
H. Levine (UC – San Diego)
B. Matkowsky (Northwestern)
M. Mimura (Meiji – Japan)
M. Nitsche (New Mexico)
H. Ockendon (Oxford)
J. Ockendon (Oxford)
J. Rinzel (Neural Sciences, NYU)
A. Scheel (IMA and Minnesota)
M. Shelley (Courant, NYU)
A. Sherman (NIH)
K. Stebe (Johns Hopkins)
P. Steen (Cornell)
D.S. Stewart (Illinois)
H. Stone (Harvard)
D.W. Sumners (Florida State)
J.-M. Vanden-Broeck (East Anglia – UK)
J. Wang (Cornell)
W. Zhang (Chicago)

PROGRAM INFORMATION:

Abstracts for contributed posters should be submitted by April 1, 2005 to suttons@njit.edu. For registration and additional conference information, see: http://math.njit.edu/Events/FACM05

Graduate students, postdoctoral fellows, and junior faculty are encouraged to submit posters for which some travel support is available. Partial funding for travel has been provided by a Strategic Initiative Award from NJIT and by the Department of Mathematical Sciences. Additional funding is being sought from NSF, AFOSR, and SMB.

SPONSORED BY: New Jersey Institute of Technology
Mathematical Biosciences Institute
Society for Industrial and Applied Mathematics

HOSTED BY: Department of Mathematical Sciences
Center for Applied Mathematics and Statistics

LOCAL ORGANIZERS (NJIT): D.S. Ahluwalia (Chair), M. Bhattacharjee, D. Blackmore, A. Bose, G. Kriegsmann, J. Luke, R.M. Miura, D. Papageorgiou, M. Siegel

Keynote Speaker, Avner Friedman

Front row from left: Joseph Keller, John Ockendon, William Van Buskirk, Daljit S. Ahluwalia, Frank Hoppensteadt, and Steve Childress

Members of the organizing committee and plenary speakers

From left: Holly Stern, Fadi Deek, Frank Hoppensteadt, Priscilla Nelson, Hilary Ockendon, Robert Altenkirch, John Ockendon, Joseph Keller, Robert M. Miura, Daljit S. Ahluwalia, and Nadine Aubry

Robert Altenkirch (President of NJIT) at left and Daljit S. Ahluwalia

From left: John Ockendon, Joseph Keller, Robert Altenkirch, and Daljit S. Ahluwalia

C. MISCELLANEOUS DEPARTMENTAL ACTIVITIES AND EVENTS

Colloquium speaker Dave Muraki, Victor Matveev, Louis Tao, and Roy Goodman in the CAMS Reading Room

Simon Levin (Princeton University) and Daljit S. Ahluwalia present summer 2004 research awards to graduate students Nebojsa Murisic (far left) and Anisha Banerjee (third from left)

Left: Ph.D. Graduates at the May 2005 Commencement Ceremony. From left: Christina Ambrosio, Jyoti Champanerkar, Muhammed Hameed, and Lin Zhou

Below: Focused Research Group Workshop on Pinch-off of Fluid Jets, Banff, Canada, March 2005. Organized by R. Miura, D. Papageorgiou, M. Siegel (NJIT), and H. Huang (York).

Robert Miura, Jonathan Wylie, Yuan Young, Peter Howell, Wendy Zhang, Demetrios. Papageorgiou, and Michael Siegel prepare for a strenuous mountain hike at the Banff Workshop.

Wendy Zhang shows an interesting experimental result to the workshop participants.

Alumni Dinner:

The Department of Mathematical Sciences hosted its first mathematical sciences alumni dinner at NJIT on May 12, 2005. Welcoming remarks by CSLA Dean Fadi Deek and CCS Acting Dean and Director of CAMS Daljit S. Ahluwalia were followed by brief descriptions of the alumni's current professional appointments and research activities.

Twenty alumni Ph.D.s attended the dinner and almost all of them presented their current research during the poster sessions of the FACM '05 Conference on May 13-15, 2005. By all accounts, the evening was a great success.

Row one, from left: S. Sutton (staff), M. Bhattacharjee (advisor), D. Blackmore (advisor), G. Kriegsmann (advisor), F. Deek (CSLA Dean), D.S. Ahluwalia (CCS Acting Dean and CAMS Director), Z.-H. Michalopoulou (advisor), D. Papageorgiou (advisor), N. Aubry (advisor), J. Bechtold (advisor), and P. Gulati (staff)

Row two, from left: Z. Huang, R. Addabbo, S. Walker, J. Chen, S. Kas-Danouche, J. Champanerkar, E. Antoniou, L. Zhou, U. Ghosh-Dastidar, J. Gomez, M. Picarelli, V. Lukyanov, J. Luke (advisor), P. Hou, X. Ma, M. Booty (advisor), L. Barannyk, and J. Pelesko

Row three, from left: A. Bose (advisor), J. Porus, M. Hameed, A. Goullet, R. Tanenbaum, J. Gilchrist, and I. Zorych.

VII. FUNDED RESEARCH

A. EXTERNALLY FUNDED RESEARCH

CONTINUING FUNDED PROJECTS

1. *Accuracy and Stability of Computational Representations of Swept Volume Operations*

   NSF/DARPA: July 1, 2003 -- June 30, 2006
   Denis Blackmore
   Ming Leu
   William Regli
   Wei Sun

2. *Functional Roles for Short-Term Synaptic Plasticity in Neuronal Networks*

   National Science Foundation: July 1, 2003 -- June 30, 2006
   Amitabha Bose
   Victoria Booth

3. *Activity-Dependent Regulation of Ionic Currents*

   National Institute of Mental Health: December 1, 2001 -- November 30, 2006
   Jorge Golowasch

4. *The Pyloric Model Group: Functional Analysis of a Complex, Distributed Biological Neural Network*

   National Science Foundation: March 1, 2001 -- February 28, 2006
   Jorge Golowasch
   Ron Harris-Warrick
   Scott Hooper
   Eve Marder
   Farzan Nadim
   Michael P. Nusbaum

5. *Pulse Propagation and Capture in Bragg Grating Optical Fibers*

   National Science Foundation: July 1, 2002 -- June 30, 2005
   Roy Goodman

6. *ITR: Mesoscopic Modeling and Simulation: A Novel Approach to Monte Carlo Methods*

   National Science Foundation: September 1, 2002 -- August 31, 2005
   David J. Horntrop
   Markos A. Katsoulakis (University of Massachusetts)
   Dionisios G. Vlachos (University of Delaware)

7. *Gravity and Granular Materials*

   NASA: April 1, 2004 -- October 30, 2007
   Lou Kondic
   Robert P. Behringer (Duke University)

8. *Establishment of Linked PhD Programs*

   Council for International Exchange of Scholars: August 1, 2004 -- July 30, 2006
   Lou Kondic
   Javier Diez (University Nacional del Centro, Tandil, Argentina)

9. *Efficient Shallow Water Matched Field Inversion*

   Office of Naval Research: January 1, 2002 -- December 31, 2004
   Zoi-Heleni Michalopoulou

10. *Collaborative Research: Modeling and Computational Analysis of Cell Communication in Drosophila Oogenesis*

    National Science Foundation: July 1, 2002 -- June 30, 2005
    Cyrill Muratov
    Stanislav Shvartsman

11. *Regulation of Neuronal Oscillations by Synaptic Dynamics*

    National Institute of Mental Health: December 1, 2000 -- November 30, 2005
    Farzan Nadim

12. *Mechanisms of Dose- and State-Dependence of Neuromodulation*

    United States-Israel Binational Science Foundation: September 1, 2002 -- August 31 2006
    Farzan Nadim
    Yair Manor
    Eve Marder

13. *Mathematical Problems in Electrohydrodynamics*

    National Science Foundation: July 1, 2004 -- June 30, 2007
    D.T. Papageorgiou

14. *Numerical Modeling of Electromagnetic Wave Propagation and Scattering: High-Order Schemes: Impedance Boundary Conditions and Cole-Cole Dielectrics*

    Air Force Office of Scientific Research: January 1, 2002 -- January 1, 2005
    Peter G. Petropoulos

15. *Transport and Heterogeneity in Surface-Volume Biochemical Reactions: Modeling and Experiment, with Applications to Immunocolloid Labeling and Surface Plasmon Resonance Devices*

    National Institutes of Health: August 1, 2002 -- July 31, 2007
    Christopher S. Raymond
    Ralph Albrecht
    David A. Edwards
    Paul Milewski

16. *Analysis and Numerical Computations of Moving Boundaries in Fluid Dynamics and Materials Science*

    National Science Foundation: July 1, 2001 -- June 30, 2005
    Michael Siegel

17. *Focused Research Group: Singularity Formation for the Three-Dimensional Euler Equations and Related Problems*

National Science Foundation: July 1, 2004 -- June 30, 2007
Michael Siegel
Russel Caflisch
Tom Hou
Dale Pullin

18. *Numerical Investigations of Three and Two Dimensional Free Boundary Problems*

National Science Foundation: August 1, 2002 -- July 31, 2005
Jean-Marc Vanden-Broeck

PROJECTS FUNDED DURING PRESENT FISCAL YEAR

1. *Acquisition of a Computer Cluster for the Center of Applied Mathematics and Statistics at NJIT*

National Science Foundation: Major Research Instrumentation:
September 1, 2004 – August 31, 2007
Daljit S. Ahluwalia
Qun Ma
Michael Siegel
Roy Goodman
David Horntrop
Lou Kondic
Peter Petropoulos
Louis Tao

2. *UBM: An Undergraduate Training Program in Biology and Mathematics at NJIT*

National Science Foundation: September 1, 2004 -- August 31, 2009
Amitabha Bose
Jorge Golowasch
Farzan Nadim

3. *Optical Imaging of Skeletal Muscle Microvascular Oxygen Transport*

Canadian Institutes of Health Research: April 1, 2005 -- March 31, 2008
Daniel Goldman
Christopher Ellis (University of Western Ontario)

4. *Spectral Schemes for Stochastic Partial Differential Equations for Surface Processes*

National Science Foundation: July 1, 2004 -- June 30, 2007
David J. Horntrop

5. *Applied Mathematical Problems in Microwave Processing of Ceramics*

Department of Energy: September 15, 2004 -- August 31, 2007
Gregory A. Kriegsmann

6. *Presynaptic Ca2+ Dynamics, Ca2+ Buffers and the Mechanisms of Facilitation*

National Science Foundation: August 1, 2004 -- July 31, 2007
Victor Matveev

7. *Efficient Shallow Water Matched Field Inversion: Extension*

Office of Naval Research: February 1, 2005 -- December 31, 2007
Zoi-Heleni Michalopoulou

8. *Conference on Frontiers in Applied and Computational Mathematics*

National Science Foundation: June 1, 2005 -- November 30, 2005
Robert M. Miura

9. *Conference on Frontiers in Applied and Computational Mathematics*

Air Force Office of Scientific Research: June 1, 2005 -- November 30, 2005
Robert M. Miura

10. *Conference on Frontiers in Applied and Computational Mathematics*

Society for Mathematical Biology: April 1, 2005 -- September 30, 2005
Robert M. Miura

11. *Uniform in Time Asymptotic and Numerical Methods for Propagation in Dielectrics Exhibiting Fractional Relaxation, and Efficient and Accurate Impedance Boundary Conditions for High-Order Time-Domain Numerical Schemes for Maxwell's Equations*

Air Force Office of Scientific Research: January 1, 2005 -- January 1, 2008
Peter G. Petropoulos

B. PROPOSED RESEARCH

PROJECTS PROPOSED DURING PRESENT FISCAL YEAR

1. *MSPA-MCS: Robust Computational Topology*

National Science Foundation: September 1, 2005 -- August 31, 2008
Denis Blackmore
Ralph Kopperman
Thomas Peters

2. *Kinetic and Hydrodynamic Aspects of Many-Component Particle Flows*

CRDF Competitive Grants: September 1, 2005 -- August 31, 2007
Denis Blackmore
Anatoliy Prykarpatsky

3. *Equipment and Modules for a Capstone Course in Applied Mathematics*

National Science Foundation: September 1, 2005 -- August 31, 2008
Daniel Goldman
Michael Booty
Bruce Bukiet
Lou Kondic
Michael Siegel

4. *Collaborative Modeling of Microcirculatory Transport*

CAREER: National Science Foundation: June 1, 2005 -- May 31, 2010
Daniel Goldman

5. *Mathematical Methods for Nonlinear Wave Interactions*

National Science Foundation: July 1, 2005 -- June 30, 2008
Roy Goodman

6. *Second Kind Integral Equations for Scattering by Open Surfaces*

National Science Foundation: July 1, 2005 -- June 30, 2008
Shidong Jiang

7. *Dynamics of Non-Newtonian Liquid Films Involving Contact Lines*

The Fulbright Foundation: September 1, 2005 -- August 31, 2006
Lou Kondic

8. *Laminar Film and Flow Boiling in Vertical Microchannels*

National Science Foundation: July 1, 2005 – June 30, 2008
Lou Kondic
Anette Hosoi (MIT)
Burt Tilley (Olin College)

9. *Developing a Thermodynamic Description of Dense Granular Flows*

National Science Foundation: July 1, 2005 -- June 30, 2008
Lou Kondic
Robert Behringer (Duke University)
Corey O'Hern (Yale University)

10. *Statistical Approach to Dense Granular Systems*

Department of Energy: July 1, 2005 – June 30, 2008
Lou Kondic
Robert Behringer (Duke University)

11. *Decay of Velocity Fluctuations in a Sedimenting Suspension*

National Science Foundation: September 1, 2005 -- August 31, 2008
Jonathan Luke

12. *Collaborative Research: Patterns, Stability, and Thermal Effects in Parametric Gain Devices*

National Science Foundation: August 1, 2005 -- July 31, 2008
Richard O. Moore
Keith Promislow

13. *Simulation of Rare Events in Optical Systems*

National Science Foundation: September 1, 2005 -- August 31, 2007
Richard O. Moore

14. *FRG: Collaborative Research: Stochastic Modeling in Applied Sciences*

    National Science Foundation: July 1, 2005 -- June 30, 2008
    Cyrill Muratov
    Weinan E
    Charles Peskin
    Weiqing Ren
    Eric Vanden Eijnden

15. *Collaborative Research: Multiscale Analysis of Epithelial Patterning: Modeling and Experiments*

    National Science Foundation and National Institutes of Health: July 1, 2005 -- June 30, 2008
    Cyrill Muratov
    Joseph Duffy
    Stanislav Shvartsman

16. *Collaborative Research: Modeling and Computational Analysis of Cell Communication in Epithelial Patterning*

    National Science Foundation: July 1, 2005 -- June 30, 2008
    Cyrill Muratov
    Stanislav Shvartsman

17. *Nonlinear Phenomena in Electrified Interfacial Flows*

    National Science Foundation: August 1, 2005 – July 31, 2008
    D.T. Papageorgiou
    J.-M. Vanden-Broeck

18. *Cortical Processing Across Multiple Spatial and Time-Scales*

    National Science Foundation: August 1, 2005 -- July 31, 2008
    Louis Tao
    David Cai
    Gregor Kovacic
    David McLaughlin
    Michael Shelley

19. *Analysis and Simulation of the Dynamics of Visual Cortical Network*

    National Science Foundation: August 1, 2005 -- July 31, 2008
    Louis Tao

20. *Mathematical Strategies for Scale-Up of Neural Systems*

    Department of Energy --- Young Investigator Award: August 1, 2005 -- July 31, 2008
    Louis Tao

21. *New Modeling Methods for Flexible Structures Immersed in Biological Fluids*

    National Science Foundation: July 1, 2005 -- June 30, 2008
    Sheldon Wang

22. *Development and Evaluation of the Reversible Jump Algorithm for Longitudinal Biomarkers*

    National Science Foundation: September 1, 2005 – August 31, 2007
    Wonsuk Yoo

23. *Internal Structure and Dynamics in the Rayleigh-Taylor Mixing Zone*

National Science Foundation: July 1, 2005 – June 30, 2008
Yuan-Nan Young

24. *Air-Sea Exchange in Breaking Ocean Waves*

Office of Naval Research: July 1, 2005 – June 30, 2008
Yuan-Nan Young

25. *Multi-Scale Mixing in Rayleigh-Taylor Turbulence*

Department of Energy: July 1, 2005 – June 30, 2006
Yuan-Nan Young

C. EXTERNALLY FUNDED PROJECTS -- NOT THROUGH CAMS

CONTINUING PROJECTS — NOT THROUGH CAMS

1. *Laboratory for Electro-Hydrodynamics*

W. M. Keck Foundation: January 1, 2000 -- December 31, 2005
N. Aubry
A. Acrivos
B. Khusid

2. *New Jersey Center for Micro-Flow Control*

NJ Commission on Science and Technology: December 1, 2000 – November 30, 2005
N. Aubry
E. Geskin
Y. Kevrekidis (Princeton University)
B. Khusid
P. Singh
S. Sundaresan (Princeton University)

3. *Corrugated Steel Culvert Pipe Deterioration*

US Department of Transportation/New Jersey Department of Transportation:
January 1, 2003 -- December 31, 2005
J. Meegoda
T. Juliano

4. *US-France Cooperative Research (INRIA): Approximate Boundary Conditions for Computational Wave Problems*

National Science Foundation-Office of International Science and Engineering:
August 1, 2003 -- July 31, 2006
Peter G. Petropoulos
Jan Hesthaven (Brown University)
Patrick Joly (INRIA-Rocquencourt)
Eliane Becache (INRIA-Rocquencourt)
Houssem Haddar (INRIA-Rocquencourt)

5. *Three-Dimensional Gravity Free Surface Flows*

EPSRC (Engineering and Physical Sciences Research Council in the UK)
October 1, 2003 -- September 30, 2006
Jean-Marc Vanden-Broeck

6. *Mathematical Problems in Nonlinear Interfacial Electrohydrodynamics*

Engineering and Physical Sciences Research Council of U.K.: June 1, 2004 -- May 31, 2006
J.-M. Vanden-Broeck
D.T. Papageorgiou

NEW FUNDING – NOT THROUGH CAMS

1. *On-Line Electrohydrodynamic Filter (OLEF)*

Office of Naval Research (ONR), Subcontract from Impact Technologies:
March 1, 2005 -- August 1, 2006
N. Aubry
P. Singh

2. *Services Agreement -- US BMA Biometrics PHV4c Support*

Novartis Pharmaceuticals Corporation, East Hanover, NJ:
September 1, 2004 -- August 15, 2005
Sunil Dhar

3. *Salt Runoff Collection System*

US Department of Transportation/New Jersey Department of Transportation:
January 1, 2005 -- December 31, 2006
J. Meegoda
B. Dresnack
E. Filippone
G. Golub
T. Harhab
W. Konon

4. *Management of Environmental Problems in Egypt*

National Science Foundation: September 1, 2004 -- August 31, 2007
J. Meegoda
Abdel-Malek
El Haggar
Ezeldin
Hsieh

5. *Sustainable Biocell Technology for Energy and Resource Recovery*

Natural Science and Engineering Research Council of Canada:
November 1, 2004 -- October 30, 2007
J. N. Meegoda
G. Achari
P. Hettiaratchi
A. Mehrotra
M. Warith
J. Wilson

6. *Evaluation of Opportunities to Improve Structural Integrity Monitoring (SIM) Capabilities for Water Mains through Federal Research and Technology Transfer*

US Environmental Protection Agency: December 1, 2004 -- October 30, 2005
J. N. Meegoda
A. Emin Aktan
R. Finlayson
T. Juliano
R. Raghavan

7. *Nonlinear Electrohydrodynamics*

EPSRC (Engineering and Physical Sciences Research Council in the UK):
October 1, 2004 -- September 30, 2006
J.-M. Vanden-Broeck

D. PROPOSED PROJECTS – NOT THROUGH CAMS

1. *Protective Jackets for Multi-Hazard Mitigation Measures (ProJack-M): Proof of Concept*

Multidisciplinary Center for Earthquake Engineering Research:
October 1, 2005 -- September 31, 2006
Bruce Bukiet

2. *Structural Integration for Veterans with Medically Unexplained Symptoms*

Samueli Institute for Information Biology: July 1, 2005 – June 30, 2008
Bruce Bukiet
Hans Chaudhry
Tom Findley
Richards Foulds
Zhiming Ji
Dr. Jyung
Miriam Maney
Karen Quigley
Dr. Yang

3. *Neuropsychological Tests, Balance, and Disability in Deployed Veterans*

   VA Rehabilitation Research Service: July 1, 2005 – June 30, 2008
   Bruce Bukiet
   Hans Chaudhry
   Tom Findley
   Richards Foulds
   Zhiming Ji
   Dr. Jyung
   Miriam Maney
   Karen Quigley
   Dr. Yang

4. *Mathematical Predictions in Biomechanics and Biomedical Engineering*

   National Science Foundation: July 1, 2005 -- June 30, 2008
   Dawn A. Lott

5. *The Development of an Interdisciplinary Ph.D. Program in Computational Biology and Applied Mathematics at an HBCU*

   Howard Hughes Medical Institute: September 1, 2006 -- June 30, 2009
   Dawn A. Lott
   Sabrina Brougher (Delaware State University)
   Melissa Harrington (Delaware State University)
   Fengshan Liu (Delaware State University)
   Dragoljub Pokrajac (Delaware State University)

6. *Elucidation of the Mechanisms of Allosteric Regulation of Soluble Guanylyl Cyclase*

   American Heart Association (AHA) Scientist Development Grant:
   January 1, 2005 -- December 31, 2007
   Marc Q. Ma

7. *Interdisciplinary Graduate Training Program in Quantitative Neurosciences*

   Howard Hughes Medical Institute: January 1, 2006 -- December 31, 2008
   Robert M. Miura
   Joshua Berlin (NJMS - UMDNJ)
   James Tepper (RU - Newark)

VIII. COMMITTEE REPORTS AND ANNUAL LABORATORY REPORT

A. READING ROOM

The CAMS Reading Room has continued to function as a location for informal gathering of faculty and graduate students. Due to increased interest, this year the schedule of weekly teas has been extended to four days a week. In addition, the weekly tea is now completely organized by graduate students, who also in this way contribute more and more to the department activities. The most active days are Fridays, when faculty and students have a chance to interact more closely with the DMS and CAMS Colloquium speaker, in addition to other days when attractive and interesting seminars in mathematical biology, fluid dynamics, statistics and wave propagation take place.

B. SEMINAR COMMITTEE REPORT

CAMS sponsored a very active Applied Mathematics Colloquium Series in 2004-2005. The weekly series, which began modestly in 1986, has grown into a prestigious forum for internationally-known applied mathematicians, physicists and engineers to lecture on current developments in science and engineering.

This year CAMS hosted a diverse group of speakers from industry and academia. The list of speakers, given in Section IV, includes two members of the National Academy of Sciences, as well as visitors from Brown, Columbia, Cornell, Princeton, Chicago, Courant, RPI, Northwestern, Arizona, Michigan, Texas, Maryland, and ExxonMobil. The series also has developed a genuine international spirit, with visitors coming from as far away as Switzerland, Hong Kong, Vancouver, and Norway.

The audience at the colloquia has also grown in numbers in recent years, and is a testament to CAMS' commitment to foster cooperation and collaboration within the local scientific community. In addition to faculty and grad students in the Department of Mathematical Sciences, the lectures routinely attract members of other departments at NJIT as well as several area universities. This year, CAMS co-sponsored speakers with the Department of Mechanical Engineering, the College of Computing Science and the Department of Mathematics at Rutgers-Newark.

