CAMS

Center for Applied Mathematics and Statistics

ANNUAL REPORT

2001-2002

NJIT
New Jersey Institute of Technology

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I. FROM THE DIRECTOR

The period covered by this report, the 2001-2002 fiscal year, has produced dramatic changes in the environment in which CAMS operates. Without a doubt, the events of September 11, 2001, the most horrific of which occurred within sight of NJIT, will have a long lasting effect on all of us. The downturn in the economic fortunes of the country has had a harsh effect in the State of New Jersey. Despite all of these negatives, our belief is that the challenge of adversity spurs us to make the critical evaluations and take the required actions that bear fruit in the future. Our experience gives us confidence that we will succeed.

Locally, Dr. Saul Fenster, who oversaw the transformation of NJIT into a first-rate research institution, has retired from the presidency of NJIT following twenty-four years in that position. We take this opportunity to thank President Fenster for his vision for research at NJIT and his unflagging support for CAMS. We are fortunate to have Dr. Robert A. Altenkirch, who succeeded Dr. Fenster as the seventh president of NJIT in July of 2002, to take up leadership at NJIT. His outstanding reputation as a nationally recognized leader in combustion (an area well represented in CAMS) and his success as Vice President for Research at Mississippi State University give us reason to hope that NJIT and CAMS will be inspired to attain dramatically new levels under his guidance.

Through a challenging year, CAMS continued to strengthen its research and research infrastructure. Six new research grants as well as renewal of several others made 2001-2002 a banner year for research funding. Even more satisfying and promising for the future is the new funding of at least four of the proposals by first and second year members of CAMS to be formally reported in *next year's* report. In the spring semester, the Applied Mathematics and Statistics Colloquium series was augmented with a weekly Mathematical Biology Workshop. The Capstone Laboratory continues to make progress in bringing the CAMS vision of the Mathematical Sciences to NJIT's undergraduates. With an NSF SCREMS grant, generously matched by NJIT, CAMS significantly enhanced its computing resources with the acquisition of two Compaq ES40 compute servers, each with four state-of-the art Alpha processors. In our efforts to maintain high quality computational resources for CAMS researchers and their students, we appreciate the assistance and support provided by David Ullman, Associate Provost for Information Services and Technology, David Perel, Director of Engineering Computing, and their staff. The CAMS 2002 summer program for graduate students has seen them taking greater responsibility for activities such as organizing twice-weekly seminars and refreshments.

The accomplishments of CAMS have been built with the support, inspiration, and dedication of many individuals. CAMS is grateful to William Van Buskirk, Provost, NJIT, for creating an environment where the aspirations of CAMS are espoused and appreciated. G. Miller Jonakait, Dean of CSLA, and Donald Sebastian, Vice President for Research and Development, have encouraged CAMS through their strong support of scientific research. CAMS continues to be appreciative of the deep commitment of Gregory A. Kriegsmann, Foundation Chair in Applied Mathematics, whose generous supply of resources, advice, and energy have been instrumental in our ongoing success.

Daljit S. Ahluwalia, Director **Jonathan Luke, Associate Director**

II. MISSION STATEMENT

The Center for Applied Mathematics and Statistics (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. The formal structure of CAMS consists of the Director, Associate Director, and various committees. However, the essential nature of the organization is that of a voluntary association of individual researchers from many disciplines joined in a collegial collaboration to enhance mathematical research at NJIT.

CAMS undertakes a wide range of activities in pursuing its mission. CAMS brings together researchers from academia, industry, and government with complementary strengths and common goals to NJIT and neighboring institutions by organizing interdisciplinary workshops. In some cases, CAMS secures the appointment of Research Professors to formalize this relationship to NJIT so that grants can be jointly pursued. CAMS provides its members with laboratory support by maintaining the CAMS/Math Computational Laboratory, the NSF Capstone Laboratory, and the Statistical Consulting Laboratory. CAMS activities also include support for the submission of research proposals, which is done through the dissemination of information, organization of group projects, collegial advice, and assistance with the application documents. Senior members of CAMS commit a significant amount of time and effort in providing guidance and mentoring to young researchers in their efforts to obtain funding. Exploring new areas of application of the mathematical sciences for the purpose of maintaining a presence in the forefront of science is a fundamental function of CAMS. Graduate student research is encouraged through the CAMS Summer Research Program and with support for students to attend conferences.

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 research and academic relationships with industry and business.

III. MEMBERS AND VISITORS

Department of Mathematical Sciences

Ahluwalia, Daljit S.
Andrushkiw, Roman
Bechtold, John
Bhattacharjee, Manish
Blackmore, Denis
Booth, Victoria
Booty, Michael
Bose, Amit
Bukiet, Bruce
Chaudhry, Hans
Dhar, Sunil
Dios, Rose
Elmer, Christopher
Goldberg, Vladislav
Goldman, Daniel
Horntrop, David
Kappraff, Jay
Kondic, Lou
Kriegsmann, Gregory A.
Lott, Dawn
Luke, Jonathan
Michalopoulou, Zoi-Heleni
Milojevic, Petronije
Miura, Robert M.
Muratov, Cyrill
Nadim, Farzan
Papageorgiou, Demetrios
Perez, Manuel
Petropoulos, Peter G.
Ray, Bonnie
Siegel, Michael
Spencer, Thomas
Stickler, David
Tavantzis, John
Tilley, Burt

Visiting Members

Balaji, Srinivasan
Goodman, Roy
Rodrigo, Marianito
Volkov, Darko

Department of Biomedical Engineering

Michael Lacker

Department of Civil and Environmental Engineering

Meegoda, Jay N.

Department of Mechanical Engineering

Aubry, Nadine
Rosato, Anthony

CAMS Research Professors

Erneux, Thomas	Université Libre de Bruxelles, Belgium
Georgieva, Anna	Novartis Pharmaceuticals Corporation, East Hanover, NJ
Vanden-Broeck, Jean-Marc	University of East Anglia, Norwich, England

Short-Term Visitors

Chopra, Dharam V.	Wichita State University, Kansas
Smith, Paul	University of Dundee, Scotland

IV. COLLOQUIA AND SEMINARS

Applied Mathematics Colloquium

September 7 **Roman Samulak**, Center for Data Intensive Computing, Brookhaven National Laboratory, Upton, New York

"Computational Hydro- and Magnetohydrodynamics of 3D Free Surface Flows of Real Materials"

September 14 **Robert V. Kohn**, Courant Institute of Mathematical Sciences, New York University, New York, New York

"A New Approach to the Continuum Modeling of Epitaxial Growth"

September 21 **Serafim Kalliadasis**, Department of Chemical Engineering, University of Leeds, Leeds, West Yorkshire, United Kingdom

"Free-Surface Thin Film Flows Over Topography"

September 28 **Richard J. Braun**, Department of Mathematical Sciences, University of Delaware, Newark, Delaware

"A Model for Crystal Growth on a Masked Substrate"

October 5 **Victoria Booth**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Neural Mechanisms for Generating Rate and Temporal Codes in Networks of Hippocampal Pyramidal Cells"

October 12 **Marianito R. Rodrigo**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Front Dynamics and Exact Solutions of Reaction-Diffusion Systems"

October 19 **Jean-Marc Vanden-Broeck**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Free Surface Flows with Exponentially Small Waves"

October 26 **Weinan E**, Mathematics Department, Princeton University, Princeton, New Jersey

"Numerical Methods with Multi-Scale Physics"

November 2 **Roy Goodman**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Trapping Light: Numerical Experiments and ODE Models"

November 9 **James Keener**, Department of Mathematics, University of Utah, Salt Lake City, Utah

"The Dynamics of Defibrillation of Cardiac Tissue"

November 14 **Joseph B. Keller**, Department of Mathematics and Mechanical Engineering, Stanford University, Stanford, California

"Mathematics of Visual Perception: Color Vision"

November 16 **Robert Lipton**, Department of Mathematics, Louisiana State University, Baton Rouge, Louisiana

"Bounds for the Homogenized Failure Surface and the Design of Composite Structures for Strength and Stiffness"

November 30 **L. Pamela Cook**, Department of Mathematical Sciences, University of Delaware, Newark, Delaware

"Polymers: Properties and Characterization"

December 7 **Paul A. Martin**, Department of Mathematical and Computer Sciences, Colorado School of Mines, Golden, Colorado

"Fundamental Solutions and Functionally-Graded Materials"

January 25 **Tim Lewis**, Center for Neural Science and Courant Institute of Mathematical Sciences, New York University, New York City, New York

"Dynamics of Neurons Connected by Inhibitory Synapses and Electrical Coupling"

January 30 **Jorge Golowasch**, Biological Sciences Department, Rutgers-Newark/NJIT, Newark, New Jersey

"Biological and Computational Approach to Study the Homeostasis of Neuronal Electrical Activity"

February 1 **V. V. Goldberg**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Webs and PDEs"

February 8 **Cyrill Muratov**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Testing a Hypothesis in Developmental Biology: Modeling and Computational Analysis of Autocrine Loops in Drosophila Oogenesis"

February 15 **Christopher Elmer**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"An Introduction to Discretized Reaction-Diffusion Equations: Traveling Wave Solutions, Applications, and Phenomena"

February 22 **Peter Petropoulos**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Absorbing Boundary Conditions for the Numerical Solution of the Time-Dependent Maxwell Equations"

March 1 **Jean Taylor**, Department of Mathematics, Rutgers University, New Brunswick, New Jersey

"Rotating Crystals"

March 8 **Ranganathan Narayanan**, Department of Chemical Engineering, University of Florida, Gainesville, Florida

"Morphological and Other Interfacial Instabilities"

March 14 **Christopher S. Raymond**, Department of Mathematics, University of Wisconsin-Madison, Madison, Wisconsin

"Mathematical Modeling for Immunocolloid Labeling"

March 15 **Philip Holmes**, Department of Mechanical and Aerospace Engineering and Program in Applied and Computational Mathematics, Princeton University, Princeton, New Jersey

"Low Dimensional Models of Turbulent Plane Couette Flow"

March 22 **Cameron Connell**, Department of Mathematics, University of California, Los Angeles, California

"Atomistic Theory of Elasticity for Epitaxial Growth"

April 5 **Jonathan H. C. Luke**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Sedimentation and the Dynamics of Stratification and Fluctuation Decay"

April 12 **Nadine Aubry**, Department of Mechanical Engineering and Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Numerical Simulations and Experiments of Electrorheological Suspensions"

April 17 **Michael Shub**, IBM, TJ Watson Research Center, Yorktown Heights, New York

"Newton's Method on Manifolds and a Geometric Model of the Human Spine"

April 19 **John W. M. Bush**, Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts

"Pipes, Polygons, Chains and Fishbones: The Form and Physics of Falling Fluids"

April 26 **Philip Broadbridge**, Department of Mathematical Sciences, University of Delaware, Newark, Delaware

"Applications of Integrable Nonlinear Diffusion Equations"

April 29 **Fazle Hussain**, Department of Mechanical Engineering, University of Houston, Houston, Texas

"Coherent Structures in the Near-Wall Region of Turbulent Boundary Layers"

May 3 **Triantaphyllos R. Akylas**, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts

"Nonlinear Internal Gravity-Wave Beams"

June 7 **Anil C. Wijeyewickrema**, Department of Civil Engineering, Tokyo Institute of Technology, Tokyo, Japan

"Dispersion of Extensional Waves in Pre-Stressed Imperfectly Bonded Incompressible Elastic Layered Composites"

Statistics Colloquium

September 19	**S.P. Mukherjee**, Department of Statistics, University of Calcutta, Calcutta, India *"Multivariate Extensions of Univariate Life Distributions"*
October 3	**Sanjib Basu**, Merck Research Laboratories, on sabbatical from Northern Illinois University, DeKalb, Illinois *"Bayesian Analysis of Competing Risks with Masked Cause-of-Failure"*
October 24	**Srinivasan Balaji**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey *"Risk Sensitive Control and Multiplicative Ergodicity for Markov Chains"*
October 31	**Serge Wind**, Lucent Technologies (Retired) *"Managing Corporations for Value Using a Realized Profit Metric"*
November 7	**James W. Watson**, Statistical Modeling and Survey Analysis, Management Systems Center, AT&T Labs *"Customer Acquisition Using Logistic Regression"*
December 12	**Sunil K. Dhar**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey *"Various Hats a Statistical Consultant May Wear"*
January 15	**Weichung Joe Shih**, Professor of Biostatistics Division of Biometrics, UMDNJ-School of Public Health and Director of Biometrics, The Cancer Institute of New Jersey, New Brunswick, New Jersey *"The Dropout Problem in Clinical Trials: Issues and Suggestions"*
March 6	**Russ Labe**, Vice President and Director in the Merrill Lynch Management Science Group, Princeton, New Jersey and **Raj Nigam**, Chief Scientist, Director and Vice President of the Management Science group at Merrill Lynch, Princeton, New Jersey *"The Pricing Analysis for Merrill Lynch Integrated Choice"*
March 13	**Srinivasan Balaji**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey *"Passage Time Moments for Diffusion Processes"*
March 18	**Peter Olofsson**, Department of Statistics, Rice University, Houston, Texas *"Sampling in Branching Processes: Theory and Biological Applications"*
March 21	**Yu-Yun Ho**, Applied Research, Telcordia Technologies, Morristown, New Jersey *"Data Mining in Uncovering Terrorist Networks"*
April 10	**Sudhansu Baksi**, Analytic Modeling Group, Management Systems Center, AT&T Labs *"Inventory Monitoring and Auditing with PPS Sampling"*

April 17 **Ken Johnson**, Principal Technical Staff Member at AT&T Labs in the Statistical Modeling & Survey Analysis Group

"Forecasting and Consulting - An Interesting Example"

May 13 **Agnes Kovacs**, Project/Senior Statistician at BioCor, Yardley, Pennsylvania

"Maximum Likelihood Estimation in the Poly-Weibull Model"

May 15 **Jun Ying**, Department of Statistics, University of Connecticut, Storrs, Connecticut

"Estimation of Bivariate Measurements Having Different Change Points, with Application to Cognitive Aging"

May 17 **Antai Wang**, Department of Biostatistics, University of Rochester, Rochester, New York

"Parameter Estimation in Bivariate Copula Models"

June 25 **Dharam Chopra**, Department of Mathematics and Statistics, Wichita State University, Kansas

"On Some Matrices With Some Combinatorial Structure"

Mathematical Biology Workshop

February 5 **Robert M. Miura**, Departments of Mathematical Sciences and Biomedical Engineering, New Jersey Institute of Technology, Newark, New Jersey

"Analysis of Bursting Electrical Activity in Pancreatic β-Cells"

February 13 **Daniel Goldman**, Departments of Mathematical Sciences and Biomedical Engineering, New Jersey Institute of Technology, Newark, New Jersey

"Experiment-Based Modeling of Oxygen Transport in Microvascular Networks"

February 20 **Cyrill Muratov**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Matched Asymptotics: An Application to Two Problems in Mathematical Biology"

February 27 **Ken Harris**, Center for Molecular and Behavioral Neuroscience, Rutgers-Newark, Newark, New Jersey

"Phase and Population Coding in the Hippocampus"

March 13 **Bronwyn Bradshaw-Hajek**, School of Mathematics and Applied Statistics, University of Wollongong, Australia

"Reaction-Diffusion Equations for Changing Gene Frequencies"

March 27 **Amitabha Bose**, Department of Mathematical Sciences, New Jersey Institute of Mathematical Sciences, Newark, New Jersey

"Roles of Synaptic Depression in Neuronal Networks"

April 3 — **Michael Lacker**, Departments of Biomedical Engineering and Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Some Open Questions in a Symmetry Breaking Model That Regulates Cell Growth and Ovarian Follicle Development Through Hormonal Feedback"

April 10 — **Farzan Nadim**, Department of Mathematical Sciences, New Jersey Institute of Technology and Department of Biological Sciences, Rutgers-Newark, Newark, New Jersey

"A Mathematical Analysis of the Interaction Between Two Oscillators With Different Frequencies"

April 17 — **John Rinzel**, Courant Institute and Center for Neural Science, New York University, New York City, New York

"Network Bursting Oscillations in Developing Spinal Cord"

April 24 — **Dawn Lott**, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, New Jersey

"Advances in Modeling and Numerical Techniques for Optimal Patterns of Suturing Wounds Based on Nonlinear Stress Analysis"

May 1 — **Diana Thomas**, Department of Mathematical Sciences, Montclair State University, Upper Montclair, New Jersey

"A Model Describing the Phytoremediation of Metals: A Reset Equation"

V. PUBLICATIONS, PRESENTATIONS, AND REPORTS

A. PUBLICATIONS

JOURNAL PUBLICATIONS

Roman Andrushkiw

Spectral Problem for a Class of Polynomial Operator Pencils, Nonlinear Boundary Value Problems (Nelineinye Granichnye Zadachi), Vol. 12, pp. 13-18, 2002.