In addition to the weekly applied math colloquia, CAMS now hosts seminar series in fluid mechanics, mathematical biology, waves, and statistics. On virtually any day, one can attend a CAMS-sponsored activity. Indeed, the CAMS colloquia and seminar series has firmly established itself as a vibrant hub of intellectual activity at NJIT!

C. MAJOR RESEARCH INSTRUMENTATION COMPUTER CLUSTER

The Department of Mathematical Sciences (DMS) and Center for Applied Mathematics and Statistics (CAMS) at the New Jersey Institute of Technology, under the auspices of the MRI program at NSF, have acquired a 64-node Beowulf-class computer cluster for research in the mathematical sciences. Each compute-node of the cluster is composed of two 2.0 GHz, 64-bit processors (AMD Opteron CPU); the cluster includes a total of 256 GB of memory, mass storage devices, scientific software, and hardware for a high speed Myrinet network. The machine is dedicated to the support of research by faculty and graduate students in CAMS and DMS, and is used for projects which involve mathematical modeling and the development of computational techniques to study fundamental processes in physical science and biology. Examples of these projects include: the development of efficient molecular dynamics methods with applications to fluid flow in nano-devices and drug molecule/protein target interactions; simulations of large interacting systems of neurons in the visual cortex; investigations of granular systems; studies of mesoscopic models for surface processes in biology; simulations of surface evolution in crystalline materials; and improved numerical methods for studying aspects of electromagnetic wave propagation.

The research activities are primarily involved with the mathematical modeling of important processes in science and technology and hence are of benefit to scientists and engineers in a wide variety of disciplines. For example, the research on molecular dynamics methods is used to obtain insights in the interactions between drug molecules and their protein targets, numerical simulations of interacting neurons in the visual cortex can lead to an improved understanding of high-level visual processing events, such as ``edge-detection,'' and studies of surface evolution in crystalline materials aid in the design of novel microelectronic devices. In addition, the described research promotes interdisciplinary collaborations between applied mathematicians and scientists in diverse areas. The computational resources available for CAMS fluid dynamics scientists are substantial. The cluster will be used to obtain numerical solutions to continuum models of fluid dynamic phenomena, molecular dynamics simulations, the study of flows in granular media, and many other complex fluid flow problems. Graduate students and postdocs involved in the research receive training in state-of-the-art numerical techniques.

D. STATISTICAL CONSULTING LABORATORY REPORT

The Mathematical Sciences faculty serves the NJIT community and outside individuals and organizations as statistical consultants. Here are some examples of such consulting activities.

Date: Fall 2004 Client: Mercer County
Description: Designed an experiment for collecting electronic voting data and assessed the reliability of electronic voting machines.
Consultant: Professor Aridaman K. Jain

Date: Spring 2005 Client: Old Bridge Township Public Schools
Description: Analyzed the high school students' data and presented the results to the officials of the Old Bridge Township schools.
Consultants: Jon Porus (M.S. student) and Professor Aridaman K. Jain

Date: Spring 2005 Client: Martin J. Moskovitz, M. D.
Description: Conducted a statistical analysis of the medical data from a study on the effectiveness of Liposuction surgery for breast hypertrophy.
Consultant: Professor Aridaman K. Jain

Date: Spring 2005 Client: Mark A. Grant, M. D., of Newark Beth Israel Medical Center
Description: Consulted on survival analysis of a pacemaker wire (Telectronics Accufix) for assessing the risk to patients.
Consultant: Professor Wonsuk Yoo

Date: Spring 2005 Client: Manalapan-Englishtown Regional Schools
Description: Started the process of extracting the students' data for subsequent analysis and presentation of the results to the officials of the Manalapan-Englishtown Regional schools.
Consultants: Xun Yang (M.S. student) and Professor Aridaman K. Jain

IX. CURRENT AND COLLABORATIVE RESEARCH

A. RESEARCH AREAS IN CAMS

Mathematical Biology

Researchers in CAMS working on problems related to Mathematical Biology:
Booth, Bose, Bukiet, Dhar, Elmer, Georgieva, Goldman, Golowasch, Khan, Lott, Nadim, Matveev, Miura, Muratov, Perez, Raymond, Tao, Wang, Yoo.

Mathematical Biology broadly refers to the branch of mathematics that is devoted to the study of biological processes. Historically, applications have arisen in a number of disparate areas such as population ecology, pattern formation, blood flow in mammals, and nerve impulse propagation in the central nervous system. More recently, there has been quite a bit of emphasis on the intersection of mathematics with developmental biology, neurophysiology, and especially genomics. Moreover, mathematicians are applying their modeling and analytical skills to the study of various diseases, such as diabetes, Parkinson's disease, multiple sclerosis, Alzheimer's disease, and HIV-AIDS. The kinds of mathematics needed to describe and address problems in these areas of Mathematical Biology are quite vast and include dynamical systems, partial differential equations, fluid dynamics, mechanics, and statistics, to name only a few. Researchers in Mathematical Biology at NJIT have strong interdisciplinary research programs since most of them have active collaborations with experimentalists. This group of Mathematical Biologists is the largest in a department of mathematics in North America.

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 (STNS). The main focus of Nadim's research is to understand how synaptic dynamics, such as short-term depression and facilitation contribute to the generation and control of oscillatory neuronal activity. Experiments in Nadim's lab involve characterizing the synaptic dynamics in the STNS and studying the contributions of these dynamics, through mathematical modeling, to the output from the biological network. Using both electrophysiological and computational tools, Golowasch studies mechanisms of neuronal plasticity and homeostasis of the ionic currents that determine the excitability and electrical activity of neurons and simple neural networks in the STNS. Currently, he also is screening several neuropeptides for their possible involvement in trophic regulation of dissociated adult neurons in culture and in long term organotypical culture. These neuropeptides are known to have short-term neuromodulatory effects.

Various aspects of Computational and Mathematical neuroscience are being studied by Victor Matveev, Louis Tao, Amitabha Bose, and Robert Miura. Matveev studies mechanisms responsible for short-term synaptic plasticity. He is particularly interested in understanding the role of residual calcium in synaptic facilitation. Tao is interested primarily in the modeling and analysis of the dynamics of neuronal networks, with application to visual cortex and other large-scale cortical networks. He focuses on developing analytical techniques to study networks in simplified settings and on identifying possible biological functions of emergent network dynamics. Bose is interested in developing mathematical techniques to understand the role of short-term synaptic plasticity in producing multi-stable periodic solutions within neuronal networks. He is also interested in developing models for persistent localized activity in excitatory networks. Miura has worked extensively on modeling and analysis of models for electrical activity in excitable cells, including neurons and pancreatic beta-cells. He is currently working on mathematical models for spreading depression, a slowly propagating chemical wave in the cortex of various brain structures, which has been implicated in migraine with aura. Also, he is working on developing a theory for the formation of glass microelectrodes, which are used daily in electrophysiology laboratories around the world.

In the area of Developmental Biology, Cyrill Muratov is interested in developing models that describe the patterning events leading to the formation of dorsal appendages during Drosophila egg development. He studies a system of coupled reaction-diffusion equations driven by a localized input and characterizes the oocyte phenotype by the number of peaks in the signaling pattern. Dan Goldman and Sheldon Wang use techniques of fluid dynamics to study various biological phenomenon. The research of Dan Goldman is centered on developing a flexible, efficient and highly realistic computational model for simulating microvascular blood flow and oxygen delivery. His model has been used to study both steady-state and time-dependent oxygen delivery, which is of primary interest for understanding physiological functioning. Current studies use this model to understand blood flow and oxygen transport during sepsis and at the onset of exercise. Sheldon Wang is developing new immersed boundary/continuum methods which will provide a platform for effective modeling of highly deformable shells/beams and solids immersed in biological fluids. These methods will facilitate further research in multi-scale and multi-physics coupling of complex fluid-solid systems with microscopic models. Chris Raymond is interested in mathematical modeling for immunocolloid labeling. In this process, colloidal metal particles are conjugated to ligand molecules which bind to the molecule of interest, commonly a receptor molecule on a cell surface. With experimental and mathematical collaborators, he is developing mathematical models for the immunocolloid labeling process with the goal of optimizing the choice of experimentally adjustable parameters to maximize labeling efficiency.

Fluid Dynamics

Researchers in CAMS working on problems related to Fluid Dynamics:
Aubry, Bechtold, Booty, Bukiet, Goldman, Jiang, Kondic, Luke, Papageorgiou, Petropoulos, Siegel, Vanden-Broeck, Wang, Young.

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

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

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

The fluid dynamics group in the Department of Mathematical Sciences at NJIT has an active research program covering interfacial fluid dynamics, thin films, nanofluidics, electrohydrodynamics, hydrodynamic stability theory, sedimentation, and combustion. A particular focus for six 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.

Wave Propagation

Researchers in CAMS working on problems related to Wave Propagation:
Booty, Elmer, Goodman, Jiang, Kriegsmann, Michalopoulou, Miura, Moore, Petropoulos, Wang.

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.

For obvious reasons, water waves have been studied the longest, and are still regarded as the point of reference for wave phenomena in other fields. George Stokes' notoriously intractable equations describing the motion of water waves were rendered far more accessible by the various small-amplitude limits considered by Joseph Boussinesq, D. J. Korteweg, and Gustav de Vries. Their explorations laid the groundwork for a discovery that would prove to have far-reaching consequences in several fields: the soliton, a solitary wave with special self-preserving properties. This exotic ``soliton'' propagates as a solitary wave without spreading due to the competing influences beween nonlinearity and dispersion, but preserves its shape and speed through collisions with other solitons. Even more important than the solitons themselves is the structure that makes their existence possible. Their study and the study of equations that support them now fall generally under the heading of ``integrable systems'', and have given rise to such mathematical tools as the inverse scattering transform.

One field that has been affected very profoundly by the relatively new science of nonlinear waves is optical communications. Pulse-like waveforms that maintain their shape for long times and over great distances are of obvious interest to an industry seeking to ensure error-free transmission of digital information. Every environment is subject to some form of noise, whether it be thermal noise, electronic noise, or quantum noise, so these pulses must also be tested for their resistance to external influences. Richard Moore is currently using perturbation theory and statistical techniques to develop efficient ways to characterize the effect of perturbations on solitons used for optical communications. The same nonlinear and dispersive properties that give rise to solitons can be manipulated to condition light for use in novel devices that will ultimately replace the electronics upon which telecommunications and computing still depend. Dr. Roy Goodman uses Hamiltonian mechanics and asymptotic methods to explore how light can be slowed, delayed, or ``trapped'' by engineering defects in nonlinear periodic structures.

The simple cylindrical geometry of an optical fiber lends itself to analytical treatment of the electromagnetic wave propagating inside of it; however, the vast majority of electromagnetic scattering problems have far more complexity due to complicated geometries and inhomogeneous material properties with disparate spatial scales. The treatment of transient electromagnetic signals such as those arising in signal analysis, spectroscopic applications, and the nondestructive testing of structures requires sophisticated numerical techniques that are stable, fast, and accurate, and that have reasonable memory requirements. Peter Petropoulos is conducting research on a variety of approaches that address these restrictions, including high-order finite difference schemes, boundary integral methods, and perfectly matched layers. Shidong Jiang investigates nonreflecting boundary conditions and scattering problems for acoustic and electromagnetic waves by open surfaces. He employs fast algorithms, including the fast multipole method, iterative solvers, and integral equation formulation of boundary value problems for such problems and for related large-scale problems in physics and engineering.

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, through the analysis of information gathered by receivers placed strategically or at random within the same medium, is of obvious use in national defense, in environmental studies, in seismology, etc. Zoi-Heleni Michalopoulou has developed a localization-deconvolution approach based on Gibbs sampling that explores the space of allowable configurations with improved speed and accuracy over conventional approaches.

Finally, the propagation of waves through materials is often influenced by parameters that depend on the waves in a way that requires fundamentally different physics. The microwave heating of ceramics or the passage of optical fields through photorefractive crystals, for instance, couples hyperbolic equations to parabolic equations governing the evolution of thermal profiles and chemical species. In optics, this can lead to the generation of self-guided optical beams and, given the difference in time scales dominating the hyperbolic and parabolic behaviors, bistability. In the case of microwave heating of ceramics, it can lead to the formation of weak spots that compromise the quality of the material. Gregory Kriegsmann and Richard Moore are investigation asymptotic and numerical methods to treat such coupled hyperbolic-parabolic systems.

Dynamical Systems

Researchers in CAMS working on problems related to Dynamical Systems:
Aubry, Blackmore, Bose, Elmer, Goldman, Golowasch, Jiang, Kappraff, Kriegsmann, Matveev, Miura, Moore, Nadim, Papageorgiou, Siegel, Tao, Tavantzis, Wang, Young.

Today's research in the theory and applications of dynamical systems all have their roots in the work of early innovators in differential equations and mathematical modeling, such as Newton, the Bernoullis, Euler, Lagrange, Laplace, Legendre, Gauss, Cauchy, Abel, Fourier, Liouville, Weierstrass, Dirichlet, Hamilton, and Riemann. But we have come a long way since the middle of the nineteenth century in terms of our understanding and the variety of applications of both finite-dimensional dynamical systems (ordinary differential equations) and infinite-dimensional dynamical systems (partial differential equations).

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

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

Dynamical systems research in CAMS has a decidedly applied focus, and is extremely active in a wide and diverse range of areas including mathematical biology, fluid dynamics, wave propagation, computational topology, nonlinear optics, and quantum field theory and its applications to such things as quantum computing. There are a significant number of researchers who employ techniques from nonlinear dynamics in their work, and a smaller but sizeable core group whose interests are centered around dynamical systems and their applications. One of the most appealing aspects of research in dynamical systems is the wealth of opportunities it provides for interdisciplinary studies, and our dynamical systems group is one of the most active in such efforts.

CAMS research in dynamical systems can be described briefly as follows: Nadine Aubry uses methods from dynamical systems to characterize fluid flows and how they can be controlled by a variety of mechanisms such as the placement of vortex configurations. Denis Blackmore applies nonlinear dynamics to study the motion of vortices and vortex filaments in fluids and particles in granular flows, the chaotic evolution of biological populations, the computational topological nature of certain geometric objects, and quantum computing. He also does fundamental research in bifurcation theory, chaos theory, and algebraic and differential integrability analysis of infinite-dimensional Hamiltonian dynamical systems. Amithaba Bose employs dynamical systems techniques in his studies of coupled neuronal oscillators; in particular, he uses geometric singular perturbation theory to effect reductions in dimension of high dimensional systems, so that they can be more readily analyzed using such techniques as Poincare maps. Recently, he has studied the global effects of localized neuronal activity with regard to phase relationships and multi-stability. Christopher Elmer's research focus is on both finite- and infinite-dimensional time dependent differential equations that are discrete in space. He employs both analytical and computational methods to analyze the regular and singular behavior of these systems, and to interpret his findings with regard to several physical applications of these types of systems. Daniel Goldman uses a variety of techniques from dynamical systems theory to study dynamical systems arising from the modeling of fluid mechanical phenomena related to biological applications. Jorge Golowasch employs approaches from nonlinear dynamics to investigate the cellular mechanism of activity-dependent regulation of ionic currents, neuronal excitability, and neural network activity. Dynamical systems methods applied to nonlinear waves and optics is the focus of Roy Goodman's research. A key ingredient in his work is the development of methods for obtaining insights from finite-dimensional reductions of infinite-dimensional systems such as the nonlinear Schrodinger equation.

Shidong Jiang applies methods from nonlinear dynamics in his research on mathematical fluid dynamics, and wave propagation. Jay Kappraff has used dynamical systems techniques to uncover interesting relationships among regular geometric figures, matrix groups, chaotic regimes, and fractal geometry. Lou Kondic employs a variety of dynamical systems approaches in his research on interfacial fluid dynamics, and granular flows. Gregory Kriegsmann's research in applied mathematics has involved the application of bifurcation theory and differential equation techniques in several problems related to wave propagation and electromagnetics. Victor Matveev's work in computational neuroscience, stochastic process theory, and statistical mechanics has employed several methods from nonlinear dynamics. In his research on the kinetic theory of gases, mathematical biology, interfacial surface tension, and direction reversal in Brownian motion, Robert Miura has employed a variety of techniques from dynamical systems theory. For example, some of his recent work in mathematical biology has made use of the theory of Hopf bifurcations and saddle-node bifurcations.

Richard Moore studies nonlinear wave equations with both deterministic and stochastic perturbations with the aid of a variety of techniques from dynamical systems theory. Cyrill Muratov studies, among other things, traveling wave solutions and propagation phenomena in gradient reaction-diffusion systems using both variational and dynamical systems methods. He also studies several other types of infinite-dimensional dynamical systems arising from such areas as mathematical biology and fluid dynamics. Farzan Nadim makes liberal use of techniques from nonlinear dynamics in his research in computational and analytical neuroscience. Demetrius Papageorgiou employs ideas from infinite-dimensional dynamical systems theory, such as inertial manifolds and chaotic dynamics, in his research in fluid dynamics. Nonlinear dynamical techniques related to vortex dynamics play a key role in some of Michael Siegel's research in fluid dynamics. Louis Tao employs methods from dynamical systems theory in his work in neuroscience and mathematical biology. John Tavantzis has been investigating relationships between biologically generated time series and dynamical systems models for the associated phenomena, and also methods for capturing periodic orbits. Sheldon Wang has made several contributions to the literature in applications of dynamical systems, and is currently working on the development of methods for capturing periodic orbits of finite-dimensional dynamical systems. Yuan-Nan Young uses a variety of nonlinear dynamics approaches in his research in fluid dynamics and complex systems.

Numerical Methods

Researchers in CAMS working on problems related to Numerical Methods:
Bhattacharjee, Bukiet, Elmer, Goldman, Goodman, Horntrop, Jiang, Kondic, Luke, Ma, Matveev, Michalopoulou, Moore, Muratov, Papageorgiou, Petropoulos, Rosato, Siegel, Tao, Wang, Yoo, Young.

Given the rapid development of the power of computers 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 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 immersed boundary method is being developed and refined in order to improve computational 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. Monte Carlo simulation is used to study molecular biology and bioinformatics. Stochastic models of sedimentation are being developed and refined through a combination of analysis and simulation. Markov Chain Monte Carlo methods are used in studies in statistics and biostatistics. Simulations taking advantage of variance reduction techniques are being used to study the effects of stochastic perturbations on solitons. New computational techniques for stochastic partial differential equations based upon spectral methods are being developed and applied to multiscale models of surface processes.

Statistics

Researchers in CAMS working on problems related to Statistics:
Bhattacharjee, Dhar, Dios, Khan, Jain, Yoo.

Applied Probability and Statistics, as a discipline, is concerned with the study and analysis of processes in which uncertainty plays a significant role. In today's data driven environment in which we live, the need for and utility of uncertainty modeling and statistical analysis is assuming increasing importance in virtually every field of human interest, e.g., 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, to name a few.

While the field of Applied Probability and Statistics is driven by the need to solve applied problems, its progress and development comes from basic research and from their application 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 problems which had to be solved by developing new methods (e.g., survival analysis and clinical trials). Conversely, new theoretical ideas and methods which were developed in a specific applied context were later seen to be of much broader applicability to other areas (e.g., nonparametric aging ideas which owe their origins to research in stochastic modeling of hardware reliability of physical systems were later seen as useful constructs in many other areas such as in the studies of queuing systems, stochastic scheduling, branching processes as well as in modeling economic inequality).

The Statistical Consulting Laboratory (SCL), which operates under the umbrella of CAMS, provides methodological/data analysis consulting services to the University community on request, as well as to external clients. Consulting activities channeled through the SCL, are under the overall administrative supervision of a statistics faculty member (currently, A. Jain). Examples of recent consulting projects, in which graduate students were involved to gain valuable hands-on experience, include (i) analysis of demographic and student performance data from public schools to identify student and teacher characteristics that are helpful in predicting student performance, and (ii) survey design to assess the reliability of electronic voting machines.

The current research interests of the Statistics faculty are in the following broad and overlapping areas: distribution theory and statistical inference (Bhattacharjee, Dhar, Khan), minimum distance estimation (Dhar), Bayesian modeling (Bhattacharjee) and Bayesian inference (Yoo, Khan), DNA microarray analysis (Khan), orthogonal arrays in experimental designs (Dios), applied probability models (Bhattacharjee, Dhar), statistical theory of reliability and survival analysis (Bhattacharjee), stochastic orders and their applications (Bhattacharjee), discrete multivariate distribution/reliability statistical issues in clinical trials (Dhar), Markov Chain Monte Carlo methods (Yoo), and non-traditional applications of reliability theory (Bhattacharjee).

B. RESEARCH DESCRIPTIONS

Daljit S. Ahluwalia

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

Roman Andrushkiw

The research of Roman Andrushkiw has focused on the spectral theory of operator-valued functions and the analysis of free boundary problems, with application to numerical modeling in the area of cryosurgery and medical diagnostics. His study of operator-valued functions deals with spectral theory and approximation methods for eigenvalue problems that depend nonlinearly on the spectral parameter. His study of Stefan-type free boundary problems is concerned with modeling of heat transfer phenomena in the freezing of living tissue, involved in cryosurgery. His current projects include the development of a variational method for approximating the eigenvalues of polynomial differential operator pencils, and the study of a pattern recognition algorithm in medical diagnostics related to breast cancer.

Nadine Aubry

Nadine Aubry's research involves the development of novel, enabling technologies leading to new classes of products through radical flow performance gains via miniaturized actuation. Such gains will result in manipulation of micro- and nano-size objects in suspensions, mixing enhancement, suppression/enhancement of turbulence, suppression of flow-generated noise and vibrations, and thermal management. She is working on the development of computational fluid dynamics software for complex flows, miniaturized flows and flows subjected to actuators, the development of flow control software, the development of miniaturized sensors and actuators with required characteristics, the development of integrated MFC devices, and the development of validation techniques for the latter. She is the Director of the New Jersey Center for Micro-Flow Control and is in close collaboration with the following labs: W.M. Keck Laboratory, Electro-hydrodynamics, and Computational Fluid Dynamics.

John Bechtold

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

Manish C. Bhattacharjee

Research of Manish Bhattacharjee has focused on applying reliability theoretic ideas to the modeling and study of non-negative variables and processes in time to better understand the probabilistic structure of particular distributions of interest in various application settings. Additionally, his research interest and work includes stochastic orders to investigate aging and degradation concepts. Current research includes work on some natural strengthenings of the 'decreasing failure rate' (DFR) property via 'completely monotone functions' and stochastic comparisons of branching processes.

Denis Blackmore

Dynamical systems (nonlinear dynamics) theory is a rich amalgam of techniques from algebra, analysis, chaos theory, differential equations, differential geometry, differential topology, fractals, geometry, singularity theory, and topology, and has important applications in every branch of science and engineering. Denis Blackmore's research is primarily in the theory and applications of dynamical systems and closely related fields. He has studied a plethora of applications in such areas as acoustics, automated assembly, biological populations, computer aided geometric design, fluid mechanics, granular flows, plant growth (phyllotaxis), relativistic and quantum physics, and rough surface analysis. His theoretical work includes fundamental results on solution properties and integrability of differential equations, and analysis of hypersurface singularities. Among his current projects are acoustically generated particle flows, biocomplexity of marshes, competing species dynamics, dynamical models in economics, integrability of infinite-dimensional dynamical systems (PDEs), particle dynamics, phyllotaxis, virtual reality systems, vortex dynamics, and weak shock waves.