John Bechtold

The Dependence of the Markstein Length on Stoichiometry, (with M. Matalon), Combustion and Flame, Vol. 127, pp. 1906-1913, 2001.

Denis Blackmore

Creation of Freeform Solid Models in Virtual Reality, (with M. Leu, B. Maiteh, L. Fu), Annals of CIRP, Vol. 50, pp. 73-76, 2001.

Dynamical Properties of Discrete Lotka-Volterra Equations, (with J. Chen, J. Perez, M. Savescu), Chaos Solitons & Fractals, Vol. 12, pp. 2553-2568, 2001.

A Perspective on Vibration-Induced Size Segregation of Granular Materials, (with A. Rosato, N. Zhang, Y. Lan), Chemical Engineering Science, Vol. 57, pp. 265-275, 2002.

Higher Order Conditions for Weak Shocks: Modified Prandtl Relation, (with L. Ting), PAMM, Vol. 1, pp. 397-398, Zurich, 2002. (online journal)

Victoria Booth

Neural Mechanisms for Generating Rate and Temporal Codes in Model CA3 Pyramidal Cells, (with A. Bose), Journal of Neurophysiology, Vol. 85, pp. 2432-2445, 2001.

Burst Synchrony Patterns in Model Hippocampal Pyramidal Cell Networks, (with A. Bose), Network: Computation in Neural Systems, Vol. 13, pp. 157-177, 2002.

Transitions Between Different Synchronous Firing Modes Using Synaptic Depression, (with A. Bose), Neurocomputing, Vols. 44-46C, pp. 61-67, 2002.

Michael Booty

Synthetic Fuel for Imitation of Municipal Solid Waste in Experimental Studies of Waste Incineration, (with S.S. Thipse, C. Sheng, R.S. Magee, E.L. Dreizin), Chemosphere, Vol 44, pp. 1071-1077, 2001.

Chemical Makeup and Physical Characterization of a Synthetic Fuel and Methods of Heat Content Evaluation for Studies on MSW Incineration, (S.S. Thipse, C. Sheng, R.S. Magee, J.W. Bozzelli), Fuel, Vol. 81, pp. 211-217, 2002.

Amitabha Bose

Bistable Oscillations Arising from Synaptic Depression, (with Y. Manor and F. Nadim), SIAM Journal of Applied Mathematics, Vol. 62, pp. 706-727, 2001.

Burst Synchrony Patterns in Hippocampal Pyramidal Cell Model Networks, (with V. Booth), Network: Computation in Neural Systems, Vol. 13, pp. 157-177, 2002.

Transitions Between Different Synchronous Firing Modes Using Synaptic Depression, (with V. Booth), Neur. Comp., Vol 44-46C, pp. 61-67, 2002.

Neural Mechanisms for Generating Rate and Temporal Codes in Model CA3 Pyramidal Cells, (with V. Booth), Journal of Neurophysiology, Vol. 85, pp. 2432-2445, 2001.

Bruce Bukiet

Mechanical Properties of Diseased Hearts During Adaptation, (with H. R. Chaudhry, A. Ritter, R. Arora), Journal of Mechanics in Medicine and Biology, Vol. 2, pp. 1-12, 2002.

Hans Chaudhry

Mechanical Properties of Diseased Hearts During Adaptation, (with B. Bukiet, A. Ritter, R. Arora), Journal of Mechanics in Medicine and Biology, Vol.2, pp. 1-12, 2002.

Sunil Dhar

Longitudinal Assessment of Neuropsychological Functioning, Psychiatric Status, Functional Disability and Employment Status in Chronic Fatigue Syndrome, (with Lana A. Tersky, et al.), Journal of Applied Neuropsychology. Vol 8(1), Special Issue: pp. 41-50, 2001.

Rose Dios

On Orthogonal Arrays of Strength Four, (with D. Chopra), Congressus Numerantium, Vol. 152, pp. 125-131, 2001.

On the Existence of Balanced Arrays of Strength Five, Journal of Combinatorial Mathematics and Combinatorial Computing, Vol. 41, pp. 3-7, 2002.

A Note on Balanced Arrays of Strength Eight, (with D. Chopra), Journal of Combinatorial Mathematics and Combinatorial Computing, Vol. 41, pp. 133-138, 2002.

Christopher Elmer

Traveling Wave Solutions for Bistable Differential-Difference Equations with Periodic Diffusion, (with E.S. Van Vleck), SIAM Journal on Applied Mathematics, Vol. 61, pp. 1648-1679, 2001.

Thomas Erneux

Chaos in Coherence Modulation: Bifurcations of an Oscillator Generating Optical Delay Fluctuations, (with L. Larger, M.W. Lee, J.-P. Goedgebuer, W. Elflein), JOSA B, Vol. 18, pp. 1063-1068, 2001.

Dimensionless Rate Equations and Simple Conditions for Self-Pulsing in Laser Diodes, (with T.W. Carr), IEEE J. of Quantum. Electronics, Vol. 37, pp. 1171-1177, 2001.

Cascade of Parametric Instabilities in a Multimode Laser, (with T.W. Carr, C. Szwaj, M. Lefranc, D. Derozier, S. Bielawski), Phys. Review A, Vol. 64, 053808, 2001.

An Analytical Study of a Periodically Driven Laser with a Saturable Absorber, (with T.W. Carr), Europ. J. Phys. D, Vol. 17, pp. 67-74, 2001.

Bridges of Periodic Solutions and Tori in Semiconductor Lasers Subject to Delay, (with D. Pieroux, B. Haegeman, K. Engelborghs, D. Roose), Physical Review Letters, Vol. 87, 193901, 2001.

Minimal Rate Equations Describing Polarization Switching in Vertical-Cavity-Surface-Emitting Lasers, (with J. Danckaert, B. Nagler, J. Albert, K. Panajotov , I. Veretennicoff), Optics Communications, Vol. 201, pp. 129-137, 2002.

Averaged Equations for Injection Locked Semiconductor Lasers, (with M. Nizette, A. Gavrielides, V. Kovanis), Physica D, Vol. 161, pp. 220-236, 2002.

Period Three Limit-Cycles in Injected Semiconductor Lasers, (with A. Gavrielides, V. Kovanis, M. Nizette, T.B. Simpson), Journal of Optics B: Quantum and Semiclassical Optics, Vol. 4, pp. 20-26, 2002.

Bifurcation to Polarization Self-Modulation in Vertical-Cavity Surface-Emitting Lasers, (with M. Sciamanna, F. Rogister, O. Deparis, P. Mégret, M. Blondel), Optics Letters, Vol. 27, pp. 261-263, 2002.

Bifurcation Bridges Between External-Cavity Modes Lead to Polarization Self-Modulation in Vertical-Cavity Surface-Emitting Lasers, (with M. Sciamanna, F. Rogister, O. Deparis, P. Mégret, M. Blondel), Phys. Rev. A, Vol. 65, 041801, 2002.

Bistability of Pulsating Intensities for Double-Locked Laser Diodes, (with M. Nizette, A. Gavrielides, V. Kovanis, T.B. Simpson), Physical Review E, Vol. 65, 056610, 2002.

Vladislav V. Goldberg

On the Structure of Submanifolds with Degenerate Gauss Maps, (with M. A. Akivis), Geometriae Dedicata, Vol. 86, pp. 205-226, 2001.

Local Equivalence of Sacksteder and Bourgain Hypersurfaces, (with M. A. Akivis), Hokkaido Mathematical Journal, Vol. 30, pp. 361-370, 2001.

An Affine Analogue of the Hartman-Nirenberg Cylinder Theorem, (with M. A. Akivis), Mathematische Annalen, Vol. 323, pp. 573-582, 2002.

Daniel Goldman

Calculations of Oxygen Transport by Red Blood Cells and Hemoglobin Solutions in Capillaries, (with A. Vadapalli, A. Popel), Artificial Cells, Blood Substitutes and Immobilization Biotechnology, Vol. 30, pp. 157-188, 2002.

Roy Goodman

Modulations in the Leading Edges of Midlatitude Storm Tracks, (with A. J. Majda, D. W. McLaughlin), SIAM Journal of Applied Mathematics, Vol 62, pp. 746-776, 2001.

Interaction of Sine-Gordon Kinks with Defects: Phase Space Transport in a Two-Mode Model, (with P. Holmes, M. Weinstein), Physica D, Vol. 161, pp. 21-44, 2002.

David J. Horntrop

Spectral Methods for Mesoscopic Models of Pattern Formation, (with M. Katsoulakis and D. Vlachos), Journal of Computational Physics, Vol. 173, pp. 364-390, 2001.

Monte Carlo Simulation of a Random Field Model for Transport, Monte Carlo Methods and Applications, Vol. 8, pp. 31-49, 2002.

Jay Kappraff

Polygons and Chaos, (with G.W. Adamson), Symmetry: Art and Science, No. ½, 2001.

Connections: The Geometric Bridge between Art and Science (2nd edition). World Scientific, 2002.

Lou Kondic

Pattern Formation in Gravity Driven Flow of Thin Films: Constant Flux Flow, (with J. Diez), Physics of Fluids, Vol. 13, pp. 3168-3184, 2001.

Granular Friction, Coulomb Failure, and Fluid-Solid Transition for Horizontally Shaken Granular Materials, (with G. Metcalfe, G., S. G. K. Tennakoon, D. G. Schaeffer, R. P. Behringer), Physical Review E, Vol. 65, pp. 31302-1 - 031302-15, 2002.

Flow of Thin Films on Patterned Surfaces: Controlling the Instability, (with J. Diez), Physical Review E, Vol. 65, pp. 045301-1 - 045301-3, April 2002.

Gregory A. Kriegsmann

Microwave-Enhanced Chemical Vapor Infiltration: A Sharp Interface Model, (with B.S. Tilley), Journal of Engineering Mathematics, Vol. 41, pp. 33-54, 2001.

Jay N. Meegoda

Ultrasound to Decontaminate Organic Compounds in Dredged Sediments (with K. Veerawat), Soil & Sediment Contamination: An International Journal, Vol. 11, pp. 91-116, 2002.

Ultrasound to Decontaminate Metals in Dredged Sediments (with R. Perera), Journal of Hazardous Materials Vol. 85, pp. 73-89, 2001.

Zoi-Heleni Michalopoulou

Estimating the Impulse Response of the Ocean: Correlation vs. Deconvolution, Inverse Problems in Underwater Acoustics, Editors: M. Taroudakis and G. Makrakis, pp. 65-76, Springer-Verlag, 2001.

Petronije Milojevic

Continuation Theory for A-Proper Mappings and their Uniform Limits and Nonlinear Perturbations of Fredholm Mappings, Set Valued Mappings with Applications in Nonlinear Analysis (eds. R. P. Agarwal and D. O'Regan), 2001, pp. 311-359, Series in Mathematical Analysis and Applications, Gordon and Breach Publishers, NY.

Robert M. Miura

Analysis of Excitable Cell Models, Journal of Computational and Applied Mathematics, Vol. 144, pp. 29-47, 2002.

Direction Reversal of Fluctuation-Induced Biased Brownian Motion on Distorted Ratchets, (with B. Yan, Y. Chen), Journal of Theoretical Biology, Vol. 210, pp. 141-150 2001.

Asymptotic Analysis of Buffered Calcium Diffusion Near a Point Source, (with G. Smith, L. Dai, A. Sherman), SIAM Journal on Applied Mathematics, Vol. 61, pp. 1816-1838, 2001.

Farzan Nadim

Bistable Oscillations Arising from Synaptic Depression, (with A. Bose, Y. Manor), SIAM Journal of Applied Mathematics, Vol. 62, pp. 706-727, 2001.

Synaptic Depression Mediates Bistability in Neuronal Networks with Recurrent Inhibitory Connectivity, (with Y. Manor), Journal of Neuroscience, Vol. 21, pp. 9460-9470, 2001.

Frequency Regulation Demonstrated by Coupling a Model and a Biological Neuron, (with Y. Manor), Neurocomputing, Vol. 38-40, pp. 269-278, 2001.

Demetrios T. Papageorgiou

Dynamics and Rupture of Planar Electrified Liquid Sheets, (with B.S. Tilley, P.G. Petropoulos), Physics of Fluids, Vol. 13, pp. 3547-3563, 2001.

The Onset of Instability in Couette Flows of Concentrated Suspensions, (with R. Mauri), International Journal of Multiphase Flow, Vol. 28, pp. 127-136, 2002.

Using Surfactants to Control the Formation and Size of Wakes Behind Moving Bubbles at Order One Reynolds Numbers, (with Y. Wang, C. Maldarelli), Journal of Fluid Mechanics, Vol. 453, pp. 1-19, 2002.

Pinchoff and Satellite Formation in Surfactant Covered Viscous Threads, (with R.V. Craster, O. Matar), Physics of Fluids, Vol. 14, pp. 1364-1376, 2002.

Peter G. Petropoulos

Dynamics and Rupture of Planar Electrified Liquid Sheets, (with B. Tilley, D. T. Papageorgiou), Physics of Fluids, Vol. 13, pp. 3547-3563, 2001.

Approximating the Surface Impedance of a Homogeneous Lossy Half-Space: An Example of "Dialable" Accuracy, IEEE Transactions on Antennas and Propagation, Vol. 50, pp. 741-744, 2002.

Marianito Rodrigo

Exact Solutions of Reaction-Diffusion Systems and Nonlinear Wave Equations, (with M. Mimura), Japan J. Indust. Appl. Math., Vol. 18, pp. 657-696, 2001.

Annihilation Dynamics in the KPP-Fisher Equation, (with M. Mimura), European J. Appl. Math., Vol. 13, pp. 195-204, 2002.

Anthony Rosato

An Overview of Particle Technology, in The Expanding World of Chemical Engineering, 2nd edition (eds: S. Furusaki, J. Garside, L.-S. Fan), Taylor & Francis, 2001.

A Perspective on Vibration-Induced Size Segregation of Granular Materials, (with D. Blackmore, N. Zhang, Y. Lan), Chemical Engineering Science, Vol. 57, pp. 265-275, 2002.

Burt Tilley

Microwave-Enhanced Chemical Vapor Infiltration: A Sharp Interface Model, (with G.A. Kriegsmann), Journal of Engineering Mathematics, Vol. 41, pp. 33-54, 2001.

Dynamics and Rupture of Planar Electrified Liquid Sheets, (with P.G. Petropoulos, D. T. Papageorgiou), Physics of Fluids, Vol. 13, pp. 3547-3563, 2001.

Jean-Marc Vanden-Broeck

Stern Waves with Vorticity, (with Y. Kang), ANZIAM Journal, Vol. 43, pp. 321-332, 2002.

The Influence of Variable Surface Tension on Capillary Gravity Waves, (with E. Ozugurlu), Journal of Engineering Mathematics, Vol. 40, pp. 269-282, 2001.

Computations for a Nonlinear Theory of Fluid Pressure Impulse, (with M.J. Cooker), Quarterly Journal of Mechanics and Applied Mathematics, Vol. 54, pp. 585-598, 2001.

Damped Waves Generated by a Moving Pressure Distribution, European Journal of Applied Mathematics, Vol. 12, pp. 357-366, 2001.

Motion of a Triple Junction, (with M. Miksis), Journal of Fluid Mechanics, Vol. 437, pp. 385-394, 2001.

Free Surface Wave Damping Due to Viscosity and Surfactants, (with B. Spivak, T. Miloh), European Journal of Mechanics-B/Fluids, Vol. 21, pp. 207-224, 2002.

Do True Elevation Gravity-Capillary Solitary Waves Exist? A Numerical Investigation, (with A. R. Champneys, G. J. Lord), Journal of Fluid Mechanics, Vol. 437, pp. 403-417, 2002.

Wilton Ripples Generated by a Moving Pressure Distribution, Journal of Fluid Mechanics, Vol. 451, pp. 193-201, 2002.

PROCEEDINGS PUBLICATIONS

Roman Andrushkiw

Pattern Recognition of Malignancy-Associated DNA Changes in the Nuclei of Buccal Epithelium in the Pathology of the Thyroid and Mammary Glands, (with D. A. Klyushin, Y. I. Petunin, N. V. Boroday, K. P. Ganina) International Conference on Mathematical Engineering Techniques in Medicine and Biological Sciences, Las Vegas, Nevada, pp. 167-173, 2001.

Nadine Aubry

Direct Simulation of Electrorheogical suspensions, (with A. Wang, P. Singh), ASME Paper No. IMECE 2001/FED-24923, pp. 179-185, New York: American Society of Mechanical Engineers, 2001.

Optimal Control of Vortex Shedding by an Electro-Magnetic Field, (with X. Sun), FEDSM2002-31277, Montreal Quebec Canada, ASME, 2002.

Denis Blackmore

Analysis of Fractionation of Sediments Caused by an Acoustic Field, (with N. Aboobaker, J. Meegoda), Proceedings of Conference on Numerical Analysis of Chemical Processes, pp. 550-563, Boston, 2001.