Victoria Booth

The research of Victoria Booth is in the area of computational neuroscience focusing on mathematical and biophysical modeling of the electrical firing behavior of neurons and neuronal networks. Her studies in single cell modeling involve the development of models from experimental data, mathematical analysis of cell properties and mechanisms that generate experimentally observed firing patterns, and investigation of pharmacological modulation of cell behaviors. An additional area of her research is in the implementation of optimization schemes for parameter determination in neuronal models. Her network modeling studies involve the development of small scale networks to mathematically analyze the role of cell properties and the synaptic connections among cells in generating observed network behavior. Her current projects include the development of network models of region CA3 in the hippocampus to study the firing patterns of place cells, and modeling the pyloric network in the crab stomatogastric ganglion to investigate properties of its observed rhythmic firing patterns.

Michael Booty

Michael Booty's principal research interests are in mathematical modeling and asymptotic analysis, and most of the applications he has considered are in the area of fluid mechanics and combustion. His main studies in combustion have focused on the time-dependent and multidimensional dynamics of propagating reaction waves in gas mixtures, solid phase mixtures, and porous media, analyzed by a combination of multiple scale, stability, and bifurcation techniques. His other studies have included prototype reaction-diffusion models, the dynamics of fast reaction waves, and time-dependent effects in droplet burning. He has also collaborated (with members of the Department of Chemistry and Environmental Science at NJIT) on experimental studies for conditions that minimize pollutant formation in the thermal oxidation of common materials.

His current research interests include: time-dependent effects in droplet burning, collaborative studies on bubbles with surfactant (with Michael Siegel), localized thermal waves in microwave heating and processing of materials (with Gregory A. Kriegsmann), and studies of the interaction of flexible membranes, or sails, in two-dimensional potential flow (with Jean-Marc Vanden-Broeck, of the University of East Anglia).

Amitabha Bose

The research of Amitabha Bose focuses on the applications of dynamical systems to mathematical neurophysiology. His studies in neurophysiology include modeling sleep rhythms in the thalamocortical system, phase precession of hippocampal place cells, and the development of rigorous mathematical techniques to analyze such problems. His current projects include modeling phase maintenance in the pyloric network of crustaceans, persistent activity in cortical circuits and rhythmogenesis in frog ventilatory systems.

Bruce Bukiet

Bruce Bukiet's research concerns mathematical modeling of physical phenomena. He has studied the dynamics of detonation waves, including curved detonations and detonation models of discrete mixtures. He currently uses his expertise in this area to study issues related to homeland security. Prof. Bukiet also researches biological systems and has done work modeling stresses in the heart, blood flow in arteries, and air flow in the lungs, and currently works in the area of postural stability. The goal of this work is in diagnosis of balance problems and evaluation of treatment options. Finally, he works on understanding and optimizing aspects of baseball from a mathematical modeling perspective.

Cameron Connell

Cameron Connell's current interests are in applications of mathematics to materials science. The focus of his work is on the interface between atomistic and continuum methods for modelling materials. This is driven by its fundamental role in the current drive for multiscale modelling of materials. He is particularly interested in applications to the modelling of epitaxial growth of semiconductors and metals.

Fadi P. Deek

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

Sunil K. Dhar

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

Rose Dios

The research of Rose Dios has focused upon statistical design of experiments with particular emphasis on the study of the existence of balanced fractional factorial designs arising from orthogonal and balanced arrays. She also has applied statistical modelling techniques to research problems in remote sensing, environmental engineering, and clinical medicine, including cardiac risk analysis and recurrence of cancer.

Christopher E. Elmer

The research of Christopher E. Elmer has focused on developing analytical and numerical solution methods for functional differential equations of mixed type and their application to phase transitions in solids. His studies of spatially discrete reaction-diffusion equations include functional analysis and iterative numerical techniques to demonstrate the solution properties of propagation failure, lattice anisotropy, and step-like interfaces. His studies of solution techniques for general differential-difference equations has led to his development of a relaxation variant of Newton's method and the creation of a collocation code. His current projects include developing a public domain collocation code for solving differential-difference equations, analyzing error due to applying differencing methods to reaction-diffusion equations, analyzing multiple interface solutions to spatially discrete reaction-diffusion equations, analyzing the solutions of the spatially discrete sine-Gordon equation, developing an orthogonal spline collocation tool for studying diffusion induced grain boundary motion in thin films, and modeling crystalline material growth with energy equations which contain a spatially discrete gradient.

Anna Georgieva

Anna Georgieva's work in the Modeling and Simulation Department at Novartis Pharmaceuticals involves use of mathematical modeling and statistical approaches to aid drug development. More precisely, she has concentrated on the use of network inference algorithms to recover gene regulatory networks and pathway fragments from high throughput genomics data. At the same time, she is developing mechanistic models to assess the pro-arrythmic potential of various therapeutic agents prior to entry into the clinic. Another current project involves the use of quantitative proteomics data to develop detailed mathematical models of signalling pathways and use these models to come up with optimal combination therapy for cancer patients.

Vladislav V. Goldberg

The research of Vladislav V. Goldberg is in the field of differential geometry: projective differential geometry, conformal differential geometry, and the theory of webs. In the first field, he studies submanifolds with degenerate Gauss maps in a multidimensional projective space; in the second one, he studies the theory of lightlike submanifolds; and in the third one, his studies concern the local theory of webs and the algebraic aspects of this theory. His current projects include an investigation of the structure of varieties with degenerate Gauss maps and their singularities, finding conditions of linearizability of d-webs on a two-dimensional differentiable manifold, and writing the book Differential Geometry of Varieties with Degenerate Gauss Maps for Springer-Verlag.

Daniel Goldman

The research of Daniel Goldman has focused on the analysis and simulation of nonlinear partial differential equations, the development of numerical methods for PDEs, and the modeling of complex physiological processes. His work on the Ginzburg-Landau equation has involved the characterization of chaotic behavior in one and two spatial dimensions using tools from both turbulence and dynamical systems. His work in numerical analysis has covered operator splitting schemes for dissipative systems and efficient methods for solving reaction-convection-diffusion problems in complex geometries. His work in theoretical and computational biology has studied affinity maturation in the immune system and the relationship between capillary network structure and tissue oxygen delivery. His current projects include improvement of numerical methods for studying time-dependent microvascular transport, investigation of the factors that determine the hemodynamic properties of capillary networks, and modeling of various pathophysiological processes that occur in the microcirculation.

Jorge Golowasch

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

Roy Goodman

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

David J. Horntrop

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

Shidong Jiang

The research of Shidong Jiang has mainly focused on fast numerical algorithms for PDEs and their applications to large scale problems in physics, chemistry and engineering. He has developed a fast and accurate numerical algorithm for the nonreflecting boundary conditions for the Schrodinger equation. He also developed a stable second integral equation formulation for scattering by open surfaces in two dimensions. When the SKIE formulation is combined with a Fast Multipole Method and iterative solver, a fast and stable numerical algorithm has been developed for large scale open surface problems arising in biology and antenna and radar design. Recently, he has derived analytical solutions for the hyperpolarizabilities for the one dimensional infinite single electron periodic systems which showed that the overall symmetry in nonlinear optics is actually broken.

Lou Kondic

The research of Lou Kondic has concentrated on modeling and numerical simulations of two groups of physical systems: a) two fluid flows with emphasis on the interfacial dynamics, as well as free surface flows, and b) dynamics of granular systems. His studies of supersonic dynamics of gas bubbles in liquids exposed to acoustic radiation involved analytical and computational modeling of the convective and radiative energy transfer between fluids, and were applied predominantly to the effect of single bubble sonoluminescence. His research in the field of granular materials consisted of developing analytical models, as well as molecular dynamics simulations of 2D and 3D granular systems, with emphasis on the collective effects. His work on the dynamics of thin liquid films involved performing large-scale computational simulations with the goal of understanding contact line instabilities and resulting pattern formation. Currently, he is involved in modeling and simulations of granular materials in a microgravity environment, and in the development of numerical methods for highly nonlinear partial differential equations related to the flows of thin liquid films.

Gregory A. Kriegsmann

The research of Gregory A. Kriegsmann has focused on the modeling, analysis, and numerical simulations of physical problems arising in industrial and technological settings. His studies in microwave heating of materials describe the nonlinear interaction between electromagnetic waves and materials, and the effect of cavity geometry. His research on acoustic and electromagnetic scattering theory includes applications to radar, structural acoustics, and acoustics in flows. His studies in circuit theory cover the design and analysis of oscillators and power supplies. His current work is focused on microwave assisted chemical vapor infiltration, thermal patterns in microwave heating experiments, and microwave assisted ceramic sintering.

Dawn A. Lott

The research of Dawn A. Lott focuses on the numerical computation of partial differential equations which model physical phenomena in solid and fluid mechanics and biomechanics. Her studies in solid mechanics cover the topics of strain, thermo-viscoplastic, and strain gradient localization, and antiplane motions of nonlinearly elastic bodies. Her research in fluid mechanics covers the use of boundary element methods for slender bubbles subject to Stokes flow. In the area of biomechanics, her research covers convolution methods for calcium ion release and nonlinearly elastic/viscoelastic models for the deformation of human skin. Numerical methods utilized include spectral methods, Godunov-type schemes, and finite elements methods. Her current projects include the analysis of optimal patterns of wound closure based on stress analysis, nonlinear viscoelastic models for wound closure, simulations of slender bubbles with surfactants, determination of the release of calcium ions from intracellular storage sites in skeletal and cardiac muscle, and two dimensional viscoplastic localization as a result of strain gradient regularization.

Jonathan H. C. Luke

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

Marc Qun Ma

The research of Marc Qun Ma is in the field of computational biology and bioinformatics, mainly in the areas of biomolecular modeling and simulation and functional genomics. His study of biomolecular modeling and simulation addresses the multiscale nature of the biological systems. He has designed a family of multiscale large timestep molecular dynamics integrators to reduce drasticly the amount of time needed in solving the very large set of ordinary differential equations. These integrators are also applicable in the study of nanofluidic systems. His study of functional genomics deals with fast and accurate determination of genotypes in high-throughput single nucleotide polymorphism multiplex PCR genotyping microarray experiments. He has invented novel methods using support vector machine (SVM), a machine-learning method, for solving this problem and got encouraging results. The results of genotyping determination will aid the analysis of concerted behavior of certain genes that regulate cancerous proliferation of cells. Ultimately, in conjection with other methods, his research will help achieve the goal of personalized genomic-level treatment of many types of cancers. He also studies the gene annotation problem via gene expression profiling microarray experiments. The idea is to add the missing annotation for the genes that are involved in certain functions in which other genes already have annotation. More complete annotation of gene functions leads to more accurate understanding of life in the genomic level.

Victor Matveev

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

Roberto Mauri

Roberto Mauri's research focuses on two areas. In the first, the transport of heat, mass, and momentum in two phase systems is studied, both experimentally and theoretically. Familiar examples include the flow of suspensions through pipes and the heat and mass conduction through composite materials. Recent results include the determination of the effective velocity and diffusivity of solutes in porous media and in turbulent flow fields and the shear-induced diffusivity of suspensions of rigid spheres. In the second research effort, the phase separation and mixing of liquid mixtures into two phases is studied. Since the phase transition process can be triggered by changing either the temperature or the composition of the system, separation can be achieved either by heating and cooling the solvent mixtures across their miscibility curve, or by adding a solubility modifier. Using this second approach, a new process has been developed to obtain monodisperse distributions of nanoparticles for bioengineering applications.

Jay Meegoda

Jay Meegoda's research can be best described as mechanics of geo-environmental engineering where he utilizes scientific concepts and engineering technologies in real world applications. Under the heading of mechanics of geo-environmental engineering, his research can be further subdivided into five main trust areas: engineering properties of contaminated soils; centrifugal modeling of contaminant transport; micro-mechanics of civil engineering materials; reuse of contaminated soils; and ultrasound research. Micro-mechanic models were used to explain the mechanical behavior of civil engineering materials. He received the best practice paper award in 2001 from the Environmental Multimedia Council of the Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE) for a publication resulting from the above research. Currently, his research is focused on use of a laser to detect segregation in asphalt pavements and development of smart pipes for drinking and waste water distributions.

Zoi-Heleni Michalopoulou

The research of Zoi-Heleni Michalopoulou focuses on inverse problems in underwater acoustics. Currently, new global optimization approaches based on the tabu methodology are being developed for matched-field source localization and geoacoustic inversion. Also, arrival time and amplitude estimation in uncertain environments is pursued via a novel Gibbs sampling scheme.

Petronije Milojevic

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

Robert M. Miura

The research of Robert M. Miura covers several areas in mathematical physiology, especially in neuroscience. The techniques used are mathematical modelling, mathematical analysis, approximation methods, and numerical simulations. His research on excitable biological cells, including neurons, cardiac cells, and pancreatic beta-cells, is aimed at understanding electrical effects on cell function and signalling. These studies involve detailed investigations of membrane electrical properties, subthreshold resonance, stochastic resonance, signal propagation on dendrites, and mechanisms leading to bursting electrical activity. His studies on spreading cortical depression, and more generally intercellular communication via ion flows, include analysis and simulations of partial differential equation models. Diffusion of ions in the brain is studied using the lattice Boltzmann method.

Richard O. Moore

Richard Moore's research focuses on wave phenomena in optical communication systems and optical devices. He is particularly interested in how such systems and devices are disturbed by a variety of influences relevant to their operating environments. Current projects include using a combination of perturbation methods and importance sampling to simulate rare events in optical communication lines, and using dynamical systems techniques and rigorous reduction methods to analyze the impact of heating due to optical field absorption in devices that convert optical frequencies using parametric gain media.

Cyrill B. Muratov

The main research direction of Cyrill B. Muratov is pattern formation, self-organization, and non-linear dynamics in systems described by coupled reaction-diffusion equations, with primary applications to biological systems and materials science. He uses dynamical systems theory, singular perturbation techiniques, matched asymptotics, non-local eigenvalue problems, as well as exact analytic, variational, and numerical methods, to study traveling wave solutions, interfacial patterns, and more complicated spatiotemporal patterns. Current ongoing projects with biological applications include analytical studies of excitability, pulse propagation, and spiral waves in excitable biological cells, and modeling and computational analysis of autocrine loops in cell signaling networks. His research in materials science involve studies of the kinetics of domain pattern formation in systems with long-range interactions and polymer-liquid crystal systems, as well as formation of hot spots in ceramic and other materials.

Farzan Nadim

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

Demetrios T. Papageorgiou

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

Manuel Perez

The research of Manuel Perez is in the areas of heat transfer, drying of porous media, expert systems, medical diagnosis by computer, and mechanical properties of fibrous webs. He is now working on survival studies of prostate cancer patients, and on evaluating the efficacy of surgical procedures and radiation treatment for various stages of the disease.

Peter G. Petropoulos

The research of Peter G. Petropoulos has focused on the numerical modeling and asymptotic analysis of physical problems in the areas of transient electromagnetic wave propagation in complex media. His studies of pulsed electromagnetic waves in dispersive media mainly concern the asymptotic and numerical methods for studying the response of relaxing (Debye) and fractionally-relaxing (Cole-Cole) dielectrics, as well as the development fourth-order accurate finite difference methods for the time-domain Maxwell equations with discontinuous coefficients. His current projects include analysis of the error in problems where impedance boundary conditions are employed, development of numerical techniques to simulate pulse propagation in Cole-Cole dielectrics, analysis of perfectly matched absorbing boundary conditions in relation to exact absorbing boundary conditions, and the development of fourth-order accurate schemes in the presence of curved boundaries.

Christopher Raymond

The research of Christopher S. Raymond has focused on mathematical modeling and the development of asymptotic, perturbative, and numerical techniques for studying reaction-diffusion systems in which the reactions are confined to the vicinity of either propagating interfaces (applications to combustion, material synthesis, and frontal polymerization) or to portions of the boundary of the domain of interest (biological applications). He is currently concentrating on developing and analyzing mathematical models for immunocolloid labeling, a novel technique for imaging molecular scale features on cell surfaces using electron microscopy.

Anthony D. Rosato

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

Michael Siegel

The research of Michael Siegel is focused on the analysis and numerical computation of moving boundary problems that arise in fluid mechanics, materials science, and physiology. His research in fluid dynamics covers singularity formation on interfaces for inviscid and low Reynolds number (Stokes) flow, the dynamics of drops and bubbles (including the influence of surfactant), and effect of small regularization--such as surface tension--on mathematically ill-posed interfacial flow problems. His studies in materials science primarily involve crystal growth and diffusion controlled moving boundary problems. In physiology, he has studied optimal suturing patterns for skin wounds and formulated models for determining the stress and strain distribution in the heart wall that occur due to changes in heart geometry.

David Stickler

The research of David Stickler has centered on the application of asymptotic and numerical methods to study some basic problems in wave propagation and diffusion. The wave propagation problems have application in electromagnetics, acoustics, and elasticity. They include some problems in inverse scattering. The diffusion problems include work in thermal conduction and thermo-elastic diffusion. In this work, both uniform and non-uniform asymptotic methods have been developed. His current research focuses on the equilibrium configuration of elastic membranes with the emphasis on cylindrically symmetric annular rings.

Louis Tao

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

John Tavantzis

The research of John Tavantzis is in the field of operations research applied to problems of parking allocations. Given several parking lots with certain capacities, how does one assign parking so as to minimize total cost to individuals who need to park during certain time intervals. Discrete and probabilistic models are considered.

Jean-Marc Vanden-Broeck

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

Sheldon Wang

The research of Sheldon Wang focuses on combining computational fluid and solid mechanics with various modeling of physical and chemical phenomena at different temporal and spatial scales. A current generic model problem of interest to him involves a deformable cell immersed in viscous fluid environment. The evolution of such a fluid-solid system can be triggered by chemical kinetics, thermal fluctuation, reaction, diffusion, or even convection due to environment alternation, osmotic pressure gradient, and solid deformation. The understanding of this model system will shed light on behaviors of cells and biosystems.

Wonsuk Yoo

Wonsuk Yoo has research interests in methodological development on trans-dimensional Markov chain Monte Carlo (reversible jump MCMC), design and analysis of Clinical Trials (Bayesian mixture model, joint density of survival time and changepoint), and statistical diagnostic methods in cancer research, statistical diagnostic methodologies in microarray analysis and computational biology.

Yuan-Nan Young

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

C. SELECTED RESEARCH RESULTS

Michael Booty and Gregory A. Kriegsmann
"Flamelet Models of Combustion"

Daniel Goldman
"Blood Flow and Transport Processes in Microvascular Networks"

Roy Goodman
"A New Fractal Structure Describing the n-Bounce Resonance in Wave Interactions"
(joint work with R. Haberman)

David Horntrop
"Simulation of Mesoscopic Models for Surface Processes"

Shidong Jiang
"Fast Algorithms and Scattering by Open Surfaces"

Lou Kondic
"Force Transmission Through Sheared Particulate Matter"

Victor Matveev
"Mechanisms and Functional Roles of Short-Term Synaptic Plasticity"

Victor Matveev, Amitabha Bose, and Farzan Nadim
"Effect of Short-Term Facilitation on Neural Dynamics"

Cyrill Muratov
"Modeling and Computational Analysis of EGF Receptor-Mediated Cell Communication in Drosophila Oogenesis"

Louis Tao
"Dynamics of Neuronal Networks"

Sheldon Wang
"Multi-Scale and Multi-Physics Modeling of Biological Systems"

Sheldon Wang
"Multi-Scale and Multi-Physics Modeling Using Immersed Methods"

Yuan-Nan Young, Michael Siegel, and Demetrios Papageorgiou
"Effects of Surfactant on Bubble Breakup"

Michael Booty and Gregory A. Kriegsmann

Title: Flamelet Models of Combustion

Flamelet models of combustion, also referred to as reaction-sheet models, describe the dynamics of a flame in a combustible gas mixture in the limit of small inverse activation energy, e tends to 0. In this limit, effects of chemical activity are relatively small except within a spatially narrow region, which is the flame or flamelet. Asymptotic analysis of the governing (reactive Navier-Stokes) equations is used to replace the flame by a surface of discontinuity across which a rationally derived set of jump conditions must be satisfied by the flow field on either side. These jump conditions can be appended to the traditional equations of inert gasdynamics and reactive acoustics in much the same way that the Rankine-Hugoniot jump conditions are appended to the Euler equations to describe the evolution of a shock wave. However, the form taken by the jump conditions varies with the flame speed, or propagation Mach number M, and how this is scaled on the inverse activation energy e.

To date, flamelet models have been used to describe the slowest category of premixed flames, which are referred to as diffusional-thermal flames and have propagation Mach number M to activation energy e scaling M = O(e exp(-1/2eTb)) where Tb (approximately 6) is the ratio of ambient absolute temperatures ahead and behind the flame. In the work described here, a new flamelet model was derived for the next fastest category of flames, for which the M to e scaling is M=O(e). The model was then adapted in an attempt to describe the phenomenon of deflagration to detonation transition, whereby a low-speed flame or deflagration evolves and accelerates to become a high-speed wave or detonation, as is widely observed in simple experiments and applications.

In this adaptation, the flow field immediately ahead of the flame is described by small-amplitude disturbances (T1, p1, u1) in temperature, pressure, and gas velocity about a uniform basic state with temperature near a critical ignition value. Even in the absence of the flame, gas in this state will ultimately develop directly into a supersonic weak detonation wave at some nondimensional time t of order unity. Flow disturbances in this region are governed by the semilinear hyperbolic system of reactive acoustics, or induction domain equations. The gas temperature is raised to ignition value by a shock wave, which precedes the induction domain and flame, and is driven by a piston that moves into the gas from a location immediately behind the flame. The model reduces to an initial-boundary-value problem for the induction domain equations, which requires numerical solution. Initial data are given describing a quiescent state ahead of the shock wave, and an initial temperature profile in the induction domain just ahead of the flame. Known boundary conditions describe (1) reflection and transmission of disturbances at the preceding shock wave, and (2) data on a path immediately ahead of the flame, which follows from the flamelet jump conditions and describe transmission and reflection of disturbances across the flame and piston pair.

Booty and Kriegsmann (continued)

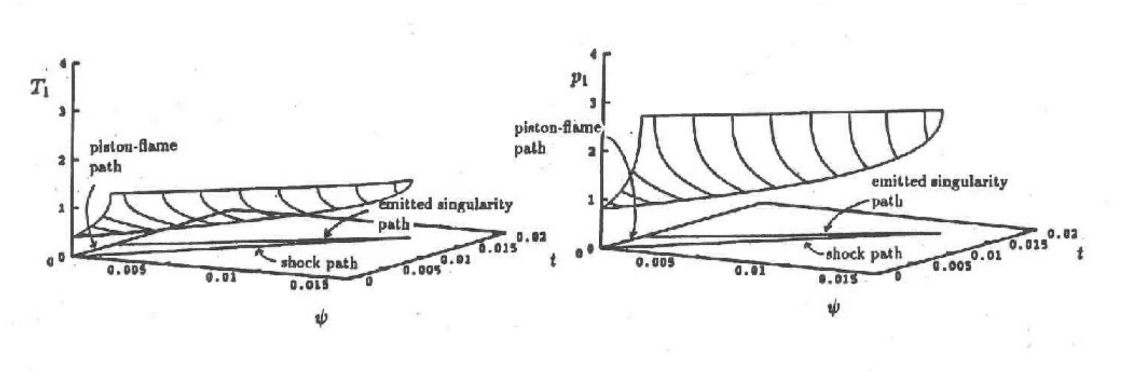


FIGURE: Temperature disturbance T1 and pressure disturbance p1 as functions of lagrangian distance psi and time t in the induction domain ahead of a deflagration with small Mach number in a category M=O(e).