Chaos in Vibrating Granular Flows, (with R. Samulyak, A. Rosato), Proceedings of Dynamic Systems and Applications, Vol. 3, G. Ladde, N. Medhin, M. Sambandham (eds.), Dynamic Publishers, Atlanta, 2001, pp. 77-84.

A Hamiltonian Approach to Vortex Breakdown, (with O. Knio), Proceedings Euromech Colloquium No. 433: Dynamics of Trailing Vortices, pp. 100-115, Aachen, 2002. (online).

Victoria Booth

Neural Mechanisms for Generating Rate and Temporal Codes in Networks of CA3 Pyramidal Cells, (with A. Bose), Society for Neuroscience Abstracts, Vol. 27, pp. 730.26, San Diego, CA, 2001.

Synaptic Depression Promotes Phase Constancy, (with F. Nadim, A. Bose, Y. Manor), Society for Neuroscience Abstracts, Vol. 27, pp. 537.20, San Diego, CA, 2001.

Amitabha Bose

Neural Mechanisms for Generating Rate and Temporal Codes in Networks of CA3 Pyramidal Cells, (with V. Booth), Society for Neuroscience Abstracts, Vol. 27, pp. 730.26, San Diego, CA, 2001.

Synaptic Depression Promotes Phase Constancy, (with F. Nadim, V. Booth, Y. Manor), Society for Neuroscience Abstracts, Vol. 27, pp. 537.20, San Diego, CA, 2001.

Sunil Dhar

Modeling with a Bivariate Geometric Distribution Advances on Methodological and Applied Aspects of Probability and Statistics, Edited by N. Balakrishnan, Gordon and Breach Science publishers, IISA 98 McMaster Conference Proceedings, Volume 1, pp. 101-109.

Thomas Erneux

Stochastic Polarization Dynamics in Vertical-Cavity Surface-Emitting Lasers Described by Simple Rate Equations, (with B. Nagler, J. Danckaert, J. Albert, M. Peeters, K. Panajotov, I. Veretennicoff), Physics and Simulations of Optoelectronic Devices IX, Y. Arakawa, P. Blood, M. Osinski, Eds., Proc. SPIE 4283 pp. 275-286, 2001.

Roy Goodman

Trapping of Kinks and Solitons by Defects: Phase Space Transport in Finite Dimensional Models, (with P. Holmes, M. Weinstein), Proceedings of the International Conference on Progress in Nonlinear Science dedicated to Alexander Andronov, Nizhny Novgorod, Russia, July 2001.

Interaction of NLS Solitons with Defects: Numerical Experiments and Finite-Dimensional Modeling, (with P. Holmes, M. Weinstein), Invited paper for Mathematics as a Guide to the Understanding of Applied Nonlinear Problems, a conference in honor of Klaus Kirchgassner's 70th birthday, Kloster Irsee, Germany, Jan 6-10, 2002.

Jay Kappraff

The System of Proportions of the Parthenon and its Meaning, Proceedings of the 5th Bridges Conference, ed. by R. Sarhangi, 2002.

The Arithmetic of Nicomachus of Gerasa and its Application to Systems of Proportion, Proc. of Math. and Design 2001 Conference. Geelong, Aus.: Deakin Univ. Press, 2001.

Lou Kondic

Solid-Liquid Transitions of Horizontally Shaken Dry Granular Materials, (with G. Metcalfe, S. G. K. Tennakoon, D. G. Schaeffer, R. P. Behringer), Powders and Grains, ed. Y Kishino, Balkema, Rotterdam, pp. 513-516, 2002.

Contact Line Instabilities in Thin Films Flowing Down an Incline, (with J. Diez), Proceedings of the Seventh International Seminar on Recent Advances in Fluid Mechanics, Physics of Fluids and Associated Complex Systems, Buenos Aires, Argentina, pp. 1-33, 2001.

Science in the Sandbox: Fluctuations, Friction and Instabilities, (with R. Behringer, E. Clement, J. Geng, D. Howell, G. Metcalfe, C. O'Hern C. Reydellet, S. Tennakoon, L. Vanel, C. Veje) Coherent Structures in Complex Systems, Lecture Notes in Physics, ed. D. Reguera, L.L. Bonilla, and J. M. Rubi, Springer, vol. 567, pp. 351-391, 2001.

Thin Film Flows on Patterned Surfaces: Controlling the Instability, (with J. Diez), Bull. Amer. Phys. Soc., Vol. 46, pp. 113, 2001.

Instabilities in the Flow of Thin Liquid Films, (with J. Diez), Proceedings of IUTAM Symposium on Free Surface Flows, Birmingham, United Kingdom, eds. A. C. King and Y. D. Shikhmurzaev, Fluid Mechanics and its Applications, Kluwer Academic Publishers, Norwell, MA, Vol. 62, pp. 161-168, 2001.

Jay N. Meegoda

Intelligent Systems for Conveyance and Storage Infrastructure, (with T. Juliano), presented at the Society of Photo-Optical Instrumentation Engineers - SPIE International Symposium on Environmental and Industrial Sensing in Boston, MA on Nov. 1, 2001, Proceedings of SPIE Vol. 4576 - Advanced Environmental Sensing Technology II.

Zoi-Heleni Michalopoulou

Gibbs Sampling Optimization in Underwater Sound Problems, Proceedings of Oceans 2001, Vol. 2, pp. 782-785, Honolulu, Hawaii, 2001.

A Gibbs Sampling Approach to Maximum a Posteriori Time Delay and Amplitude Estimation, (with Michele Picarelli), Proceedings of the International Conference in Acoustics, Speech, and Signal Processing, Vol. 3, pp. 3001-3004, Orlando, Florida, 2002.

Farzan Nadim

Synaptic Depression Promotes Phase Constancy, (with A. Bose, V. Booth, Y. Manor), Society for Neuroscience Abstracts, Vol. 27, pp. 730.16, 2001.

Synaptic Dynamics Regulating The Pyloric Network Period, (with S. Atamturktur, A. Mamiya, Y. Manor), Society for Neuroscience Abstracts, Vol. 27, pp. 730.26, 2001.

Gap Junction Effects On Ionic Current Measurements, (with J. Golowasch), Society for Neuroscience Abstracts, Vol. 27, pp. 813.4, 2001.

A Synapse That Dynamically Switches From Inhibitory To Excitatory, (with A. Mamiya, Y. Manor), Society for Neuroscience Abstracts, Vol. 27, pp. 922.12, 2001.

Peter G. Petropoulos

A Non-Dissipative Staggered Fourth-Order Accurate Explicit Finite Difference Scheme for the Time-Domain Maxwell's Equations, (with A. Yefet), 16th Annual Review of Progress in Applied Computational Electromagnetics Proceedings, Vol. II, pp. 906-916, Boston, MA, 2000.

Subgridding a Fourth-Order FD-TD Scheme for Maxwell's Equations, (with A. Yefet), Fourth International Workshop Proceedings on Computational Electromagnetics in the Time-Domain: TLM, FDTD and Related Techniques, pp. 39-45, Nottingham, UK, 2001.

Anthony Rosato

Chaos in Vibrating Granular Flows, (with D. Blackmore, R. Samulyak), Proceedings of Dynamic Systems and Applications, Vol. 3, G. S. Laddle, N. G. Medhin, M. Sambandham (eds.), Dynamic Publishers, Atlanta, 2001, pp. 77-84.

Jean-Marc Vanden-Broeck

Solitary and Periodic Gravity Capillary Waves with Constant Vorticity, (with Y. Kang), IUTAM Symposium on Free Surface Flows, Kluwer, 2001, pp. 319-326.

Waves Trapped under a Moving Pressure Distribution, IUTAM Symposium on Diffraction and Scattering in Fluid Mechanics and Elasticity, Kluwer, pp. 61-68, 2002.

Water Waves and Related Free-Surface Flows, IUTAM Symposium on Free Surface Flows, Kluwer, pp. 29-38, 2001.

B. PRESENTATIONS

Roman Andrushkiw

August 2001: International Conference on Nonlinear Partial Differential Equations, Kyiv, Ukraine
Spectral theory and eigenvalue approximation for a class of polynomial operator pencils

June 2002: International Conference on Mathematical Engineering Techniques in Medicine and Biological Sciences, Las Vegas, Nevada
1) *Diagnosis of breast cancer by the modified nearest neighbor recognition method*
2) *Statistical tests for comparing two probabilities with application to cancer risk analysis*

Nadine Aubry

November 2001: 54th Annual Meeting of the Division of Fluid Dynamics, San Diego, CA
1) *Electro-magnetic control of vortex shedding*
2) *Direct simulation of dielectrophoresis in miniature channel flows*

December 2001: Office of Naval Research (ONR), Washington, DC
Ultra-filtration of contaminated fluids

August 2002: National Starch and Chemical Company/NJIT Meeting, Newark, NJ
The William M. Keck Laboratory overview

October 2001: New Jersey Institute of Technology, Presentation to ABET 2000 evaluator, Newark, NJ
The Mechanical Engineering Department at NJIT

February 2002: New Jersey Institute of Technology (Presentation for site visit of ONR and NSWC), Newark, NJ
Electro-filter: Project status update meeting

June 2002: University/Industry Workshop on micro-flow control, Newark, NJ
Center for Micro-Flow Control

June 2002: 14th U. S. National Congress of Theoretical and Applied Mathematics (USNCTAM14), Blacksburg, VA
1) *Mixing enhancement by dual speed rotating stirrer*
2) *Direct simulation of electroreheological suspensions*
3) *Control of vortex shedding from cylinder by electromagnetic field*

Manish Bhattacharjee

June 18, 2002. Summer 2002 Colloquium Series in Statistics.
Alternative perspectives in modeling the sex ratio

June 28, 2002. Summer 2002 seminar series for graduate students.
Composition of coherent structures

Denis Blackmore

March 2002: Euromech Colloquium No. 433: Dynamics of Trailing Vortices, Aachen, Germany
A Hamiltonian approach to vortex breakdown

Victoria Booth

July 2001: CNS*01 Tenth Annual Computational Neuroscience Meeting, Monterey, CA
Modeling place cell firing: Phase precession and the firing rate code

November 2001: 31st Annual Meeting of the Society for Neuroscience, San Diego, CA
1) *Neural mechanisms for generating rate and temporal codes in networks of CA3 pyramidal cells*
2) *Synaptic depression promotes phase constancy*

February 2002: Joint Seminar to the Departments of Mathematics and Biology, University of Michigan, MI
Neural mechanisms for generating rate and temporal codes in networks of hippocampal pyramidal cells

March 2002: First SIAM Conference on Life Sciences 2001, Boston, MA
Neural mechanisms for generating rate and temporal codes in networks of CA3 pyramidal cells

April 2002: MAA EPADEL Spring 2002 Meeting, Millersville, PA (invited talk)
Hippocampal place cells and the generation of temporal codes

Michael Booty

July 2001: London Mathematical Society Durham Symposium on Combustion Theory, Durham UK
The dynamics of reactive hot spots and inert spikes in microwave heated ceramic materials

Amitabha Bose

November 2001: 31st Annual Meeting of the Society for Neuroscience, San Diego, CA.
1) Synaptic depression promotes phase constancy
2) Neural mechanisms for generating rate and temporal codes in networks of CA3 pyramidal cells

March 2002: 1st SIAM Meeting on Life Sciences, Boston, MA
Roles for synaptic depression in organizing neuronal rhythms

March 2002: Mathematical Biology Workshop, Dept. Mathematical Sciences, NJIT
Roles of synaptic depression in neuronal networks

Hans Chaudhry

May 2001: Sant Longowal Institute of Engineering and Technology, Longowal, Punjab, India
Applications of computers in chemical sciences and engineering

Sunil Dhar

December 12, 2001: Statistics Colloquium presented by the Department of Mathematical Sciences and The Center for Applied Mathematics and Statistics
Various hats a statistical consultant may wear

Rose Dios

October 2001: Midwest Conference on Combinatorics, Computing and Cryptography, University of Nevada at Las Vegas
Investigations on the existence conditions of some balanced arrays

Christopher Elmer

August 2001: Dynamics of Numerics Workshop, Fields Institute, Toronto, Canada
Some effects of discretization on traveling wave solutions of bistable reaction-diffusion equations

November 2001: Applied Mathematics Colloquium, University of Delaware
An introduction to discretized reaction-diffusion equations: traveling wave solutions, applications, and phenomena

Thomas Erneux

September 2001: Workshop on "Dynamics of Semiconductor Lasers", Berlin, Germany
Analytical bifurcation studies of delay-differential equations modeling lasers

October 2001: Lectures given at a doctoral school, Borzée, Belgium
Introduction to delay differential equations

November 2001: KUL - PAI meeting, Leuven, Belgium
Mixed external cavity modes for semiconductor lasers subject to optical feedback: past, present, future

March 2002: Kick Off Meeting of the IAP Photon network, Vrije Universiteit Brussels, Belgium
Laser dynamics

March 2002: Bristol, UK
Multiple scales problems for dynamical laser instabilities

Anna Georgieva

March 2002: First SIAM Meeting on Life Sciences, Boston, MA
Time-dependent airflow in rat and human nasal passages

Vladislav V. Goldberg

September 2001: 8th International Conference on Differential Geometry and Applications, Opava, Czech Republic
The structure of submanifolds with degenerate Gauss maps

September 2001: Colloquium of the Department of Mathematical Sciences, NJIT, Newark, NJ
Webs and PDEs

November 2001: International Colloquium in honor of the 100th birthdate of Renato Calapso, Messina, Italy
Renato Calapso's contribution to projective differential geometry

June 2002: The First Joint Meeting of the American Mathematical Society and Italian Mathematical Union, Pisa, Italy.
Webs and partial differential equations (an invited 1-hour lecture at the Special Session "Advances in Differential Geometry of PDEs and Applications")

Daniel Goldman

August 2001: International Society on Oxygen Transport to Tissue, Philadelphia, PA
Simulations of capillary network oxygen transport during transient ischemia in the presence and absence of tissue myoglobin

October 2001: Biomedical Engineering Society, Durham, NC
Simulations of capillary oxygen transport under transient conditions

November 2001: APS Division of Fluid Dynamics, San Diego, CA
The effect of structural and rheological properties on blood flow distributions in capillary networks

December 2001: Magnetic Resonance Center, Yale University, CT
Detailed mathematical modeling of oxygen transport in the microcirculation

April 2002: Experimental Biology/Microcirculatory Society, New Orleans, LA
Calculations of three-dimensional tissue and capillary network oxygen distributions during sepsis

Roy Goodman

October 2001: Lefschetz Center for Dynamical Systems Seminar, Brown University, Providence, RI
Trapping light: experiments and models

December 2001: Mathematics Colloquium, Department of Mathematics and Statistics, University of Maryland Baltimore County, Baltimore, MD
Trapping light: numerical experiments and ODE models

January 2002: Department of Mathematics and Computer Science, Drexel University, Philadelphia, PA
Trapping light: numerical experiments and ODE models

February 2002: Department of Mathematical Sciences, Worcester Polytechnic Institute, Worcester, MA
Trapping light: numerical experiments and ODE models

May 2002: NSF-CBMS Regional Research Conference on Mathematical Methods in Nonlinear Wave Propagation, Greensboro, NC
Trapping light with grating defects

Lou Kondic

June 2002: Gordon Research Conference: Granular & Granular and Fluid Flow, Plymouth, NH
Couette flow of granular materials

May 2002: Third International Symposium on Contact Angle, Wettability and Adhesion, Providence, RI
Thin film flows on heterogeneous surfaces

November 2001: Division of fluid mechanics meeting of American Physical Society, San Diego, CA
Thin film flows on patterned surfaces: Controlling the instability

October 2001: Department of Applied Physics and Applied Mathematics, Columbia University, New York City
Contact line instabilities of thin films

Gregory A. Kriegsmann

August 2001: Department of Mathematics, Manchester University, Manchester, UK
Matrix analysis of a photonic Fabry-Perot resonator

August 2001: Department of Mathematics, Dundee University, Dundee, Scotland
Electromagnetic propagation in periodic porous structures

December 2001: South Eastern Conference on Applied Mathematics, North Carolina State University, Rayleigh-Durham, NC
Mathematical problems in microwave heating

December 2001: Department of Mathematics, Baruch College, NY
Ubiquitous waves

January 2002: Department of Applied Physics and Applied Mathematics, Columbia University, NY
Pattern formation in microwave heated ceramics, cylinders and slabs

February 2002: Department of Mathematics, Lafayette College, Eastern, PA
Ubiquitous waves

March 2002: Department of Mathematics, Duke University, Durham, NC
Scattering matrix analysis of a photonic Fabry-Perot resonator

April 2002: Department of Mathematics, Wright State University, Dayton, OH
Microwave heating of materials: a math overview

April 2002: Department of Mathematics, Air Force Institute of Technology, Dayton, OH
Scattering matrix analysis of a photonic Fabry-Perot resonator

June 2002: 14th U.S. National Congress of Theoretical and Applied Mechanics, Blacksburg, VA
Microwave joining of two hollow tubes: an asymptotic theory and numerical simulation
(with Jonathan H. C. Luke)

Dawn Lott

November 2001: Montclair State University, Upper Montclair, NJ
Viscoelastic effects on wound closure in human skin

April 2002: New Jersey Institute of Technology, Newark, NJ
Advances in modelling and numerical techniques for optimal patterns of suturing wounds based on nonlinear stress analysis.