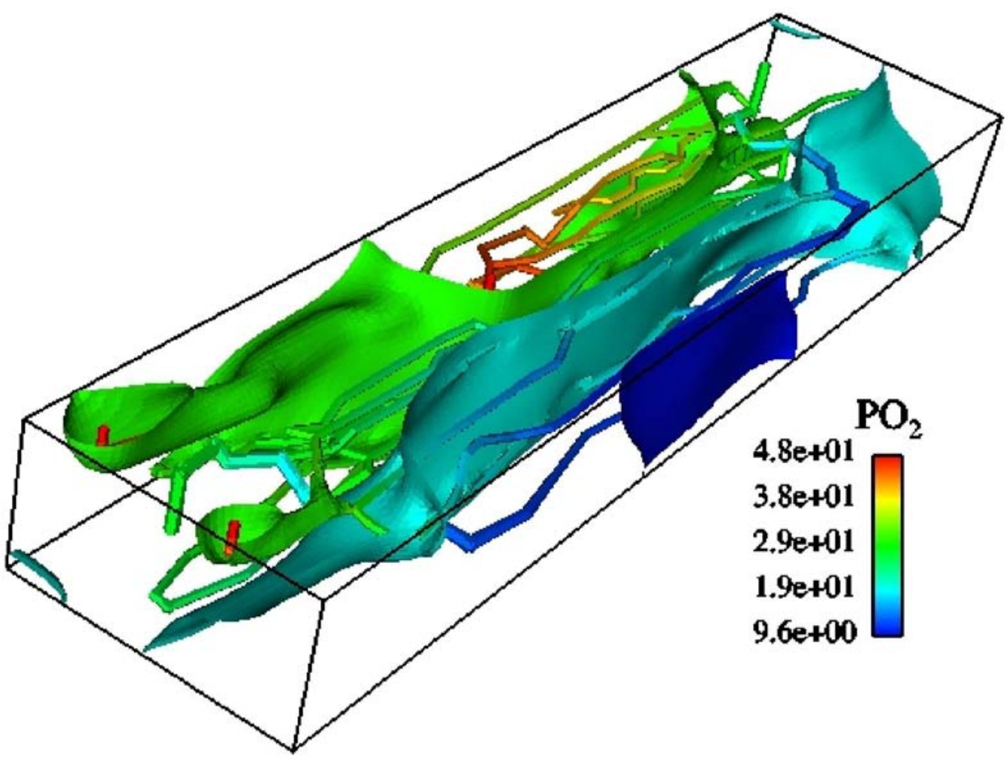
The figures above show temperature and pressure disturbances T1(psi, t) and p1(psi, t) in the induction domain for a typical evolution pattern of the flow field where psi is a lagrangian distance coordinate measured from the piston. The curve of intersection of the disturbance surfaces with the flame path psi=0 is found to have a turning point singularity at a time near 0.005. This singularity type propagates into the induction domain along the characteristic entering the domain from the flame path at the critical instant. Note that the critical instant occurs at a far earlier time than would spontaneous development of a weak detonation in absence of the flame. The computations show that as the critical instant is approached the flame speed remains finite while its acceleration becomes unbounded, with the event emitting a well-defined disturbance into the flow field ahead of the flame. Computations have not yet been taken beyond the critical event, but a hypothesis suggested by the experimentally observed phenomenon of galloping flames is that the flame will then slow immediately at the critical event - before the process, qualitatively, begins to repeat itself.

Daniel Goldman

Title: Blood Flow and Transport Processes in Microvascular Networks

The primary role of the circulatory system, and in particular, the microcirculation, is to ensure optimal delivery of oxygen to all living cells, under both steady and time-varying conditions. The structural complexity of the microvasculature can have a profound effect on the distribution of oxygen to the surrounding tissue, especially in disease states or when the demand for oxygen is high. Following earlier work in the field, we have developed a flexible, efficient, and highly realistic computational model for simulating microvascular blood flow and oxygen delivery. This model has been used to study both steady-state and time-dependent oxygen delivery, which is of primary interest for understanding physiological functioning. Current studies use this model to understand blood flow and oxygen transport during sepsis and the onset of exercise. The goal of this ongoing project is to increase understanding of physiological processes relevant to normal and pathological phenomena in skeletal muscle and other tissues. In particular, we are interested in the time-course and spatial distribution of hypoxia and anoxia, which can cause localized tissue damage. The interaction between the structural heterogeneity of the microvasculature and the nonlinearity of certain processes, such as blood flow and oxygen consumption, is expected to have important physiological consequences. In sepsis, microvascular blood flow and autoregulation are disturbed, and our model makes it possible to study the consequences for tissue oxygenation. The onset of aerobic exercise, which greatly increases the oxygen consumption rate, is a time-dependent oxygen transport process in which the heterogeneity of microvascular geometry is expected to be important. We are investigating the consequences for tissue oxygen delivery of the interaction between structural and bio-dynamic complexity in the microcirculation in order to increase basic understanding, explain observed phenomena, and examine new approaches for minimizing tissue damage.

FIGURE: Calculations of steady-state oxygen transport during sepsis. Shown are capillary and tissue oxygen distributions computed using measured hemodynamics and three-dimensional network geometry reconstructed from experimental data. A region of loalized hypoxia can be seen (dark blue).

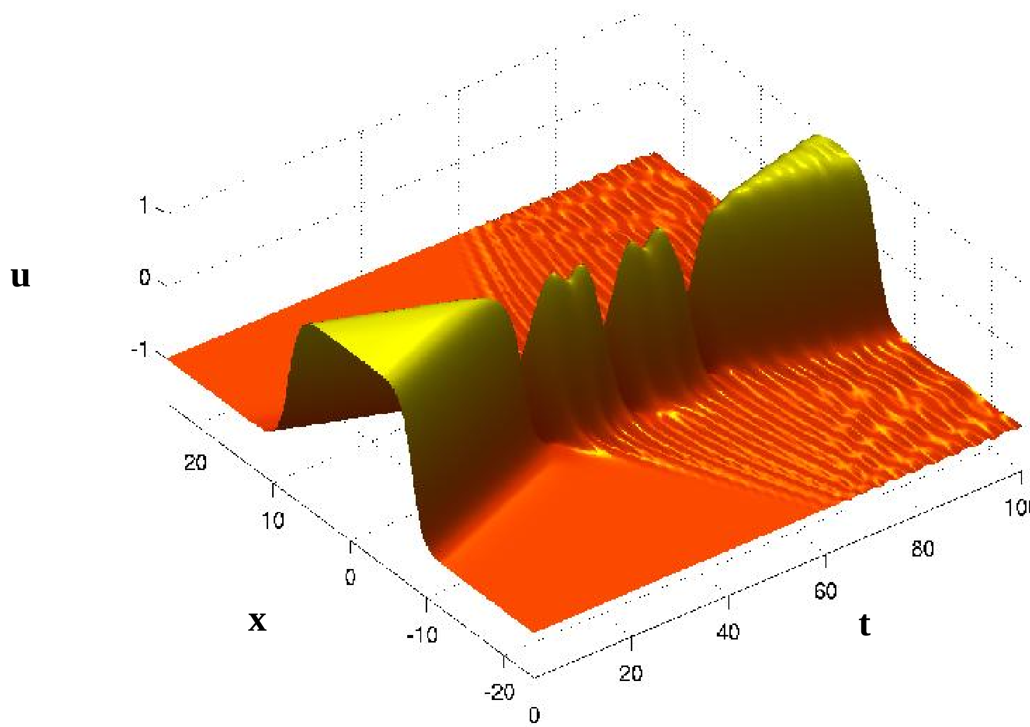


Roy Goodman

Title: A New Fractal Structure Describing the n-Bounce Resonance in Wave Interactions
(joint work with R. Haberman)

The phi-four partial differential equation is used to model many physical systems, from microscopic processes involving polymers to the emergence of structure in the early universe. In a well-known series of papers from the early 1980's, Campbell et al. discovered a phenomenon known as the n-bounce resonance. Two waves are initialized propagating toward each other and allowed to collide. If they are moving sufficiently fast, they simply bounce off each other, but if they are moving below some critical speed, their behavior is more interesting. They may be captured into a single bound state, or more interestingly, for velocities in certain "resonance windows," they may bounce off each other once, and then turn around and bounce off each other a second time--or several more times--before finally escaping. A simulation displaying the two-bounce resonance is shown in Figure 1.

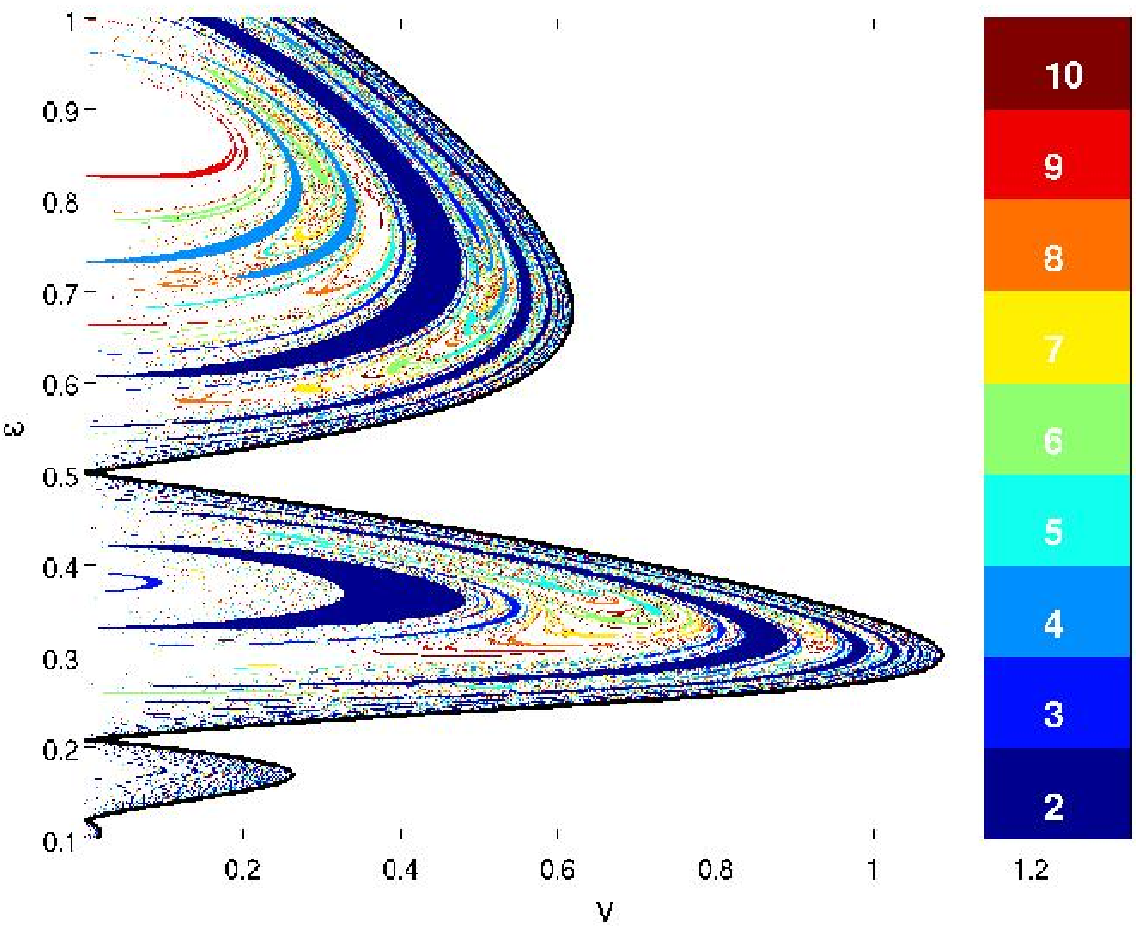
FIGURE 1:



Goodman (continued)

In joint work with Richard Haberman, Roy Goodman has been studying a finite-dimensional model of this process consisting of two second order ordinary differential equations (ODEs), a great simplification which captures much of the dynamics. The n-bounce phenomenon has been previously observed in wave interactions in many mathematical systems, and such ODE models have typically been studied numerically. Using methods from dynamical systems perturbation theory, we have derived mathematical formulas that predict the critical velocity for capture and the locations of the resonance windows. In Figure 2, we display the predictions of this formula. Along the y-axis is a parameter describing the strength of the interaction between the two modes, and along the x-axis is the velocity. The black line shows how the critical speed depends on epsilon. Everything to the right of this curve corresponds to waves which move apart after a single collision, and the regions to the left of this curve are color coded by the number of collisions the waves undergo before separating. These show a complex fractal structure, with details at all scales.

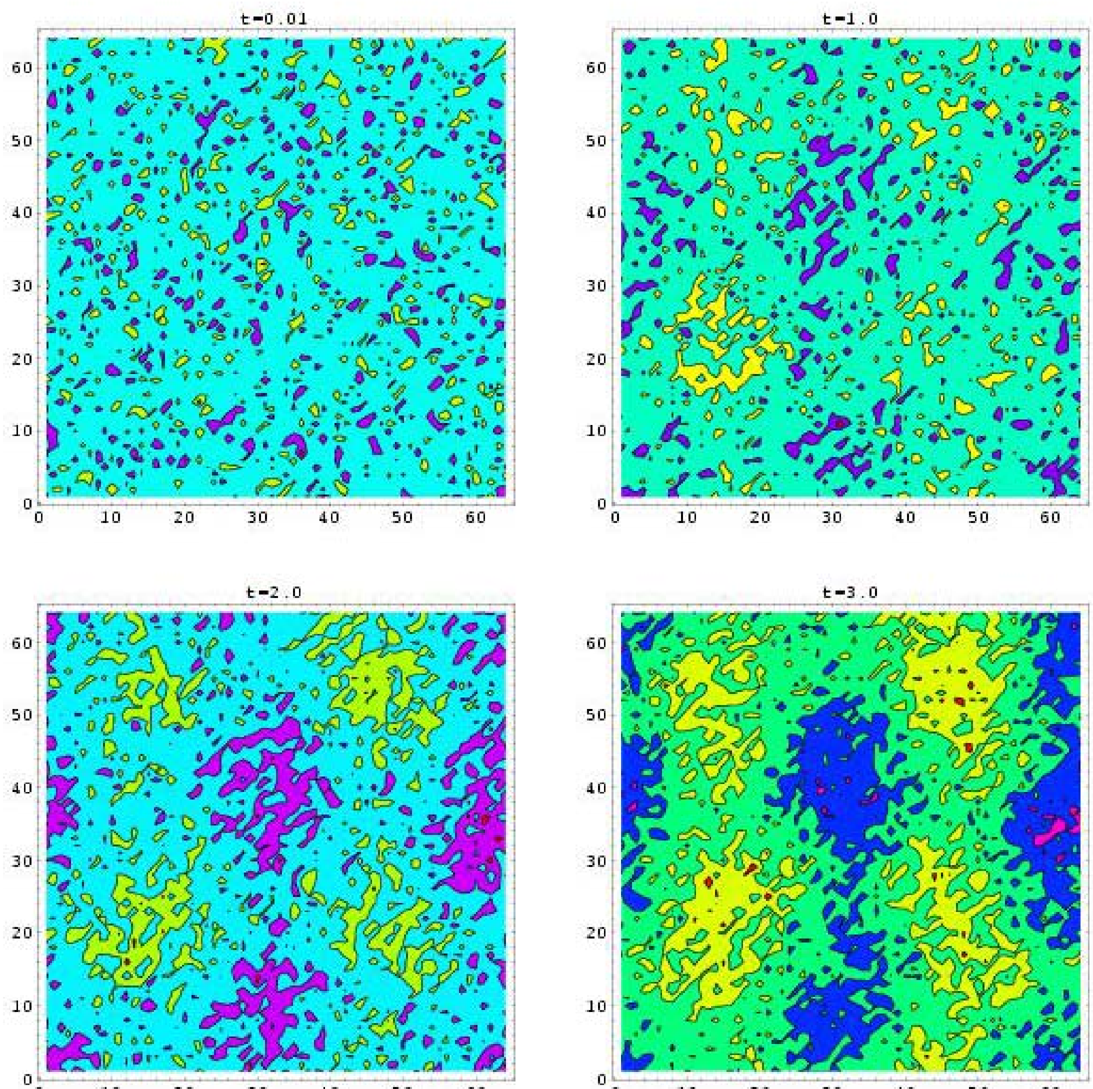
FIGURE 2:



David Horntrop

Title: Simulation of Mesoscopic Models for Surface Processes

The spontaneous self-organization of particle into larger structures is a commonly observed phenomenon in materials science. A better understanding of the rate of the self-organization and the mechanism driving this behavior would be beneficial in the design of catalytic surface reactors as well as in the creation of advanced materials. One means by which this behavior can be studied is through the use of mesoscopic models. Mesoscopic models are stochastic partial differential equations which are derived from microscopic dynamics yet involve macroscopic variables. The results given below are from numerical simulations of mesoscopic model equations using recently developed spectral schemes for stochastic partial differential equations. These plots contain a time series of contour plots where regions of low concentration are depicted with yellow whereas regions of high concentration are depicted with dark blue/purple. The first picture in the upper left-hand corner shows the very small, randomly located regions where the concentration differs from its mean value by more than 5% after a very short simulation time. As time evolves, these regions quite noticeably become much larger reflecting the self-organization that occurs.



Shidong Jiang

Title: Fast Algorithms and Scattering by Open Surfaces

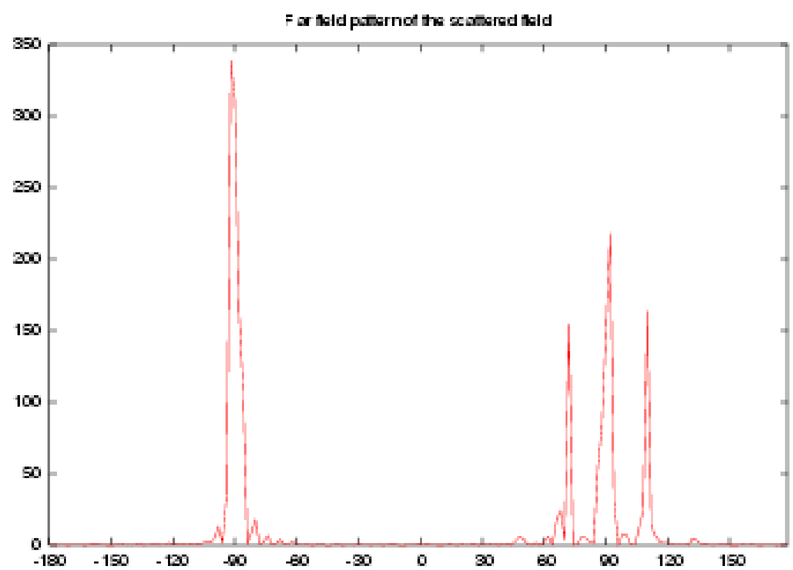
My main research interests lie in the development of stable and fast numerical algorithms and their applications to large scale problems in applied physics, quantum chemistry, and engineering. Recently I have been focusing on the development of a formulation for scattering problems by open surfaces using integral equations of the second kind.

Integral equations have been one of the principal tools for the numerical solution of scattering problems for more than 30 years, both in the Helmholtz and Maxwell environments. Historically, most of the integral equations used have been of the first kind, since numerical instabilities associated with such equations have not been critically important for the relatively small-scale problems that could be handled at the time.

The combination of improved hardware with the recent progress in the design of ``fast'' algorithms has changed the situation dramatically. Condition numbers of systems of linear algebraic equations resulting from the discretization of integral equations of potential theory have become critical, and the simplest way to limit such condition numbers is by starting with integral equations of the second kind. Hence, increasing interest in reducing scattering problems to systems of integral equations of the second kind on the boundaries of the scatterers.

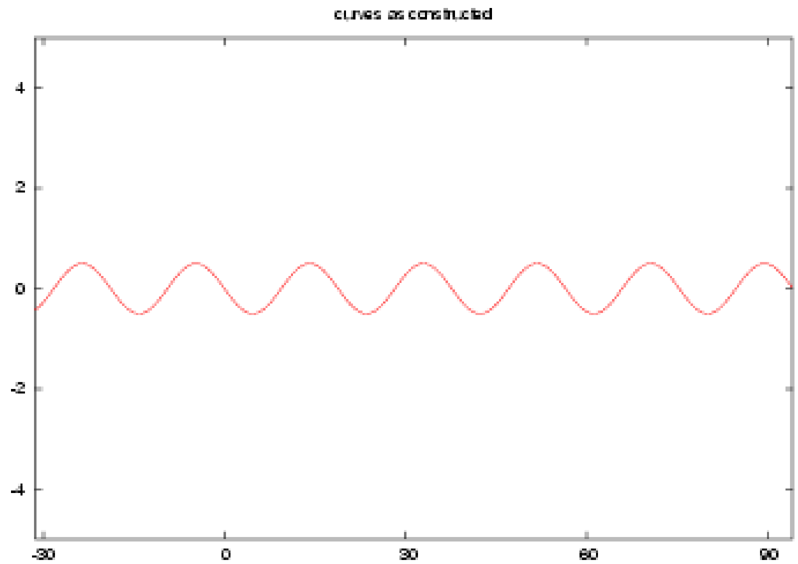
In collaboration with Prof. Vladimir Rokhlin at Yale university, I have constructed a stable formulation for an integral equation of the second kind for various boundary value problems (Dirichlet, Neumann, Robin) for the Laplace and Helmholtz equations in two dimensions, with the boundary conditions specified on a collection of ``open'' curves. When it is combined with a Fast Multipole Method and an iterative solver, a stable and fast numerical algorithm for scattering problems by open surfaces has been developed. The algorithm has potential applications in radar technology, antenna and chip design, and math biology.

FIGURE 1:



Jiang (continued)

FIGURE 2:



Lou Kondic

Title: Force Transmission Through Sheared Particulate Matter

The manner in which the force, or more generally, signals, propagate between granular particles is one of the important issues which needs to be addressed in order to develop a better understanding of these systems. In contrast to ordinary fluids, the correlation lengths in dense granular system could be as large as the system size, and therefore, the path to a realistic description based on any continuous theory is unclear. An additional motivation for studying these systems is that some aspects of their response resembles rather closely the behavior of other jammed systems, such as foams, emulsions, and supercooled liquids.

One approach to obtain a better understanding of granular systems is to perform molecular dynamics, or discrete element simulations. The figure below shows how different the force propagation is in two systems, which differ only in the fact that the left one is composed of monodisperse particles, and the right one consists of polydisperse ones. One aspect of the current research project is to understand the influence of polydispersity on correlations, forces, and velocity profiles of sheared granular systems.