Jonathan Luke

November 2001: APS Division of Fluid Dynamics, San Diego, CA
Effects of sedimentation dynamics on velocity fluctuations in a stratified suspension

March 2002: Center for Fluid Mechanics Seminar, Brown University, Providence, RI
Stratification of a sedimenting suspension

March 2002: Center for Dynamical Systems and Nonlinear Studies Seminar, Georgia Institute of Technology, Atlanta, GA
Stratification of a sedimenting suspension

April 2002: Applied Mathematics Colloquium, New Jersey Institute of Technology, Newark, NJ
Sedimentation and the dynamics of stratification and fluctuation decay

June 2002: 14th U.S. National Congress of Theoretical and Applied Mechanics, Blacksburg, VA
1) *Models for stratification of a sedimenting suspension*
2) *Microwave joining of two hollow tubes: an asymptotic theory and numerical simulation* (with Gregory A. Kriegsmann)

Jay N. Meegoda

July 2001: Department of Civil Engineering, University of British Columbia
Micro-mechanics and microscopic modeling in geotechnical engineering--current status and future

April 2002: University of South Florida Department of Civil and Environmental Engineering Graduate Transportation Seminar
Detection of segregation in asphalt pavements using surface texture laser technology

April 2002: Department of Civil and Environmental Engineering and Center for Innovative Grouting Materials and Technology, University of Houston
Detection of segregation in asphalt pavements using surface texture laser technology

Zoi-Heleni Michalopoulou

October 2001: 2001 IEEE Underwater Acoustic Signal Processing Workshop, RI
Efficient inversion in underwater acoustics

November 2001: Applied Physics Laboratory, University of Washington, Seattle, WA
Efficient approaches to source localization in underwater acoustics

February 2002: Department of Mathematics, St. Peter's College, Jersey City, NJ
Tracking whales and finding submarines in the ocean

March 2002: Women in technology leadership awards, NJIT, NJ
Applied Mathematics in Action

Robert M. Miura

December 2001: International Conference on Frontier of Applied Analysis - Fluid Dynamics and Pattern Formation, Acros Fukuoka, Fukuoka, Japan
Some nonlinear differential equation problems from biomedical applications.

February 2002: Mathematical Biology Workshop, Center for Applied Mathematics and Statistics, New Jersey Institute of Technology, Newark, NJ
Analysis of bursting electrical activity in pancreatic beta-cells.

March 2002: Physical Mathematics Seminar, Massachusetts Institute of Technology, Cambridge, MA
Analysis of bursting electrical activity in pancreatic beta-cells.

March 2002: First SIAM Conference on the Life Sciences, Boston, MA
1) *Dispersal of ions in the brain-cell microenvironment* (with Y.Q. Wang).
2) *Synchronous phase-clustering states in networks excitatory neurons with nonuniform coupling* (with Y.Q. Wang and Y.X. Li).
3) *Temporal summation of EPSPs in pyramidal neurons* (with A. Desjardins, Y.X. Li, S. Reinker, R. Neuman).

April 2002: Applied Mathematics Seminar, Courant Institute, New York University, New York City, NY
Analysis of bursting electrical activity in pancreatic beta-cells.

April 2002: Dynamical Systems Seminar, Princeton University, Princeton, NJ
Analysis of bursting electrical activity in pancreatic beta-cells.

Cyrill Muratov

April 2002: DIMACS Workshop on Complexity in Biosystems, Rutgers University, New Brunswick, NJ
Modeling cell communication in drosophila oogenesis (with S.Y. Shvartsman)

November 2001: Applied Mathematics in Bioengineering, AIChE Annual Meeting, Reno, NV
Testing a hypothesis in developmental biology: modeling and computational analysis of autocrine loops in drosophila oogenesis (with S. Y. Shvartsman and D. A. Lauffenburger)

Farzan Nadim

November 2001: Society for Neuroscience Annual Meeting, San Diego, CA
1) *Synaptic depression promotes phase constancy*
2) *Synaptic dynamics regulating the pyloric network period*
3) *Gap junction effects on ionic current measurements*
4) *A synapse that dynamically switches from inhibitory to excitatory*

April 2002: East Coast Nerve Net Meeting, Woods Hole, MA
1) *Members of the pyloric pacemaker network exhibit distinct synaptic dynamics*
2) *Target-specific dynamics from a single neuron*

Demetrios T. Papageorgiou

October 2001: Colloquium of Mechanical Engineering, NJIT
Chaotic solutions of a class of exact solutions to the Navier-Stokes equations

November 2001: Colloquium of Applied Mathematics, Columbia University, New York City
Dynamics and rupture in surface tension dominated flows

November 2001: APS Division of Fluid Dynamics, San Diego, CA
1) *Flow in a pulsating tube: A class of exact solutions of the Navier-Stokes equations*.
2) *Effect of surfactants on the nonlinear interfacial stability of core-annular film flows* (with S. Kas-Danouche and M. Siegel)
3) *Strongly nonlinear interfacial waves of a two-fluid system with surface tension: Solitary and traveling waves* (with L. Barannyk)
4) *Pinchoff dynamics of surfactant covered viscous threads* (with O. Matar and R.V. Craster)
5) *Dynamics and rupture of planar electrified fluid sheets* (with B.S. Tilley and P.G. Petropoulos)

Peter G. Petropoulos

July 2001: SIAM Annual Meeting, San Diego, CA
Fourth-order accurate FD-TD schemes for maxwell's equations

August 2001: Air Force Research Lab PIC/FDTD Workshop, Kirtland AFB, NM
Approximation of impedance boundary conditions suitable for FDTD codes

November 2001: APS Division of Fluid Dynamics, San Diego, CA
Dynamics and rupture of planar electrified fluid sheets (with B.S. Tilley and D. T. Papageorgiou)

January 2002: AFOSR Annual Electromagnetics Workshop, San Antonio, TX
A numerical and analytical study of the perfectly matched layer for Maxwell's equations in cylindrical coordinates

February 2002: NJIT Applied Mathematics Colloquium, Newark, NJ
Absorbing boundary conditions for the time-dependent Maxwell equations

June 2002: NSF-CBMS Regional Conference in the Mathematical Sciences, Numerical Methods in Forward and Inverse Electromagnetic Scattering, Golden, CO
A review of the perfectly matched layer ABC and some new results

Marianito Rodrigo

October 2001: Applied Mathematics Seminar, Courant Institute, NYU, NY, and Colloquium in Applied Mathematics (CAMS), NJIT, Newark, NJ
Front dynamics and exact solutions of reaction-diffusion systems

Anthony Rosato

June 2002: 14th U.S. National Congress of Theoretical and Applied Mechanics, Blacksburg, VA
Dynamic behavior of an intruder in a boundary-driven granular flow

Michael Siegel

July 2001: Applied Mathematics Seminar, Northwestern University, Chicago, IL
Recent results on the zero surface tension limit in Hele-Shaw flow with anisotropy (with M. Kunka and S. Tanveer)

November 2001: APS Division of Fluid Dynamics Annual Meeting, San Diego, CA
1) *Effect of surfactants on the nonlinear interfacial stability of core-annular film flows* (with S. Kas-Danouche and D. T. Papageorgiou)
2) *Simulation of surfactant mechanics within a volume-of-fluid method* (with A. James and J. Lowengrub)

November 2001: Differential Equations and Applications Seminar, Oxford University, UK
Evolution of material surfaces for large surface anisotropy (with M. Miksis and P. Voorhees)

December 2001: Applied Mathematics Seminar, University of Manchester, Manchester, UK
Evolution of material surfaces for large surface anisotropy (with M. Miksis and P. Voorhees)

January 2002: Fluid Dynamics Seminar, Imperial College, London, UK
Evolution of material surfaces for large surface anisotropy (with M. Miksis and P. Voorhees)

February 2002: Fluid Dynamics Seminar, Cambridge University, UK
Evolution of material surfaces for large surface anisotropy (with M. Miksis and P. Voorhees)

February 2002: Applied Mathematics Seminar, University of Nottingham, UK
Evolution of material surfaces for large surface anisotropy (with M. Miksis and P. Voorhees)

Burt Tilley

July 2001: Thirty-Eighth Annual Technical Meeting of the Society of Engineering Sciences, San Diego, CA
Dynamics and rupture of electrified liquid sheets (with D. T. Papageorgiou and P. G. Petropoulos)