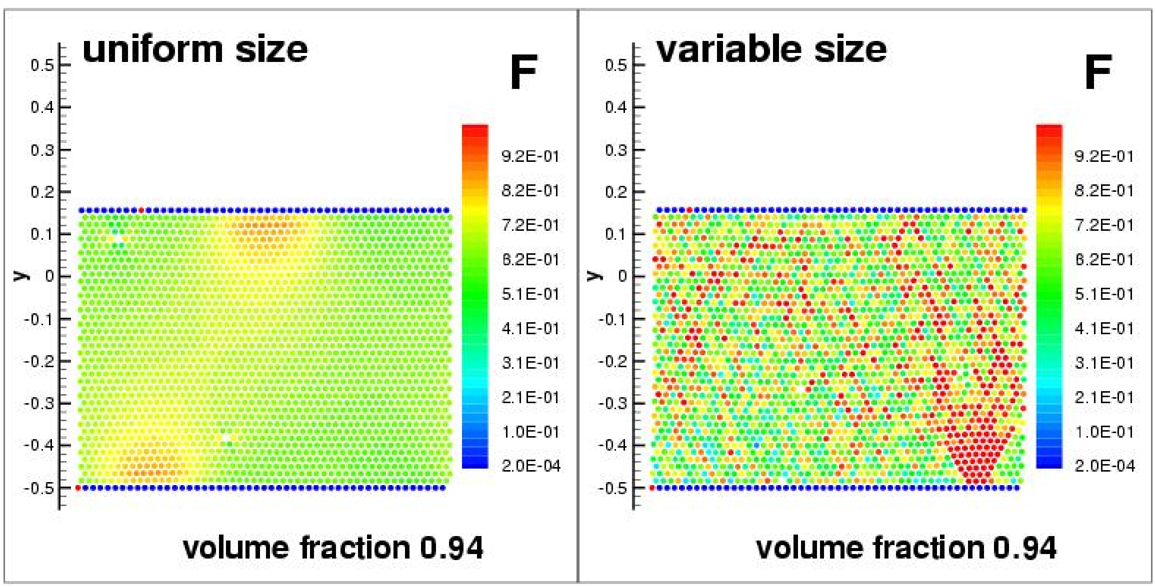


FIGURE: Figure shows the forces on the granular particles between two rough shearing walls (shown in blue at top and the bottom).

Victor Matveev

Title: Mechanisms and Functional Roles of Short-Term Synaptic Plasticity

The efficiency with which the activity of one neuron is transmitted across a synapse to another neuron is not static, but is known to change constantly, depending on the timing between the incoming action potentials. This phenomenon is called synaptic plasticity, and involves a variety of cell processes, operating on a wide range of time scales. While long-term forms of synaptic plasticity are believed to underlie learning and memory, my research is focused on short-term plasticity processes such as facilitation and depression, which have recently drawn great attention due to the role they play in regulating the activity dynamics of neural circuits on fast time scales (milliseconds to seconds). For example, Figure 1 illustrates the differential temporal filtering of spike train information by facilitating versus depressing synapses.

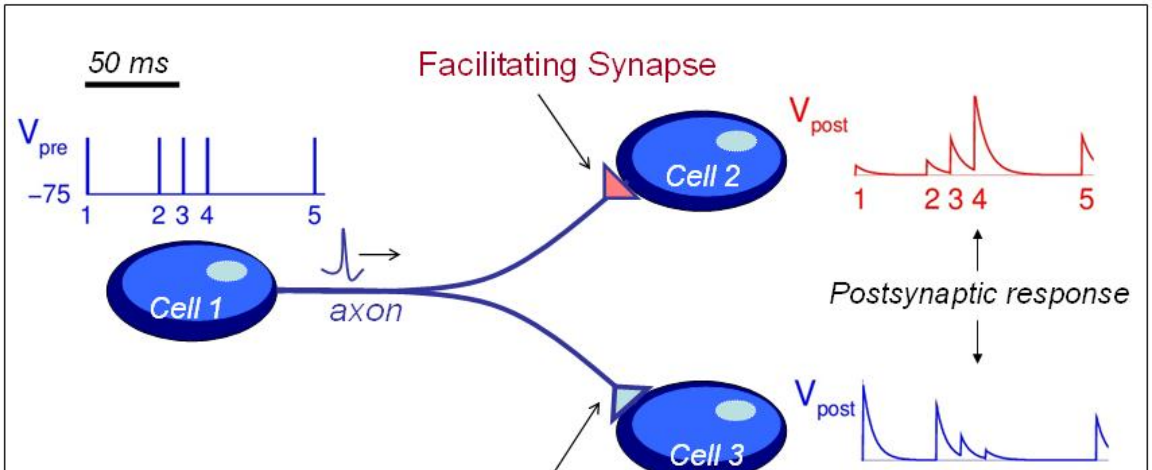
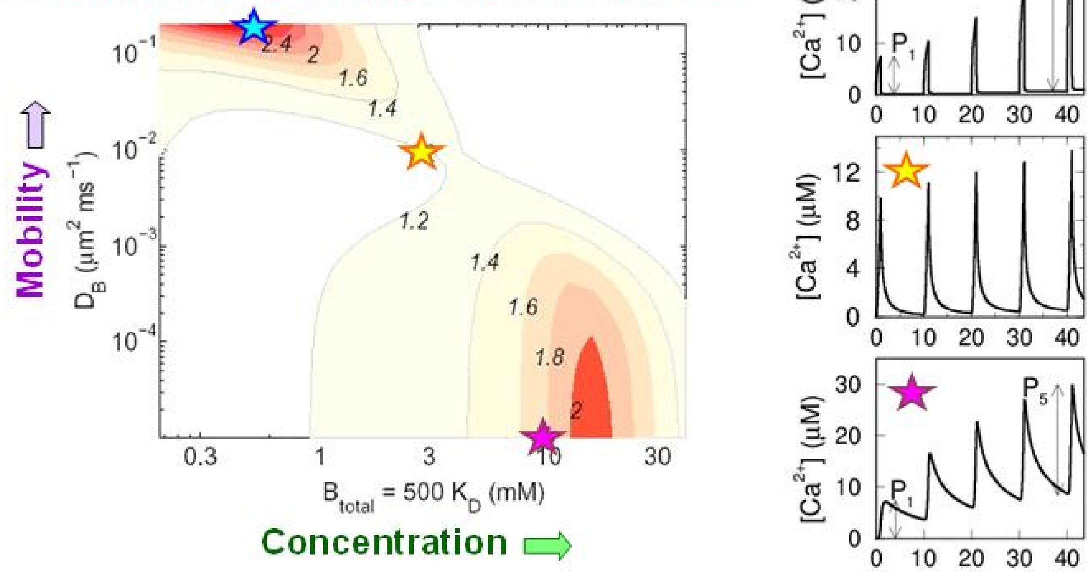


Figure 1. Short-Term Synaptic Plasticity

Apart from exploring the effect of synaptic depression and facilitation on network activity, I also investigate biological mechanisms underlying these phenomena. It is known that facilitation is caused by the accumulation of calcium ions at the synaptic terminal; in general, calcium influx is an established trigger for neurotransmitter release. However, it is still under debate how small amounts of residual calcium remaining after a single action potential can cause a dramatic increase in synaptic response to the next pulse. Answering this question depends on our understanding of the role that calcium buffers (intracellular molecules that bind calcium) play in regulating intracellular calcium diffusion. In particular, Figure 2 shows the facilitation of calcium transients produced by five consecutive pulses of activity, resulting from the saturation of calcium buffers, and demonstrates the interesting non-monotonic dependence of this effect on buffer concentration and its mobility. Understanding the intracellular buffered diffusion of calcium is important in the study of many other cell mechanisms, since calcium signals control a vast number of crucial cellular processes (collaborators: A. Sherman, NIH; R. Bertram, FSU; J.-W. Lin, Boston U; R.S. Zucker, UC Berkeley).

Figure 2. Facilitation of Ca^{2+} transients (P_5/P_1) as a function of buffer mobility and its concentration

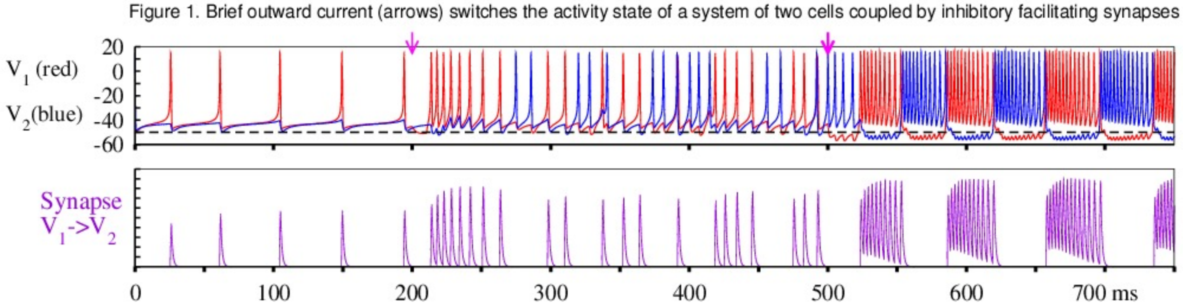


Victor Matveev, Amitabha Bose, and Farzan Nadim

Title: Effect of Short-Term Facilitation on Neural Dynamics

Short-term synaptic facilitation is a transient increase in synaptic strength elicited by one or several action potentials, and decaying on time scales from tens to hundreds of milliseconds. Facilitation has been observed in a wide variety of neural systems, from invertebrate motoneuron junctions to mammalian neocortical synapses. We explore the potential role that facilitation plays in shaping the collective activity dynamics of synaptically coupled neuronal populations. In particular, Figure 1 illustrates multistability exhibited by a network of two neurons, which arises from the interplay between the facilitation of the inhibitory synapses coupling the two cells, and the hyperpolarization-activated currents (T-currents) that cause each cell to fire a rebound burst in response to strong inhibition provided by another neuron. In the left part of the Figure, the first cell is seen to fire tonically, while the second (identical) cell is prevented from firing by the inhibitory synaptic input it receives from the first cell. The hyperpolarization-activated currents are inactivated in both cells in this state (not shown). However, when the first cell is strongly hyperpolarized (2nd magenta arrow), the T-current is activated, resulting in the firing of a rebound burst. This burst of action potentials allows facilitation to build up, which increases the synaptic hyperpolarization of the second cell, causing it in turn to fire a rebound burst of action potentials. This produces the stable anti-phase bursting state shown on the right. In addition, a weaker hyperpolarization (1st magenta arrow) leads to an intermediate meta-stable irregular firing state, where both the facilitation and the T-currents are only partially activated. We hope that understanding such interplay between facilitation and cell activity properties will help to elucidate the biological role of facilitation in regulating the activity of neural circuits.

Figure 1. Brief outward current (arrows) switches the activity state of a system of two cells coupled by inhibitory facilitating synapses



Cyrill Muratov

Title: Modeling and Computational Analysis of EGF Receptor-Mediated Cell Communication in Drosophila Oogenesis

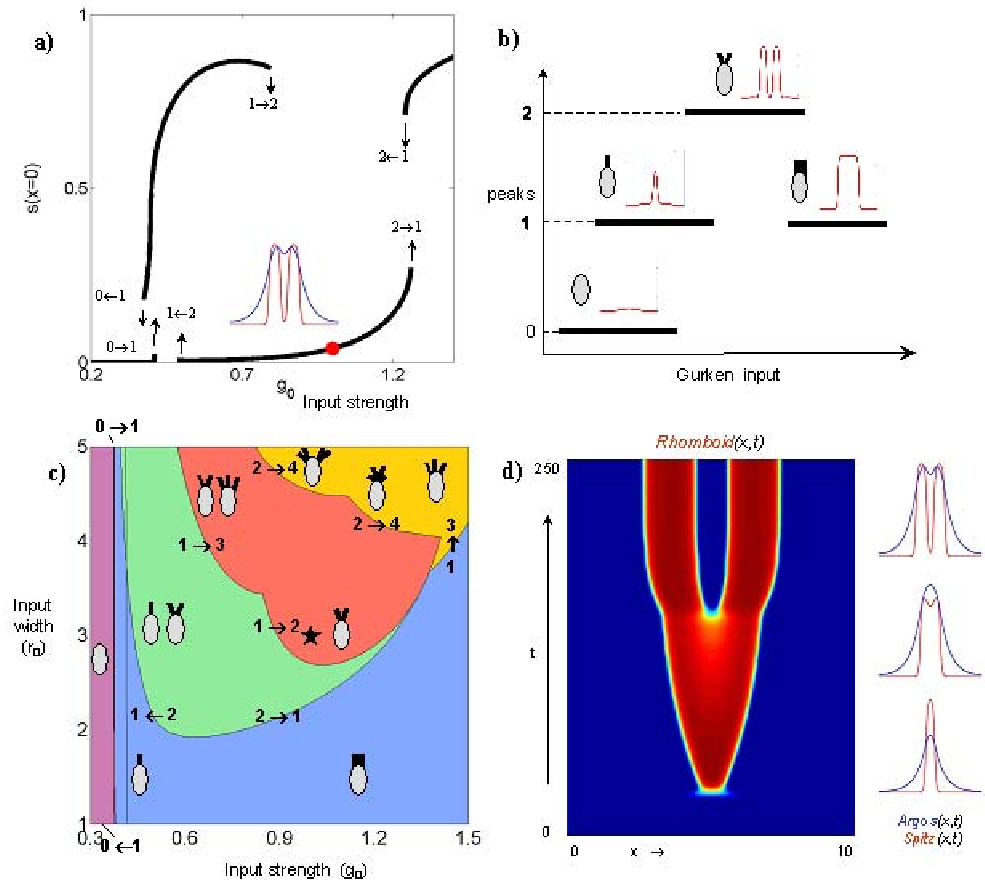
Intercellular signaling is critical in development of multicellular organisms: by regulating cell differentiation, migration, growth, and death, cell communication guides the development of tissues and organs. In adult organisms, the same mechanisms are responsible for tissue repair and maintenance; defects of cell communication systems lead to a number of life-threatening pathologies. Signaling through the Epidermal Growth Factor Receptor (EGFR) is essential in a number of developmental processes across species, from fruitflies to humans, and is extensively studied at the molecular level.

Drosophila melanogaster is a major model organism for the in-vivo analysis of development at the molecular level. One is interested in the mechanisms by which cell communication by diffusing signals patterns epithelial layers. The eggshell of a mature egg of Drosophila is characterized by the presence of two dorsal appendages, a pair organ that supplies the developing embryo with oxygen. Their formation, induced in mid-oogenesis, relies on extensive communication between the oocyte and the cells of the follicular epithelium. The appendages are produced by the two groups of cells that differentiate from the epithelium under the action of the oocyte-derived signal.

In joint work with S. Y. Shvartsman (Princeton) and D. A. Lauffenburger (MIT), Cyrill Muratov developed a mathematical model that describes the patterning events specifying the formation of dorsal appendages in Drosophila oogenesis. The model reduces to a system of coupled reaction-diffusion equations driven by a localized input and characterizes the eggshell phenotype by the number of peaks in the signaling pattern. The model is mechanistic: it is based on a biomolecular mechanism and, in the spirit of the quasi-steady state approximation, identifies the slowest relevant processes and variables responsible for the signaling patterns guiding the formation of a pair of dorsal appendages. Furthermore, the choice of the parameters of the model is guided by the available biochemical information about the relevant time and length scales, etc., of the involved processes.

Muratov (continued)

The figure below presents a summary of the analysis of the signaling patterns.



(a) Steady state bifurcation diagram showing the hysteretic transitions between branches with zero, one, and two peaks. Only the stable solutions are shown.

(b) This sequence of hysteretic transitions can be used to account for a number of observed phenotypic transitions.

(c) Two-parameter bifurcation diagram showing the regions of existence of zero- to four-peaked solutions as a function of input amplitude and width. Transitions between qualitatively different patterns is given by lines of saddle-node bifurcations. Complex phenotypes are predicted for wide and strong inputs.

(d) Space-time plot showing a transient induced by a monotonically increasing single-peaked input.

Louis Tao

Title: Dynamics of Neuronal Networks

I am interested primarily in the modeling and analysis of the dynamics of networks of active cells, with application to specific problems in neuroscience and mathematical biology. My work in this area has been focused on the question of how interacting neurons detect features in visual scenes. This interdisciplinary work involved creating biologically specific models where I could compare computational results with measured data and formulating and analyzing simple qualitative model networks for mathematical understanding.

I have developed a large-scale numerical model of primary visual cortex and have shown how, within the architectural constraints of V1, a single network circuit can provide a unified account of spatial summation and orientation selectivity. Furthermore, I showed that the generation of orientation selectivity in highly coupled networks can be related to bifurcations seen in much simpler networks of all-to-all coupled integrate-and-fire neurons (see Fig. 1). Through asymptotic reduction of the neuronal population dynamics, I show that a firing rate equation (a generalization of the Wilson-Cowan equations) can explain the bifurcations in the all-to-all network. Furthermore, within this reduced model, there is a subcritical bifurcation in the infinite size limit, which, in the finite-size case, allows the integrate-and-fire network to be in a critical state. These results imply that network-based computations can take advantage of the structured recurrent coupling between neurons in the network without resorting to biologically complex properties of single neurons. It is conceivable that these features can be implemented in biological circuits in general.

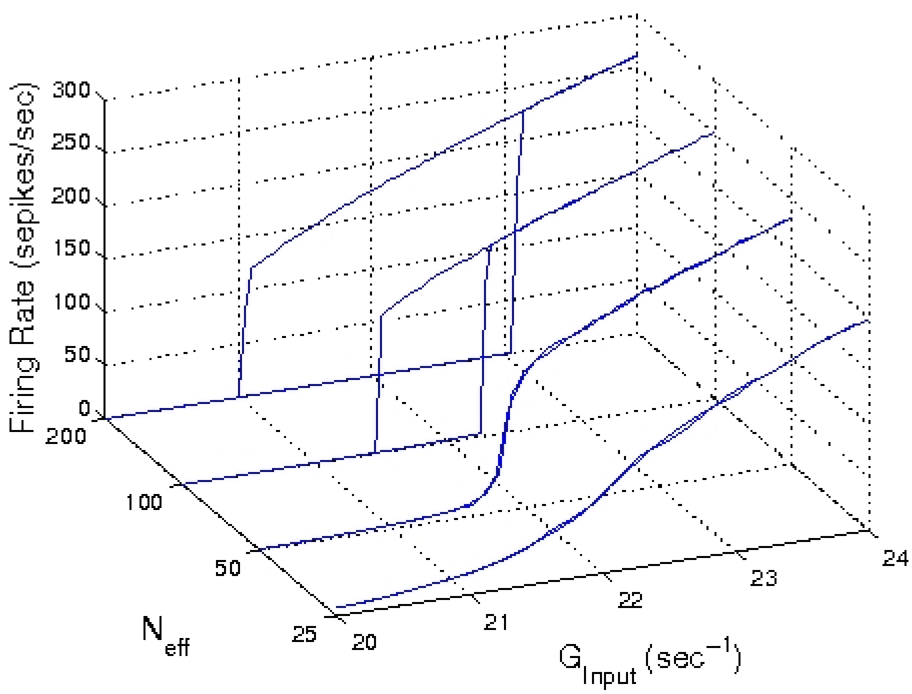


FIGURE:

Firing rate vs. G_{Input} curves for four networks with different N = 25, 50, 100, and 200. These curves were obtained by first increasing and then decreasing the strength of the feedforward excitation G_{Input}. The larger networks (N=100 and 200) show strong hysteresis in the feedforward excitation. This hysteresis can be tuned to a near critical curve at N=50.

Sheldon Wang

Title: Multi-Scale and Multi-Physics Modeling of Biological Systems

The leading challenges in science and technology of this century are clearly the quantitative understanding of biosystems. My research focus is multi-scale and multi-physics modeling of biosystems based on immersed boundary/continuum methods. Human blood is a biological fluid composed of deformable cells, proteins, platelets, and plasma. Human circulatory systems have evolved to supply nutrients and oxygen to and carry the waste from the cells of multicellular organisms through the transport of blood. In the study of the heart, arteries, veins, microcirculation, and pulmonary blood flow, multi-scale and multi-physics coupling of fluids and solids plays an important role. In simulation models, many blood constituents should be represented as immersed flexible shells/beams and solids with various material properties. Furthermore, such models also can be extended to various cardiovascular implants. The closing dynamics of the mechanical valves creates pressure transients that excessively load cells, valve structures, and surrounding tissues, and form cavitation bubbles, which on collapse can cause hemolysis and thrombus initiation. In reality, large motions of flexible structures immersed in biological fluids not only contribute to complex macroscopic stagnation and regurgitation flow behaviors but also affect microscopic chemical/physical changes due to their interaction with proteins, cells, and particles. In fact, the major problems of existing cardiovascular implants can be traced back to the lack of effective modeling tools. These tools are essential for the fine tuning of the designs according to individual organ sizes and physiological flow conditions as well as better understanding of fatigue lifespan of biocompatible materials and atherosclerosis/thrombotic processes. Currently, the intricate structural behaviors, in particular those of immersed flexible shells/beams and solids, are still not well understood. This is due to the enormous difficulties in combining complex nonlinear structural motions with equally complex fluid motions. The goal of my research work is to overcome these difficulties by developing new immersed boundary/continuum methods which will provide a platform for effective modeling of highly deformable shells/beams and solids immersed in biological fluids and facilitate further research in multi-scale and multi-physics coupling of complex fluid-solid systems with microscopic models.

Wang (continued)

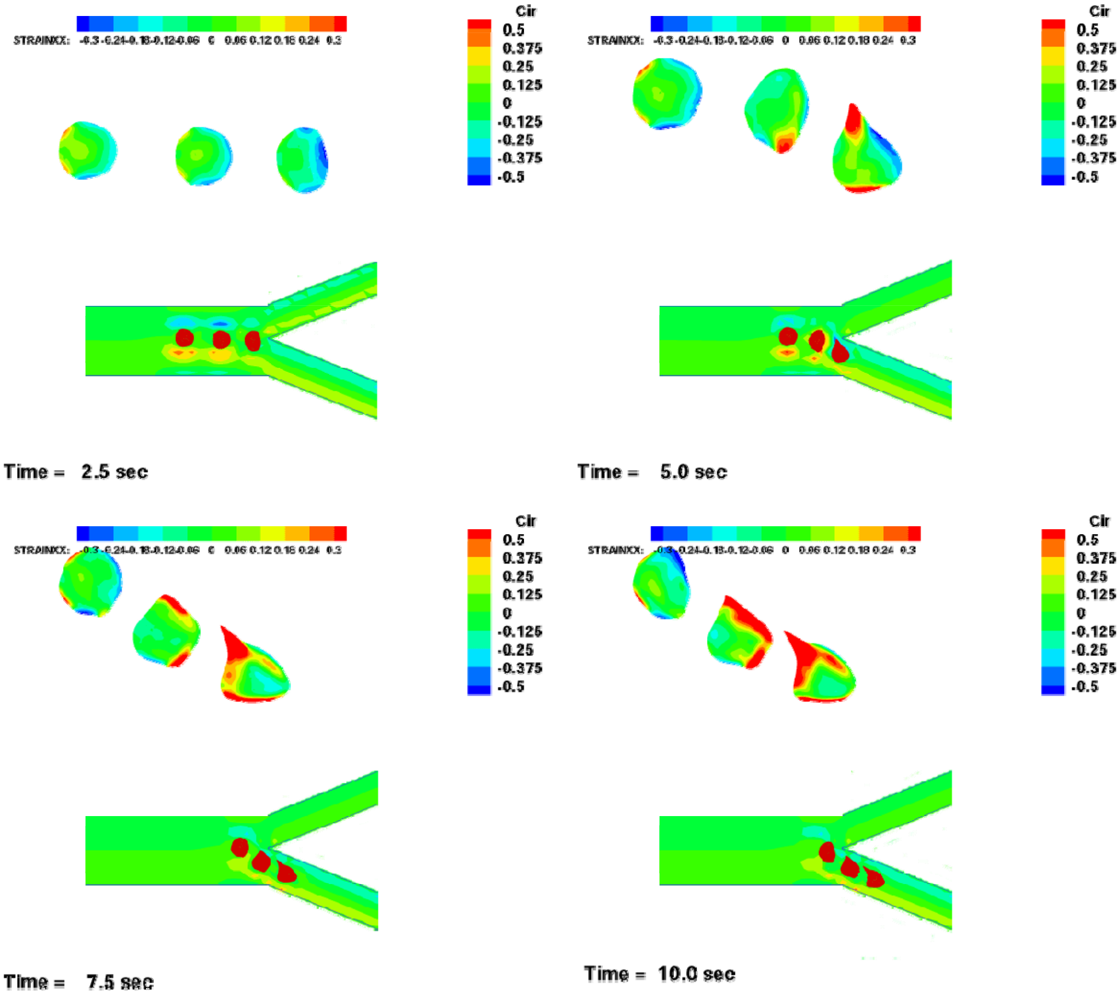


FIGURE:

Three deformable objects impact, conform, and pass around an elastic vessel bifurcation. Dynamic viscosity, density difference, and lower branch diameter are 10 Poise, 2 g/cm^3 and 0.1 cm. Fluid circulation and solid normal strain are depicted.

Sheldon Wang

Title: Multi-Scale and Multi-Physics Modeling Using Immersed Methods

Deformable flexible structures immersed in aqueous environment are ubiquitous in biological systems. In addition to large structural deformations and nonlinear material behaviors, complex chemical and physical conditions on the micro-scale also play important roles in overall system behavior. In immersed boundary/continuum methods, independent solid meshes move on top of a fixed or prescribed background fluid mesh. This simple stragtegy enables a natural coupling of various immersed deformable objects (particles, fibres, beams, 2D/3D deformable solids) with the surrounding viscous fluid and provides a direct link to micro-scale and multi-physics phenomena such as thermal fluctuation, osmosis effects, and various electromagnetic forces. The developed models and methods will assist in understanding biological systems, motivating a new generation of research ideas for computational biomechanics, in particular the formulation of new synthetic materials mimicing nature as well as further development of various micromanipulation techniques such as microneedle, micropipet, poker, and optical tweezer.

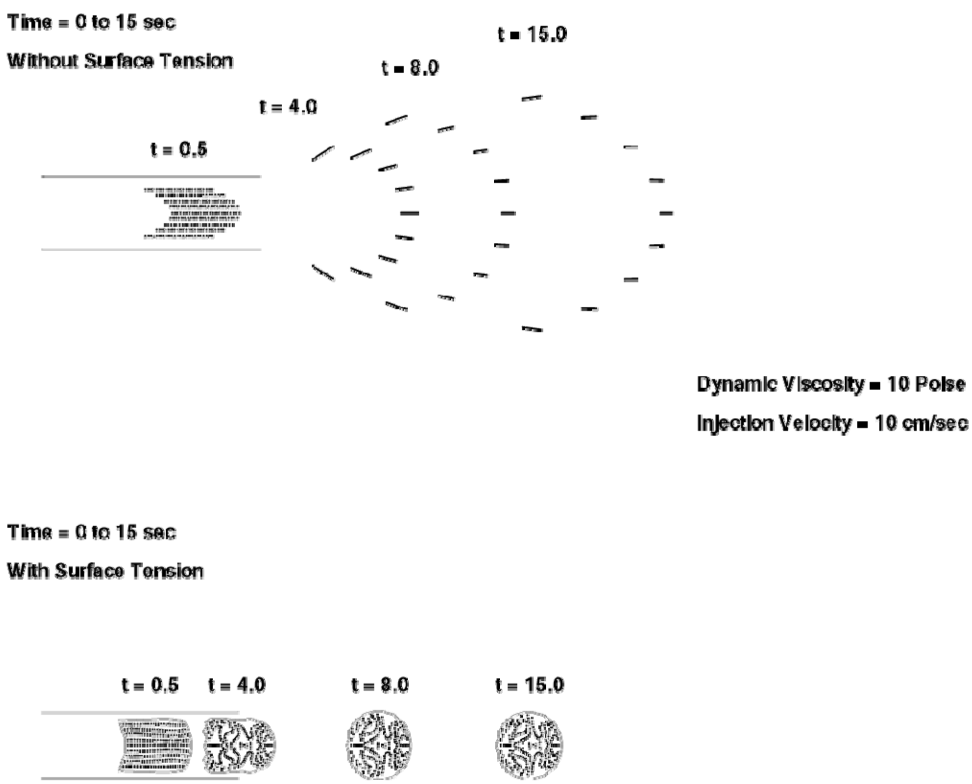


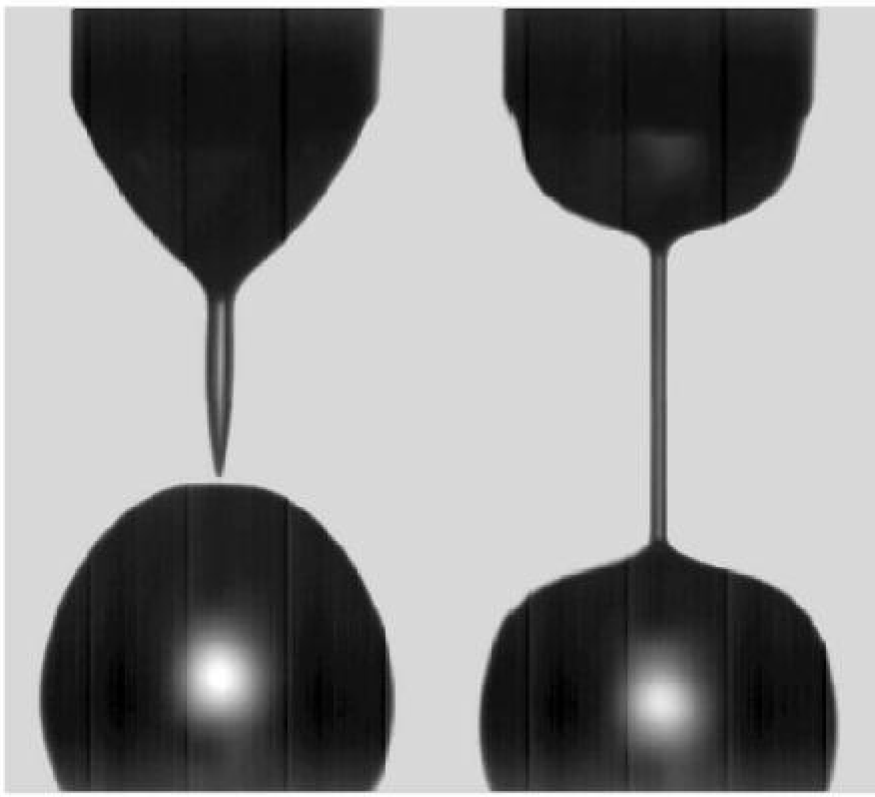
FIGURE:

Viscous fluid (with or without surface tension) is injected into another viscous fluid. The results are derived from Immersed Methods.

Yuan-Nan Young, Michael Siegel, and Demetrios Papageorgiou

Title: Effects of Surfactant on Bubble Breakup

It is well-known that the addition of very small amounts of polymer inhibits the singular behavior of a drop pinching off from the capillary: long-lived cylindrical necks or filaments form due to the polymer as the drop of fluid detaches from the capillary (see figure below, from Amarouchene et al., PRL 86, 3558, 2001. The left is clean water, and the right is dilute polymer solution.)

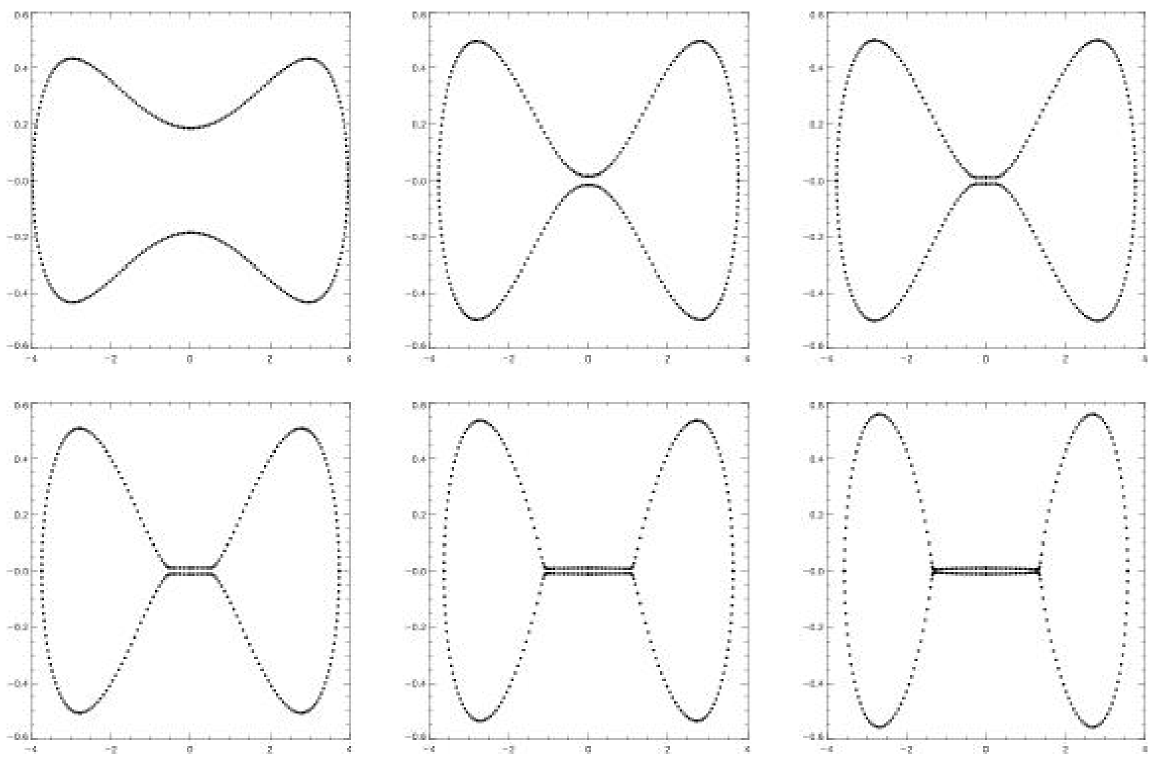


Similar phenomenon of filament formation is also found in a Newtonian fluid with insoluble surfactant on the surface of an air bubble. As a slender bubble necks due to surface tension, the inevitable pinch-off can be delayed or completely arrested by insoluble surfactant on the bubble surface. In the figure below, we see that as the bubble necks at the center, a long cylindrical neck forms due to the insoluble surfactant (the axis of symmetry is the horizontal axis). The formation of the filament can be understood as the balance between the internal pressure and the reduced capillary pressure due to the surfactant.

Young, Siegel, and Papageorgiou (continued)

Numerical simulations with both soluble and insoluble surfactants further show that the exchange between bulk and surface surfactants can lead to quite different filament dynamics and bubble pinch-off behavior. These results imply that we can control drop pinch-off by adding and tuning the bulk surfactant concentration, which will be very useful in micro- and nano-fluidic devices.

This is an ongoing collaboration with Jie Li (University of Cambridge).



D. COLLABORATIVE RESEARCH

Roman Andrushkiw

Equations of interface dynamics for quasi-stationary Stefan problem, V. Gafiychuk (Lviv)

Pattern recognition of blood mechanoemission curves in medical diagnostics, V. Orel, D. Klyushin, A. Romanov, and Y. Petunin (Kyiv)

Retrospective cohort investigation of risk factors in breast cancer, N. Boraday, D. Klyushin, Y. Petunin, and F. Miropolska (Kyiv)

John Bechtold

The effect of thermal expansion on edge flame dynamics, M. Matalon (Northwestern University)

Modeling and experiments of premixed and diffusion flames, C. K. Law, S. W. Yoo, G. Jomaas, Q. Jiao, and H. Wang (Princeton University)

Denis Blackmore

Robust shape preserving algorithms for geometric objects, R. Kopperman (CUNY), Y. Mileyko (Duke), and T. Peters (U. Conn.)

Vortex dynamics, O. Knio (Johns Hopkins), L. Ting (Courant), and B. Shashikanth (U. of New Mexico)

Integrability of infinite-dimensional Hamiltonian dynamical systems, A. Prykarpatsky (Krakow)

Particle dynamics, A. Rosato (NJIT)

Complexity measures for ecological systems, M. Levandowsky (Pace)

Global bifurcation of dynamical systems, J. Champanerkar (U. of South Alabama)

Amitabha Bose

Determining the activity phase of follower neurons in feedback networks, Farzan Nadim (NJIT)

Localized activity patterns in excitatory neuronal networks, J. Rubin (University of Pittsburgh)

Multistability in reciprocally connected inhibitory networks, V. Booth (University of Michigan)

The role of facilitation in coupled networks of neurons with T-type currents, Victor Matveev and Farzan Nadim (NJIT)

Bruce Bukiet

Mathematical modeling of cricket, M. Ovens (Monash University)

Vladislav V. Goldberg

Linearization problems for webs of codimension one, V. V. Lychagin (University of Tromso, Norway)

The generalization of a theorem of Griffiths-Harris, M. A. Akivis (Jerusalem College of Technology, Israel)

Daniel Goldman

Microvascular blood flow and mass transport during sepsis, C. G. Ellis (University of Western Ontario) and R. M. Bateman (University of British Columbia)

Tools for experiment-based modeling of microvascular transport processes, C. G. Ellis (University of Western Ontario) and R. M. Bateman (University of British Columbia)

Effect of microvascular blood flow on simulated tumor growth, Y.-N. Young (NJIT) and V. Cristini (University of California at Irvine)

Jorge Golowasch

The Pyloric Model Group: Functional analysis of a complex, distributed biological neural network, Ron Harris-Warrick (Cornell University, NY), Scott Hooper (Ohio University), Eve Marder (Brandeis University), Farzan Nadim (NJIT), and Michael Nusbaum (University of Pennsylvania).

Analysis of space-clamp errors and effect of neuronal structure of complex neurons on activity, Farzan Nadim (NJIT)

Roy Goodman

Bragg gratings in optical fiber communications, Michael Weinstein (Columbia University)

Dynamical systems modeling of wave-defect and wave-wave interactions, Richard Haberman (Southern Methodist University)

David J. Horntrop

Mesoscopic modeling for pattern formation in materials, M. Katsoulakis, (University of Massachusetts) and D. Vlachos (University of Delaware)

Lou Kondic

Dense granular systems, Robert P. Behringer (Duke University) and Corey O'Hern (Yale University)

Thin liquid films, Javier Diez (University Nacional del Centro, Tandil, Argentina)

Two-fluid flow, Burt Tilley (Olin College), Annette Hosoi (MIT), and Tetyana Segin (U. Alberta)

Flow of granular materials under gravity, Oleh Baran, Exxon Co.

Dawn A. Lott

Two-dimensional finite element analysis to assess flow characteristics of an in vitro aneurysm model, Hans R. Chaudhry (NJIT), Michael Siegel (NJIT), and Charles J. Prestigiacomo (UMDNJ)

The configuration of the aneurysm neck and proximal dome profoundly affect shear stress and flow velocities within an aneurysm and its parent vessel, Hans R. Chaudhry (NJIT), Michael Siegel (NJIT), and Charles J. Prestigiacomo (UMDNJ)

Three-dimensional stress distribution in axisymmetric cerebral saccular aneurysm, Hans R. Chaudhry (NJIT), Charles J. Prestigiacomo (UMDNJ), Michael Siegel (NJIT), and Thomas W. Findley (UMDNJ)

Effectiveness of numerical techniques for calculating the quantity of calcium species during calcium sparks in heart muscle, Joshua R. Berlin (UMDNJ)

Marc Q. Ma

Microarrays: Data exploration and analysis, H. Li (UMDNJ-Robert Wood Johnson Medical School), H-Y Wang (UMDNJ-Robert Wood Johnson Medical School), and P. Soteropolous (CAG at PHRI)

Multiscale molecular dynamics, B. Leimkuhler (University of Leicester, UK)

Molecular conformational dynamics study on soluble guanylyl cyclase, A. V. Beuve (NJ Med School of UMDNJ)

More durable biocatalysis agents by modifying the heme structure, Edgardo T. Farinas (Chemistry and Environmental Science, NJIT) and Sergiu Gorun (Chemistry and Environmental Science, NJIT)

Theoretical green chemistry, Sanjay Malhotra (Chemistry and Environmental Science, NJIT)

Victor Matveev

Effect of synaptic facilitation on multistability in inhibitory networks, A. Bose (NJIT) and F. Nadim (NJIT).

Study of calcium dynamics and the properties of endogenous calcium buffers at the crayfish neuromuscular junction, Jen-Wei Lin (Boston University)

Mechanisms of short-term synaptic facilitation and models of calcium-secretion coupling, Arthur Sherman (NIH), Richard Bertram (Florida State University), and Robert Zucker (University of California, Berkeley).

Zoi-Heleni Michalopoulou

Intereference cancellation in underwater acoustics, Uf Tureli (Stevens Institute of Technology)

Robert M. Miura

Spatial buffering mechanism: Mathematical model and computer simulations, B. Steinberg (University of Toronto), Y. Wang (Toronto), and H. Huang (York University)

On the formation of glass microelectrodes, H. Huang (York University), J. Wylie (City University of Hong Kong), and P. Howell (University of Oxford)

Thermal instability in drawing viscous threads, J. Wylie (City University of Hong Kong) and H. Huang (York University)

Mathematical modelling of ion transport in the brain-cell microenvironment with cell volume change, H. Huang (York University)

Analysis of systems of nonlinear diffusion equations with nonunique rest states, J. Wylie (City University of Hong Kong)

Richard O. Moore

Analysis and computation of thermally induced pattern formation and dynamics in parametric gain devices, K. Promislow (Michigan State University)

Simulation of rare events in optical communications, E. T. Spiller (Northwestern University), C. J. McKinstrie (Lucent Technologies), and W. L. Kath (Northwestern University)

Cyrill Muratov

Modeling and computational analysis of cell communication in Drosophila oogenesis, S. Y. Shvartsman (Princeton University)

Self-induced stochastic resonance phenomena in excitable systems, Weinan E (Princeton University) and Eric Vanden Eijnden (Courant Institute of Mathematical Sciences)

A variational approach to traveling waves and propagation phenomena for Ginzburg-Landau and combustion problems in infinite cylinders, M. Novaga (University of Pisa, Italy)

Strong segregation limit energetics in block copolymer systems, M. Novaga (University of Pisa, Italy), G. Orlandi (University of Verona, Italy) and C. Garcia-Cervera (UCSB)

Structure and simulations of domain walls in thin film micromagnetics, V. Osipov (New Physics Devices)

Farzan Nadim

Regulation of neuronal oscillations by synaptic dynamics, Y. Manor (Ben-Gurion University, Beer-Sheva, Israel), A. Bose (NJIT), and V. Booth (University of Michigan).

Configuration of circuit dynamics by modulatory fibers, M. P. Nusbaum (University of Pennsylvania Medical School, Philadelphia, PA).

Demetrios T. Papageorgiou

On compound threads with large viscosity contrasts, R.V. Craster (Imperial College London) and O. Matar (Imperial College London)

Wave formation in electrified falling films, D. Tseluiko (NJIT)

Nonlinear dynamics of a leaky dielectric fluid sheet under horizontal electric fields, O. Ozen and P.G. Petropoulos (NJIT)

Experiments on electrohydrodynamic instability of two-layer flow in a square channel, O. Ozen, N. Aubry, and P.G. Petropoulos (NJIT)

A mathematical model for core-annular flows with surfactant and no basic flow, S. Kas-Danouche (Universidad de Oriente, Venezuela) and M. Siegel (NJIT)

Influence of surfactant on necking and pinch-off in two fluid jets, M. Hameed (NJIT), M. Siegel (NJIT), and C. Maldarelli (Levich Institute, CUNY)

Effect of surfactant on bubble deformation, Y.-N. Young (NJIT), J. Li (Cambridge University), and M. Siegel (NJIT)

Antisymmetric capillary waves in electrified fluid sheets, J.-M. Vanden-Broeck (NJIT and University of East Anglia)

Gravity capillary waves in fluid layers under normal electric fields, P.G. Petropoulos (NJIT) and J.-M. Vanden-Broeck (NJIT and University of East Anglia)

Theory and experiment on the stagnant cap regime in the motion of spherical surfactant laden bubbles, R. Palaparthi (Rohm-Haas Corp.) and C. Maldarelli (Levich Institute, CUNY)

Modification of the Kortweg-de-Vries equation by normal electric fields, J.-M. Vanden-Broeck (NJIT and University of East Anglia)

Effect of horizontal electric fields on two-fluid inviscid systems, S. Grandison (University of East Anglia) and J.-M. Vanden-Broeck (NJIT and University of East Anglia)

Vortex sheets with electric fields, J.-M. Vanden-Broeck (NJIT and University of East Anglia), L. Barannyk (University of Michigan, Ann Arbor), and R. Krasny (University of Michigan, Ann Arbor)

Peter G. Petropoulos

Energy estimates and stability issues pertaining to the unsplit perfectly matched layer for hyperbolic systems of partial differential equations, Eliane Becache (Projet Ondes, INRIA-Rocquencourt, France)

Christopher S. Raymond

Mathematical modeling for immunocolloid labeling, Paul Milewski, (University of Wisconsin-Madison), Ralph Albrecht (University of Wisconsin-Madison), and David Edwards (University of Delaware)

Asymptotic analysis for traveling wave solutions of discrete reaction-diffusion equations, Christopher Elmer (NJIT)

Michael Siegel

Singularity formation for the three-dimensional Euler equations, Russ Caflisch (UCLA), Tom Hou (Caltech), and Dale Pullin (Caltech)

Surface-tension-driven breakup of an air bubble in a viscous liquid, Peter Howell (Oxford) and Wendy Zhang (University of Chicago)

Dynamics and breakup of two-fluid viscous liquid threads using asymptotic theories and experiments, Michael Booty (NJIT), Demetrious Papageorgiou (NJIT), and Muhammad Hameed (NJIT) and Charles Maldarelli (Levich Institute, CUNY)

Louis Tao

Dynamics of visual cortical neuronal networks, David Cai (CIMS, NYU), J. Andrew Henrie (CNS, NYU), David McLaughlin (CIMS, NYU), Robert Shapley (CNS, NYU), and Michael Shelley (CIMS, NYU)

Spike-triggered correlation analysis in neuroscience, David Cai (CIMS, NYU), Gregor Kovacic (RPI), and Michael Shelley (CIMS, NYU)

Bifurcations in fluctuation-driven neuronal networks, Gregor Kovacic (RPI) and Christina Lee (RPI)

Dynamics of neuronal networks of small-world architecture, David Cai (CIMS, NYU)

Estimation of synaptic conductances in neurons in recurrent networks, Antoni Guillamon (Universitat Politecnica de Catalunya, Barcelona) and David Terman (Ohio State)

Dynamics and pattern formation in myxobacteria, Roy Goodman (NJIT)

Instabilities in rotating shear flows, Edward Spiegel (Columbia) and Philip Yecko (Columbia and Montclair State)

Jean-Marc Vanden-Broeck

Nonlinear free surface flow disturbances created by submerged obstructions, F. Dias (Ecole Normale Superieure, France).

Nonlinear electrified fluid sheets, D. Papageorgiou (NJIT) and P. Petropoulos (NJIT)

Nonlinear free surface flows, M. Blyth, M. Cooker, E. Parau, and S. Grandison (all at University of East Anglia, UK)

Exponential asymptotics, J. Chapman (OCIAM, Oxford)

Wonsuk Yoo

From genes to modules of RNA metabolism: A comparative analysis of the transcription rates and transcript level, J. Song (Rutgers University)

Methodological development in trans-dimensional MCMC method, E. Slate (Medical University of South Carolina)

Yuan-Nan Young

Elastic critical layer, J. Miller (Cambridge University) and N. Balmforth (University of British Columbia)

Microvasculature transport in tumor modeling and simulation, D. Goldman (NJIT) and V. Cristini (UC Irvine)

Effects of surfactant on bubble pinch-off, J. Li (Cambridge University) and M. Siegel (NJIT)

X. STUDENT ACTIVITIES

A. UNDERGRADUATE ACTIVITIES

Amitabha Bose, Director of Undergraduate Studies

CSLA Outstanding Undergraduate Student Awards were given to Gerardo Giordano and Kunj Patel. Giordano was a double major with Applied Physics and will be joining the PhD program at Penn State in the Fall. Patel is enrolled in the BS/MS program in the Department of Mathematical Sciences.

Pi Mu Epsilon inducted four new members this year, Maciej Malej, Kunj Patel, Bryan Shaw, and Jason Viera. Kunj Patel, who had been math club president, will move to Pi Mu Epsilon president. Shaw and Malej will be vice-president and secretary-treasurer.

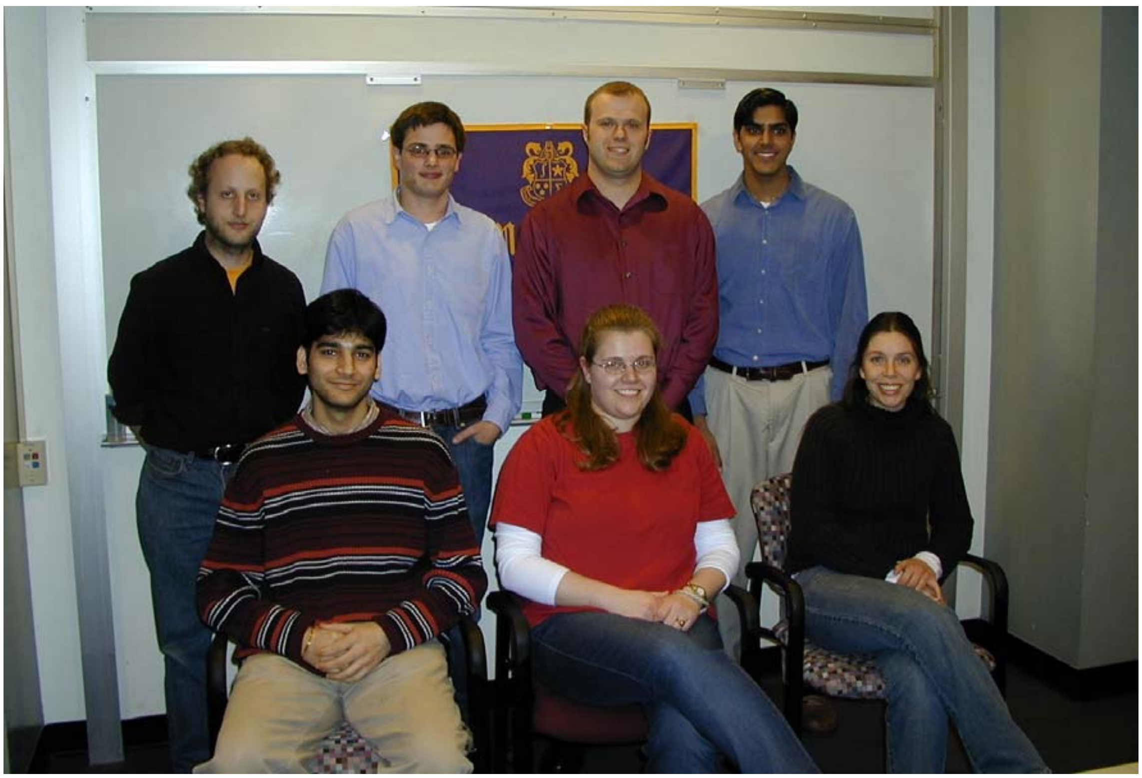
The Undergraduate Biology and Mathematics Training Program (UBMTP) began this spring. This National Science Foundation funded program seeks to train students in a research intensive atmosphere that is positioned at the interface of biology and mathematics. The six UBMTP students currently enrolled in the program are Sultan Babar, Jonathan Lansey, Maciej Malej, Angelie Mascarinas, Diana Martinez, and Kunj Patel. They are spending this summer in the biology labs of Claus Holzopfel, Jorge Golowasch, and Farzan Nadim working full time on problems involved in mathematics, ecology, and neuroscience. Amitabha Bose oversees the mathematical modeling aspects of their work.

Lukasz Kieloch completed a co-op position in the fall of 2004 with Checkfree. Henry Rodriguez completed a co-op internship during the summer of 2004 at the company TSL Services.

This was a very active year for the NJIT Math Club, which elected to call itself the Pi-Landers, a groan-inducing pun on our school mascot the Highlander. In October they took 3rd place in a campus wide contest "Major Mania" to convince visiting high-school students that theirs was the best major. Their main activity was college math contests. Four students participated in the prestigious Putnam Mathematics Competition for the first time. They also competed in the Virginia Tech Regional mathematics competition, the Garden State Undergraduate Mathematics Competition, and the Mathematical Contest in Modeling. In April, the department ran the First Annual NJIT Integration Bee. Fifteen students competed for $150 in prizes and some popular mathematics books. The winner was Abel George, a student recently transferred from India. Roy Goodman served as the faculty advisor to the Math Club.

Pi Mu Epsilon: Report by Roy Goodman

Pi Mu Epsilon inducted four new members this year, Maciej Malej, Kunj Patel, Bryan Shaw, and Jason Viera, on April 27, 2005. Kunj Patel, who had been math club president, will move to Pi Mu Epsilon president. Shaw and Malej will be vice-president and secretary-treasurer.



Top row: advisor Roy Goodman, Bryan Shaw, Maciej Malej, Kunj Patel
Bottom row: Mani Rana, Laura Medwick, Kelly Winters

Capstone Laboratory Projects:

CAPSTONE PROJECT: Chemical Oscillations and Waves: The Belousov-Zhabotinskii Reaction

Advisor: Prof. Peter G. Petropoulos

Students: Ali Monojir, Bennet Timothy, Briceno Cecilia, Mikhaylova Olga, Nijander Paul, Patel Kunj, Rana Mani, and Siddiqui Amna

The scientific study of processes occurring far from equilibrium is a relatively young discipline which sits at the intersection of a number of application areas including chemistry, biology, and mathematics. Interest in such processes dates back to the 1951 discovery of an oscillating chemical reaction by the Soviet chemist Boris P. Belousov. Subsequent work by Anatol Zhabotinskii at Moscow State University in the 1960s, and later in the United States, popularized the study of such systems and led Ilya Prigogine to formulate his theory of non-equilibrium thermodynamics. In this prototypical chemical reaction, several autocatalytic steps provide feedback loops which cause the catalyst - Cerium ions - to gain or loose electrons. In a well-stirred beaker, and in the presence of an indicator (Ferroin), the observable color of the reaction indicates the state of oxidation of the catalyst. When the reactants exhibit the color red, the catalyst is in its reduced state, while when the reactants exhibit the color blue, the catalyst is in its oxidized state. In the absence of an indicator, the reaction color oscillates between yellow (reduced state) and clear (oxidized state). Remarkably, when a small amount of this reaction mixture is poured into a Petri dish and left undisturbed, the red-blue transformations occurs quite differently; now spatial patterns arise in the form of travelling chemical waves of oxidation (blue), annihilating and reforming in a reduced background (red). As such, this so-called Belousov-Zhabotinskii (BZ) reaction is an ideal means of bringing to life, concepts from nonlinear dynamical systems theory involving both ordinary and partial differential equations when, respectively, the experiment is performed in a well-stirred beaker and in a Petri dish.

Under the supervision of the instructor, the students introduced the reactants (prepared previously) into the appropriate experimental setup to observe the bulk chemical oscillations in a well-stirred mixture and the travelling chemical waves in an undisturbed Petri dish. Potentiometric methods were employed to directly measure the concentrations of Bromide and Cerium in the well-stirred reaction. Digital imaging and post-processing of resultant images was employed in order to directly measure the speed of circularly expanding patterns in the Petri dish version of the experiment. The relevant mathematical topics were introduced and discussed in class in tandem with the experiments. The students employed software such as MATLAB, Mathematica, and ImageJ, to mathematically simulate the experiments and to post-process any collected data. Further details can be found on the Capstone Course website http://math.njit.edu/Undergraduate/Capstone/Spring%202005_petropoulos/index.htm

Included below are pictures of the laboratory setups, and some images from our experiments.

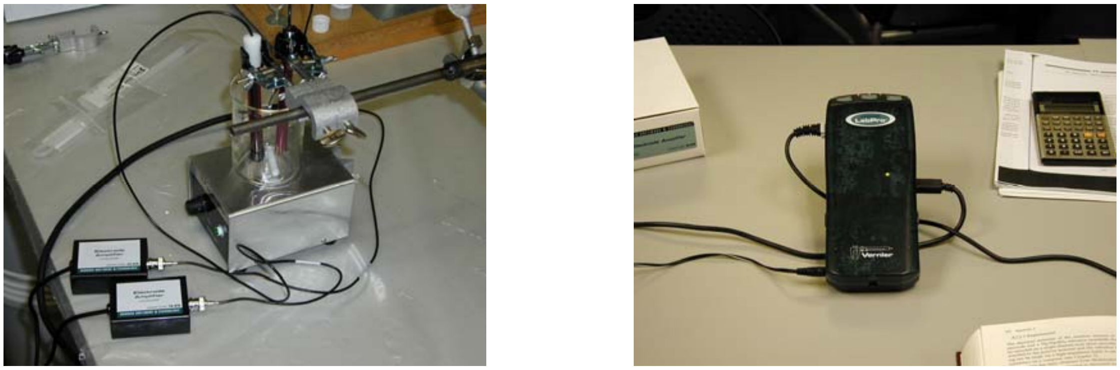


Figure 1:

(Left) The beaker sits on a magnetic stirrer while the Bromide- and Cerium-sensitive electrodes are connected through electrode amplifiers to the LabPro analog-to-digital converter,
(Right) which, in turn, is connected to the PC employed for data acquisition and analysis.

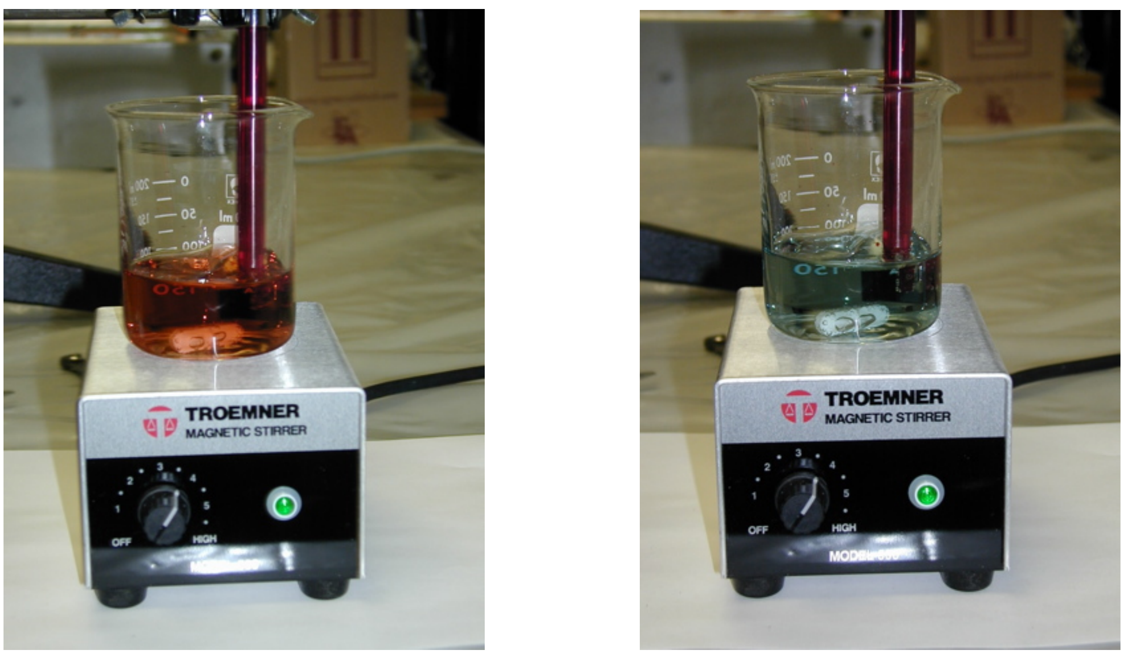
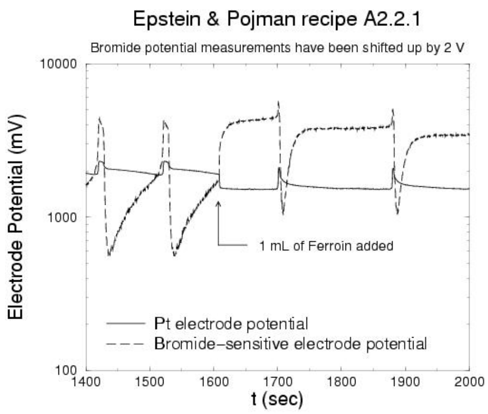


Figure 2:

State of the catalyst in the well-stirred BZ reaction mixture: (Left) reduced, (Right) oxidized.



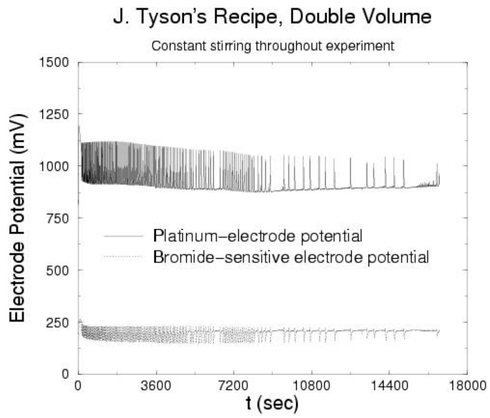


Figure 3:

Concentrations are proportional to the measured electrode potentials, shown above for two different reaction recipes. The long-time run on the right exhibits chaotic-like intermitency.

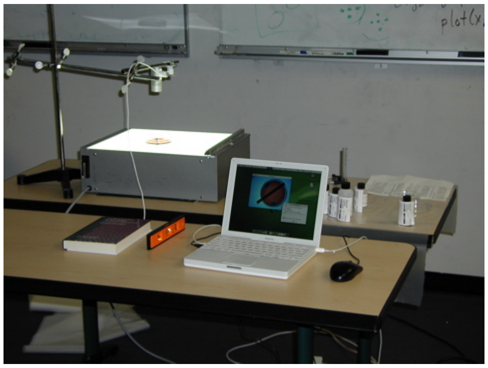
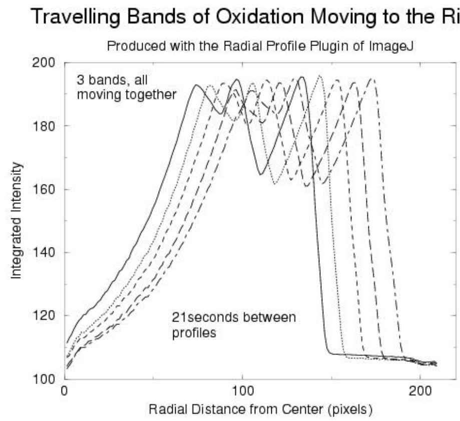


Figure 4:

(Left) In the pattern formation experiment, the Petri dish is placed on a light-box.

(Right) Typical image captured during the unstirred BZ reaction experiment; the image shows a group of three oxidation waves (light blue) expanding into the reduced (red) background from the center of the dish where an excitation was provided by gently touching a piece of wire to the surface of the fluid layer.



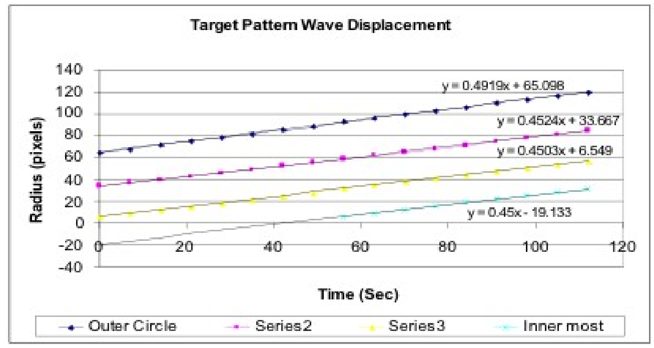


Figure 5:

(Left) Travelling wave profiles extracted from post-processed images; the wave is moving towards the right.

(Right) Front location as a function of time for various circularly expanding waves.

CAPSTONE PROJECT: Classical Mechanics--Rigid Body Motions

Advisor: Roy Goodman

Students: Gerardo Giordano, Laura Medwick, Alexander Minicozzi, Varun Oberoi, Ankit Shah, Bryan Shaw, and Kelly Winters

In a recent preprint, Diaconis, Holmes, and Montgomery have shown that under general conditions, a coin is inherently biased to land heads-up if it leaves the hand heads-up. This effect does not diminish as the coin is thrown higher or with more vigorous rotation. This bias arises because the coin precesses as it tumbles, and is a straightforward, though novel, application of results due to Euler in about 1750.

This result formed the basis of a capstone course in applied mathematics at NJIT. The first few weeks of the course were spent teaching the relevant results from classical mechanics. We reproduced experiments in which flipping coins are filmed using a high speed video camera in the laboratory of Edward Dreizin, NJIT Dept. of Mechanical Engineering, and used the Matlab Image Processing Toolbox to analyze the motion and quantify the bias. The bias arises from the interaction between two types of angular motion: flipping end over end, and the rotation of the coin's face. This is related to an angle theta defined from the initial conditions. In one experiment, we found that the coin, starting heads up would land heads up with a probability of 50.3% and verified the angle theta was consistent with this probability. We also analyzed "Feynman's plate" and the motion of the heavy top using the same techniques. The experiments are very simple, yet analyzing them required a great deal of knowledge and computational sophistication.

Included are pictures of the laboratory setup and images from our experiments.

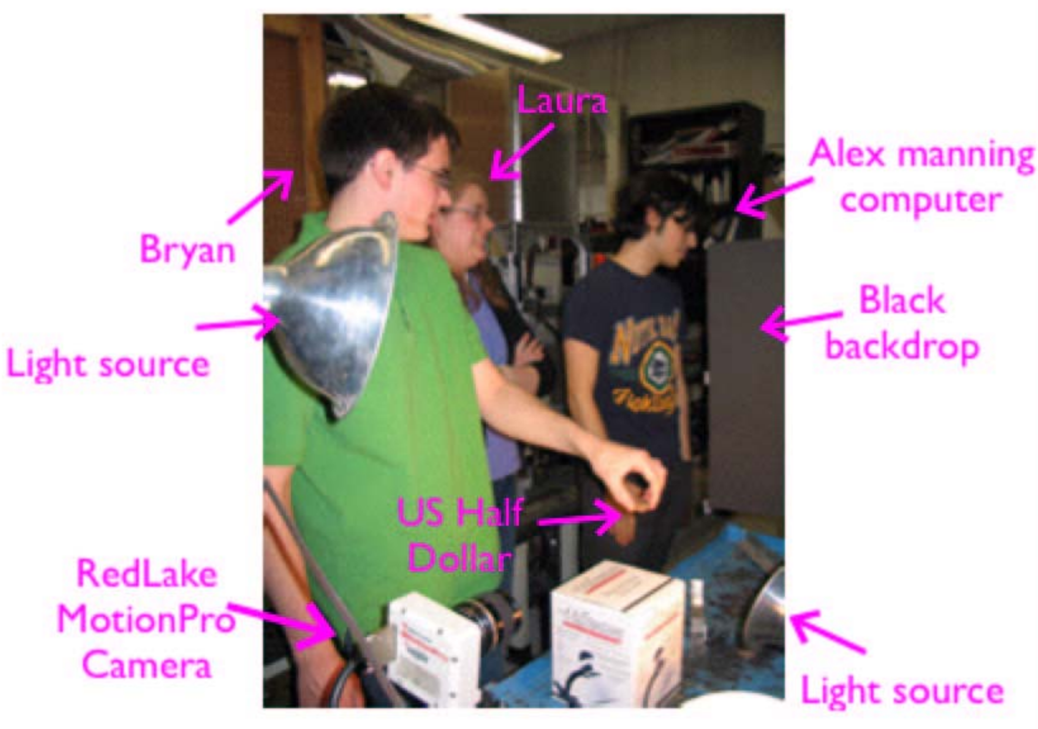


Figure 1: The gyroscope group

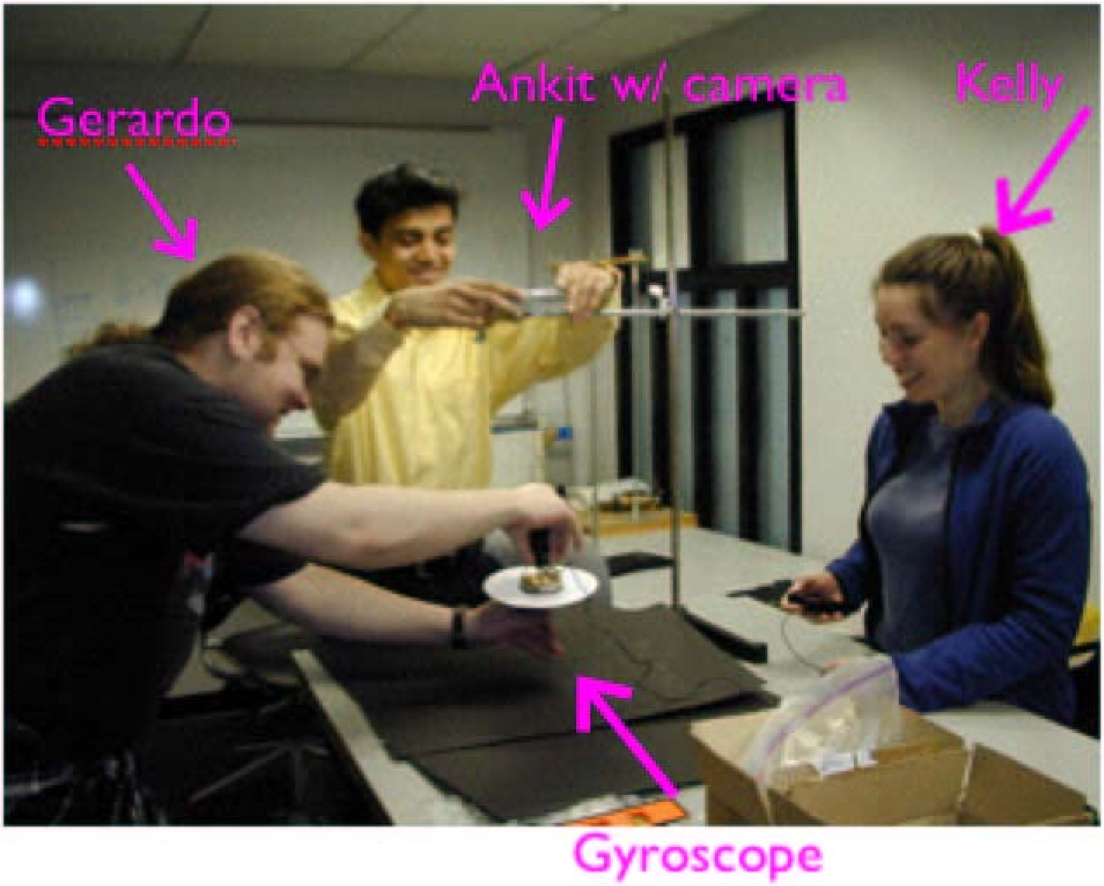


Figure 2: The coin toss group

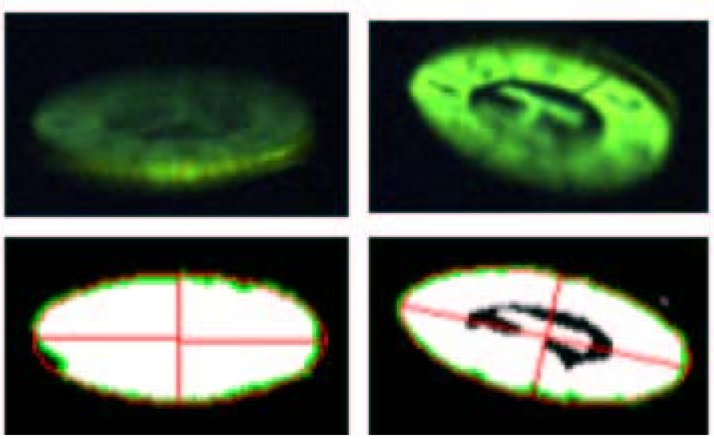


Figure 3: Stills from the coin toss video and least-squares fits to ellipses used to determine the coin's orientation.

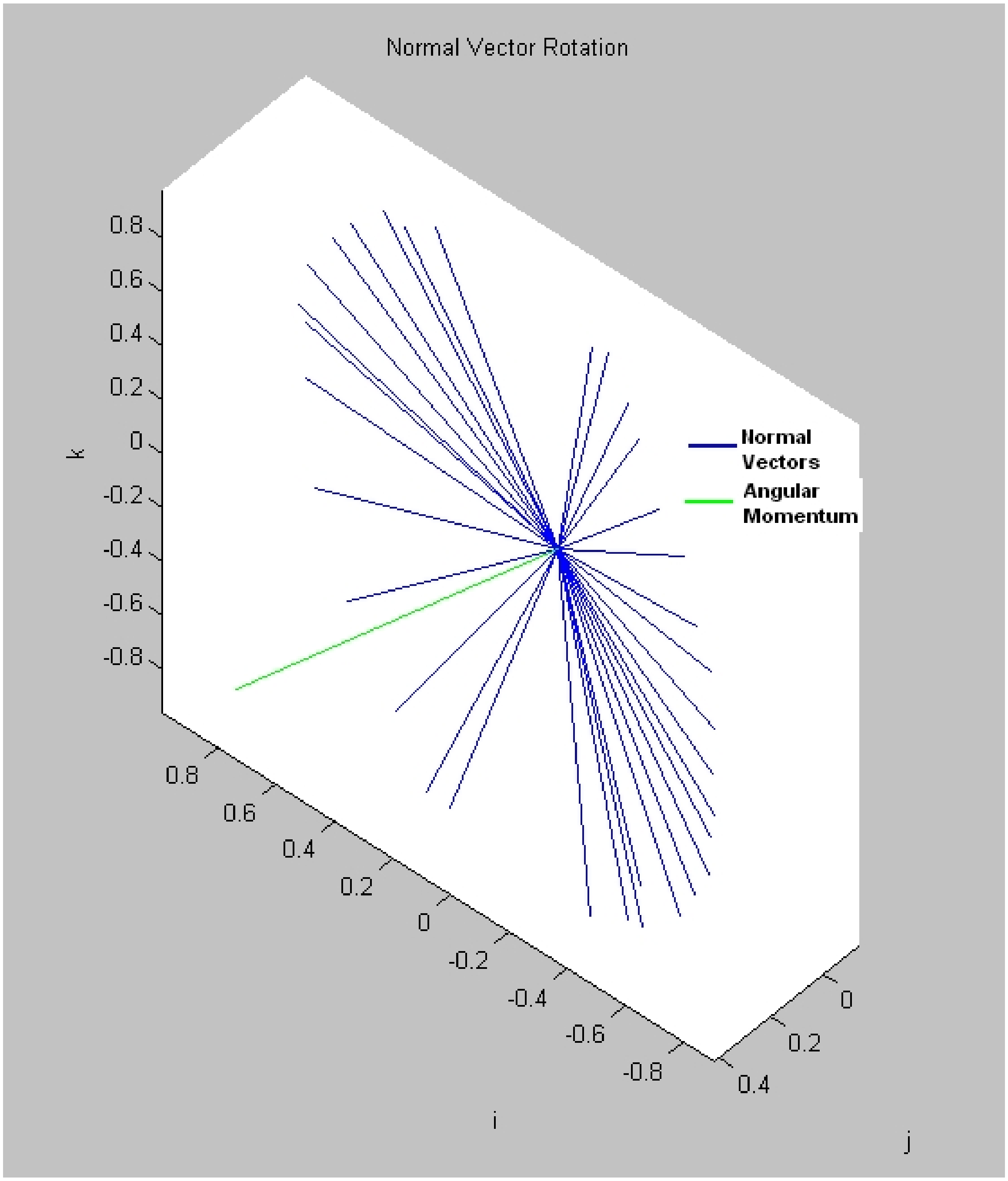


Figure 4: The mathematical reconstruction of the coin's orientation vectors (blue) and its angular velocity vector (green).

B. GRADUATE STUDENT RESEARCH PROGRAMS

Demetrios T. Papageorgiou, Director of the Graduate Program

Ph.D.s Awarded:

Jyoti Champanerkar, August 2004
Thesis: Pitchfork Bifurcations of Invariant Manifolds
Advisor: Dr. Denis Blackmore

Hoa Tran, August 2004
Thesis: Numerical Simulation of Microwave Heating of a Target with Temperature Dependent Electrical Properties in a Single Mode Cavity
Advisor: Dr. Jonathan Luke

Valery Lukyanov, January 2005
Thesis: Scattering Matrix Analysis of Photonic Crystals
Advisor: Dr. Gregory A. Kriegsmann

Christina Ambrosio, May 2005
Thesis: The Control of Frequency of a Conditional Oscillator Simultaneously Subjected to Multiple Oscillating Inputs
Advisor: Dr. Amitabha Bose

Muhammed Hameed, May 2005
Thesis: Influence of Surfactant on the Breakup of a Fluid Jet in Viscous Surrounding
Advisor: Dr. Michael Siegel

Yuriy Mileyko, May 2005
Thesis: Theory and Algorithms for Swept Manifolds Intersections
Advisor: Dr. Denis Blackmore

Lin Zhou, May 2005
Thesis: Perturbation Analysis on Dispersive Properties of Microstrip
Advisor: Dr. Gregory A. Kriegsmann

Publications, Presentations, and Conference Participation:

Christina Ambrosio:

Awards and Honors:
College of Science and Liberal Arts Award: Exceptional Graduate Student Award (April 2005); Presidential Strategic Initiative Scholar Award (Spring 2005).

Presentations:
May 2005, Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ,
The Control of Frequency of an Excitable Network Simultaneously Subjected to Multiple Oscillatory Inputs.

April 2005: Provost's Student Research Day, NJIT
The Control of Frequency of a Conditional Oscillator Simultaneously Subjected to Multiple Oscillatory Inputs.

Publications:
The Effect of Modulatory Neuronal Input on Gastric Mill Frequency, (with A. Bose and F. Nadim), Neurocomputing, Vol. 65-66 , pp. 623-631, June 2005.

Anisha Banerjee:

Awards and Honors:
Mathematical Sciences Department: Certificate of Excellence for Outstanding Research Presentation during Summer 2004.

Presentations:
March 2005, Bio-Medical Engineering Showcase, NJIT
Modeling Of Single-Capillary Oxygen Delivery In Working Muscle (Steady State).

April 2005: 1005th American Mathematical Society Meeting, Newark, DE
Modeling Of Single-Capillary Oxygen Delivery In Working Muscle (Steady State).

May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
Modeling Of Single-Capillary Oxygen Delivery In Working Muscle (Time Dependent Model).

Sibabrata Banerjee:

Awards and Honors:
Student Achievement Award (Graduate Student Association: Spring 2005).

Presentations:
May 2005: Frontiers in Applied and Computational Mathematics, NJIT, Newark, NJ
A Comparison Study of Models for the Human Sex Ratio.

Yiming Cheng:

Presentations:
April 2005: 1005th American Mathematical Society Meeting, Newark, DE
Analytical Proof of Equivalent Distorted Ratchet Potentials.

April 2005: Einsteins in the City Conference, City College of New York, New York City
Analytical Proof of Equivalent Distorted Ratchet Potentials.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Analytical Proof of Equivalent Distorted Ratchet Potentials.

Muhammad Hameed:

Awards and Honors:
Certificate of Distinction for participation in the Provost's Student Research Day, April 13, 2005.

Presentations:
November 2004, 57th Annual Meeting of the Division of Fluid Dynamics, Seattle, Washington
Influence of Surfactant on the Breakup of a Fluid Jet.

March 2005, Department of Mathematics and Statistics, Wichita State University Wichita, Kansas
Jet Pinch-off with Variable Surface Tension.

April 2005, Einsteins in the City Conference, City College of New York, New York City
Influence of Surfactant on the Breakup of a Two-Fluid Jet.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Influence of Surfactant on the Breakup of a Slightly Viscous Fluid Jet in a Viscous Surrounding.

Nickolas Kintos:

Presentations:
April 2005, Einsteins in the City Conference, City College of New York, New York City
Family of Probability Generating Functions Induced by Shock Model.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Modeling Actions of a Neuromodulator on a Rhythmic Neuronal Network (Poster).

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Family of Probability Generating Functions Induced by Shock Model (poster).

Soumi Lahiri:

Presentations:
April 2005, Einsteins in the City Conference, City College of New York, New York City
Linear and Log-Linear Models Based on Generalized Inverse Sampling Scheme.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Linear and Log-Linear Models Based on Generalized Inverse Sampling Scheme.

Filippo Posta:

Awards and Honors:
NJIT Graduate Student Association: Excellence Award, May 2005.

Satrajit Roychoudhury:

April 2005: Einsteins in the City Conference, City College of New York, New York City
Family of Probability Generating Functions Induced by Shock Model.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Family of Probability Generating Functions Induced by Shock Model.

Dmitri Tseluiko:

Awards and Honors:
Presidential Strategic Initiative Scholar Award - Spring 2005, for academic excellence in mathematical sciences.
Certificate of Distinction for participation in the Provost's Student Research Day, April 2005.

Publications:
Free Surface Cusp Formation as a Failure Mechanism for Hard Disk Drives with Fluid Dynamic Bearings (with J. Billingham, P. Dellar, P. Evans, M. Hameed, R. Hinch, F. Hendriks, T. Marchant, S. Patel, and B. Tilley), Proceedings of The Twentieth Annual Workshop on Mathematical Problems in Industry, August 2004.

Presentations:
April 2005: 1005th American Mathematical Society Meeting, Newark, DE
Nonlinear Stability of the Solutions of Modified Kuramoto-Sivashinsky Equations.

April 2005: Einsteins in the City Conference, City College of New York, New York City
Two-Dimensional Fluid Flow Down an Inclined Plane Under Normal Electric Field.

April 2005: Provost's Student Research Day, NJIT
Fluid Flow Down an Inclined Plane Under Normal Electric Field.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Nonlinear Stability of the Solutions of Modified Kuramoto-Sivashinsky Equations.

Lin Zhou:

Awards and Honors:
Best Poster Award: 1005th AMS Meeting, University of Delaware, April, 2005.

Talks and Posters:
April 2005: 1005th American Mathematical Society Meeting, Newark, DE
Complete Transmission Through a Periodically Perforated Slab.

April 2005: Einsteins in the CityConference, City College of New York, New York City
Complete Transmission Through a Periodically Perforated Slab.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Complete Transmission Through a Periodically Perforated Slab.

Ivan Zorych:

August 2004, IMA Workshop, University of Minnesota, Mathematical Modeling in Industry.

May 2005: Conference on Frontiers in Applied and Computational Mathematics, NJIT, Newark
Bayesian Models for Location Estimation in Wireless Networks.

Report of the Ph.D. Qualifying Exam Committee by Demetrios T. Papageorgiou

There are three parts to the qualifying exams in either the applied mathematics or the applied statistics track of the program. Students must obtain an A grade to pass an exam and in general they are allowed to take any one exam twice.

In August 2004, qualifying exams were given in Analysis, Linear Algebra and Numerical Methods, and Linear Algebra, Distribution Theory and Statistical Inference. The timing of the exams was such as to accommodate incoming transfer students who had the background to take the exams (the objective being timely graduation). As a result, one student successfully completed all his exams and started research work with a faculty advisor.

In January 2005, all exams in the applied mathematics track and two exams in the applied statistics track were offered. As a result two students successfully completed all their exams and started research work with faculty advisors.

In June 2005, all three exams in the applied mathematics track and one exam in the applied statistics track were offered. As a result, four more students completed all their written requirements and are currently working on the research part of their thesis.

Summer Lecture Series:

As in previous years, a twelve-week summer research program was implemented in order to provide a core of scholarly activities for graduate students at different points of their studies. In particular, a seminar series was developed consisting of a weekly lecture by a graduate student presenting his/her research. This activity was very successful, and it helped expose graduate students to each other's research and interests by giving presentations in front of their peers.

Student presentations during July and August 2004:

July 6	Roger Bustamante, “Complex Variable Method in Linear Elasticity”
July 14	Dmitri Tseluiko, “Numerical and Analytical Studies of Modified Kuramoto-Sivashinsky Equations Arising in Interfacial Electrohydrodynamics”
July 20	Ivan Zorych, “Bayesian Approach to Wireless Location Problem”
July 27	Jing Yu, “Developing Bayesian Network Inference Algorithms to Predict Causal Functional Pathways in Biological Systems”
August 3	Nickolas Kintos, “Modeling Actions of a Neuromodulator on a Rhythmic Network”

Graduate Student Lectures in Summer 2005:

May 25 — Viscous Fluid Flow Down an Inclined Plane in the Presence of a Normal Electric Field by Dmitri Tseluiko. (Advisor, D.T. Papageorgiou)

We consider equations that arise in the modelling of the wave motion in a perfectly conducting viscous thin film flowing down an inclined plate in the presence of an electric field which is uniform in its undisturbed state, and normal to the plate at infinity. Long-wave asymptotics analysis is used to derive a nonlinear evolution equation of the interface. Weakly nonlinear analysis of the evolution equation leads to a modified Kuramoto-Sivashinsky equation with an additional nonlocal term due to the Maxwell stresses exerted at the interface by the electric field. The linear stability analysis of this equation shows that the electric field induces a linear growth which is worse than the negative diffusion but still dominated by the fourth order damping. The numerical results show that the solutions of the modified Kuramoto-Sivashinsky equation are nonlinearly stable and exhibit a complicated behavior including chaotic oscillations as in the case of the usual Kuramoto-Sivashinsky equation; the basins of attraction of chaotic dynamics is significantly affected by the presence of the electric field, however, and this is seen as significantly larger windows in phase space where the global attracting solutions exhibit complicated dynamics. The nonlinear stability of the solutions is also proved analytically. The proof also leads to an upper bound estimate of the 2-norm of the solutions in terms of the length of the system and the electric field intensity parameter.

June 1 — Comparison of a Projection Neuron and Neuromodulator-Elicited Rhythmic Network in the Crab Cancer Borealis: A Modeling Study by Nickolas Kintos (Advisor, Farzan Nadim)

Neural networks can be directed to change their activity pattern when subjected to neuromodulation. We use modeling techniques to study the neuromodulation of central pattern generators (CPGs) in the crab (C. borealis) stomatogastric ganglion (STG). The STG is innervated by projection neurons whose processes release neuromodulatory substances. The modulatory commissural neuron 1 (MCN1) is one such projection neuron whose activity elicits a gastric mill rhythm (GMR: freq ~ 0.1 Hz). The frequency of this GMR is strongly regulated by a synaptic input from the pyloric circuit (freq: ~ 1 Hz). Recent experimental work has shown that bath application of the neuropeptide pyrokinin (PK) elicits a GMR in the isolated STG that mimics the MCN1-elicited GMR (S.R. Hertzberg et al., unpublished observations). We build a 2D model of the MCN1-elicited rhythm that exploits the difference in time scales operating within the asymmetric, reciprocally inhibitory CPG of the GMR. We then remove the MCN1 input and investigate what types of currents, when induced by PK in the CPG neurons can activate a GMR that mimics the MCN1-elicited GMR. We find that either (1) a slowly-inactivating plateau current

(Iplat) or (2) a slow, hyperpolarization-activated inward current (Ih) is sufficient to activate such a GMR. We also find two additional mechanisms whereby multiple PK-induced currents activate a GMR that reproduces the strong influence from the pyloric input. In particular, (3) a fast, voltage-dependent inward (Iproc) plus a slow outward (IK) current (both noninactivating) or (4) a fast inward (Iproc) and outward (IK) plus a slow inward (Ih) can activate such a GMR. We also examine the predictions of the 2D model in parallel with a more biophysically-detailed model. We conclude that a fast voltage-dependent current alone is not sufficient to activate a PK-elicited GMR and that a slow, voltage-dependent current is necessary.

June 8 Two-part seminar:

I) Cell-to-Cell Signal Propagation: A Mathematical Model by Filippo Posta (Advisor, C. Muratov)

In this talk I will present a general biological model for the propagation of a chemical signal (or Protease) within the Oocyte of a fruit fly. The biological model leads to construction of a mathematical model that consists of a coupled system of differential equations. I will introduce two possible ways of solving this system, under certain biologically valid assumptions. One method leads to a discrete solution, and the second leads to a continuous solution. I will also present some numerical results and indicate directions for future work.

II) A Family of Probability Generating Functions Induced by a Shock Model by Satrajit Roychoudhury. (Advisor M.C. Bhattacharjee)

We consider the conditions under which the function defined by $\int_{0}^{\infty}\frac{pz}{1-z+pz}Q(dp)$ is the probability generating function (pgf) of a non-negative integer-valued random variable N. We show that this is clearly true if the support of the mixing distribution Q is no larger than (0,1]. We also examine necessary conditions under which the function is a pgf. The motivation for this problem occurs in the nonparametric ageing properties of reliability methods.

June 15, no seminar due to qualifying exams.

June 22 Modeling Steady-State and Time-Dependent Oxygen Delivery in Working Muscle by Anisha Banerjee (Advisor, D. Goldman)

Oxygen delivery and distribution in muscle is studied using Krogh-type oxygen transport models. A series of modifications to the classic steady-state Krogh tissue cylinder model is used to study oxygen transport from individual capillaries in exercising skeletal muscle. Physiologically important features that are studied include intravascular resistance, myoglobin facilitation of oxygen diffusion, mitochondrial clustering near capillaries, and Michaelis-Menten oxygen consumption kinetics.

When consumption does not depend on oxygen concentration, intravascular resistance to oxygen diffusion is shown to significantly lower the partial pressure of oxygen in the tissue, suggesting a decrease in consumption rate. Mitochondrial clustering is shown to decrease the partial pressure of oxygen in most of the tissues, giving shallow tissue oxygen gradients, as observed experimentally. Myoglobin facilitation is found to play only a minor role in steady-state oxygen transport. By including oxygen-dependent consumption, the model makes it possible to study hypoxia as seeen in working muscle. This also permits more accurate calculation of tissue oxygen distributions and the total oxygen consumption rate (or oxygen extraction). The steady-state model is generalized to allow study of time-dependent oxygen transport. In particular, time-dependent tissue oxygen dixtributions and oxygen consumption are calculated for coordinated changes in muscle activity and blood flow.

June 29 Influence of Surfactant on Air Entrainment at a Contact Line by Xinli Wang (Advisor, M. Siegel)

We present a model for the rolling motion of a viscous fluid onto a rigid substrate, in the case when insolable surfactant is present at the fluid interface. The model is used to examine the influence of surfactant on air entrainment at the line where the fluid contacts the wall. In the absence of surfactant, an analytical solution has been obtained by Benney and Timson (1980) for the local flow field near the point of steady attachment. They find that a steady local solution exists for all capillary numbers. However, when surfactant is present, we conjecture that there is a critical capillary number above which steady shapes no longer exist.

July 6 Introduction to Gene Expression by Yiming Chen. (Advisor, R. Miura)

Abstract: In this presentation, I will give an introduction to the cell and to the chemical components of the cell, including DNA, RNA, and proteins. Then I will give the basic ideas of the GENE, GENE EXPRESSION, and how the GENE affects humans. Finally, I will discuss some of the technologies in this field, including Microarray Analysis and the DNA Chip.

July 13 Two part seminar

I) Geometric Analysis of Neuronal Activity by Lakshmi Chandrasekaran (Advisor A. Bose)

An excitable cell is one that responds to appropriate inputs and has the ability to fire an action potential. In this talk, phase-plane analysis is used to describe the dynamics of a model excitable cell. This geometric analysis explains how the neuron responds to transient inputs by showing which stimuli switch the neuron from inactive to active states. Further, it is shown how change of parameter values can change the position and shape of nullclines, thereby giving rise to different types of bifurcations.

II) A Two-Compartment Morris-Lecar Model by Joon Ha (Advisor A. Bose)

In this presentation, we use phase-plane analysis to explain neuron models. The Hodgkin-Huxley model was originally introduced to explain the behavior of the action potential in the squid giant axon. However, due to the complexity of its analysis, the Fitzhugh-Nagumo model was introduced as a simpler model that still captures the behavior of the action potential. Subsequently, the Morris-Lecar model was introduced, modifying the Fithugh-Nagumo model to represent the neuron's behavior more closely.

Here, we are interested in the coupled Morris-Lecar model for two soma-dendrite compartments, and see some of its dynamics.

July 20 Two-part seminar

I) Microcirculatory Transport: Modeling and Applications by D. Goldman

The microcirculation is the primary site of blood-tissue mass transport, but the relevant spatial and biophysical complexities make realistic modeling very challenging. We will outline current techniques for modeling microvascular blood flow and oxygen transport, and describe applications in biomedicine (e.g., cancer) and biotechnology (e.g., tissue engineering).

II) A Model for Two-Dimensional Sails in a Uniform Potential Flow by M.R. Booty
(on joint work with J.M. Vanden Broeck)

We consider a spatially two-dimensional potential flow model for the shape of and lift generated by one or more inextensible membranes or `sails' in a uniform stream. The problem is formulated and solved numerically via the boundary integral method.

Two problems of interest are (i) the 'luffing' of a sail, which occurs when it is nearly aligned with the oncoming stream, and (ii) the interaction of a pair of sails that share a common near-field. Here we ask whether or not there are optimal distributions of chord (or width) between the two sails and relative orientations of the pair that can maximize the total lift generated.

CAMS

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