November 2001: APS Division of Fluid Mechanics, San Diego, CA
Dynamics and rupture of electrified liquid sheets

March 2002: Physical Mathematics Seminar, MIT
Microwave-enhanced chemical vapor infiltration: a sharp interface model

Jean-Marc Vanden-Broeck

August 2001: Newton Institute, Cambridge
Capillary gravity waves of exponentially small amplitude

October 2001: New Jersey Institute of Technology
Free surface flows with exponentially small waves

September 2001: Baruch College
Waves drops and bubbles

November 2001: 54th Annual Meeting of the Division of Fluid Mechanics, San Diego
Numerical computations of three dimensional free surface flows

January 2002: Reading University
Nonlinear interfacial flows

March 2002: University College London
Two layer flows and generalized fronts

February 2002: Ecole Normale Superieure, Cachan
Numerical methods for free surface flows

March 2002: Ecole Normale Superieure, Cachan
Workshop on water waves, (Main Speaker: 6 lectures on the theory of water waves)

April 2002: British Applied Mathematics Colloquium, Warwick
Computation of steady three dimensional free surface flows

April 2002: 17th International Workshop on Water Waves and Floating Bodies, Cambridge
Two layer flows generated by moving obstacles

Darko Volkov

June 2002: NSF-CBMS, Golden CO
1) *Wave propagation in waveguides and periodic structures*.
2) *Discrete conservation laws*.

C. TECHNICAL REPORTS

REPORT 0102-1: D. Stickler
Low-Pressure Iris Deformation, Part 1

REPORT 0102-2: C. E. Elmer and E. S. Van Vleck
The Effect of Discretization on Travelling Wave Solutions of Bistable Partial Differential Equations

REPORT 0102-3: V. Booth and A. Bose
Burst Synchrony Patterns in Hippocampal Pyramidal Cell Model Networks

REPORT 0102-4: M. A. Akivis and V. V. Goldberg
An Affine Analoque of the Hartman-Nirenberg Cylinder Theorem

REPORT 0102-5: C. E. Elmer and E. S. Van Vleck
Existence of Monotone Traveling Fronts for BDF Discretizations of Bistable Reaction-Diffusion Equations

REPORT 0102-6: L. Barannyk and D. T. Papageorgiou
Fully Nonlinear Gravity-Capillary Solitary Waves in a Two-Fluid System of Finite Depth

REPORT 0102-7: V. Booth and A. Bose
Transitions Between Different Synchronous Firing Modes Using Synaptic Depression

REPORT 0102-8: P. Petropoulos
An Analytical Study of the Discrete Perfectly Matched Layer for the Time-Domain Maxwell Equations in Cylindrical Coordinates

REPORT 0102-9: K. A. Abell, C. E. Elmer, A. R. Humphries, and E. S. Van Vleck
Computation of Mixed Type Functional Differential Boundary Value Problems

REPORT 0102-10: C. E. Elmer and E. S. Van Vleck
A Variant of Newton's Method for the Computation of Traveling Waves of Bistable Differential Difference Equations

REPORT 0102-11: Y. Manor, V. Booth, A. Bose, and F. Nadim
Short-Term Synaptic Dynamics Promote Phase Maintenance in Multi-Phasic Rhythms

REPORT 0102-12: M. A. Akivis and V. V. Goldberg
Smooth Lines on Projective Planes Over Two-Dimensional Algebras and Submanifolds with Degenerate Gauss Maps

REPORT 0102-13: H. R. Chaudhry, B. Bukiet, A. B. Ritter, and R. Arora
Mechanical Properties of Diseased Hearts During Adaptation

REPORT 0102-14: L. Kondic and J. A. Diez
Simulations of Coating Flows and Drops in Higher Dimensions

REPORT 0102-15: F. Defever, R. Deszcz, M. Glogowska, V. V. Goldberg, and L. Verstraelen
A Class of Four-Dimensional Warped Products

REPORT 0102-16: R. Andrushkiw, V. Gafiychuk, A. Shnyr, and R. Zabrodsky
Equations of Interface Dynamics for Quasi-Stationary Stefan Problem

REPORT 0102-17: M.C. Bhattacharjee, S. Ravi, R. Vasudeva, and N.R. Mohan
New Order Preserving Properties of Geometric Compounds

REPORT 0102-18: P. S. Milojevic
On the Unique Constructive Solvability of Hammerstein Equations

REPORT 0102-19: M. A. Akivis and V. V. Goldberg
Application of the Duality Principle for Construction of Varieties with Degenerate Gauss Maps

REPORT 0102-20: M. C. Bhattacharjee
Discrete Convex Ordered Lifetimes: Characterizations, Equivalence and Applications

VI. EXTERNAL ACTIVITIES AND AWARDS

Daljit S. Ahluwalia

Member, NSF VIGRE Workshop, Reston, Virginia, May 3-4, 2002.

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

Nadine Aubry

Member, National Science Foundation (NSF) panel for Graduate Fellowship Program (GRP) (Mechanical and Aeronautical Engineering Panel), Member, Arlington, VA, February, 2002.

Member-at-large (one of seven), US National Committee on Theoretical and Applied Mechanics (USNC/TAM), November 1, 2001-Present (appointment by the Chair of the National Research Council).

Denis Blackmore

Recipient, Certificate of Appreciation, McNair Achievement Program

Victoria Booth

Member, Program Committee for CNS Annual Computational Neuroscience Meeting 2001-2003.

Member, Advisory Committee for the Department of Mathematics, Passaic County Community College, Paterson, NJ.

Sunil Dhar

Reviewer: the Journal of Methodology and Computing in Applied Probability, Kluwer Academic Publishers, February 11, 2002.

Science Fair Judge, May 21, 2002, Science Department, Eastside High School, Paterson, New Jersey.

Vladislav V. Goldberg

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

Editorial Board Member, Rendiconti del Seminario Matematico di Messina (elected in May 2002).

Review of the book *Elementare Differentialgeometrie* by C. Baer (de Gruyter, 2001), Mathematical Reviews, Vol. 2002e, pp. 2002e:53001, 2002.

Gregory A. Kriegsmann

Editor in Chief, SIAM Journal of Applied Mathematics.

Editorial Board Member, Wave Motion.

Editorial Board Member, IMA Journal on Applied Mathematics.

Editorial Board Member, Journal of Engineering Mathematics.

Editorial Board Member, Analysis and Applications.

Reviewer and Panelist, NSF Division of Applied Mathematics.

Dawn Lott

Recipient, Certificate of Appreciation, The McNair Achievement Program, NJIT, April 2002.

Vice Chair for Speakers, Mathematical Association of America, New Jersey Section (MAA-NJ).

Nominating Committee Member, Association for Women in Mathematics (AWM), Graduate Student Mentor.

Advisory Board Member, Enhancing Diversity of Graduate Education (EDGE).

Jay N. Meegoda

Published Report: *Research, Development, Demonstration and Validation of Intelligent Systems for Conveyance and Storage Infrastructure - Phase I Item C- Determining Technical Approaches of Systems*, Report on Research Sponsored by the U.S. Environmental Protection Agency and U.S. Army Industrial Ecology Center, Submitted by the New Jersey Institute of Technology, Newark, 75 pages, February 2002 (with T. Juliano, A.D. McDowall, D. Dalfonzo).

Editorial Board member, ASTM Geotechnical Testing Journal.
Associate Editor, ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management.

Guest editor, Journal of Hazardous Materials, special issue on Contaminated Dredged Sediments.

Chairperson of Geotechnical Group, ASCE North Jersey Section.

Member, Millburn Environmental Commission, Township of Millburn, NJ.

Offered a one-month intensive training program on Expressway Management and Operation at the International Financial Institutions Loan Project Office, Hebei Provincial Communication Department, The Peoples Republic of China, funded by the Asian Development Bank, February-March 2002.

Invited participant, AWWA workshop on Multi-Utility Buried Pipes and Appurtenances Location, May 29-31, 2002, London, England.

Petronije Milojevic

Editorial Board member, Communications on Applied Nonlinear Analysis.

Editorial Board member, Facta Universitatis.

Editorial Board member, Mathematica Moravica.

Robert M. Miura

Member, NSF VIGRE Workshop, Reston, Virginia, May 3-4, 2002.

Member, NSF/NIH Review Panel for Computational Neuroscience, Arlington, Virginia, May 6-7, 2002.

Member, MITACS Biomedical Theme Workshop, University of British Columbia, Vancouver, B.C., Canada, May 21-22, 2002.

Member, MITACS Research Management Committee Meeting, University of British Columbia, Vancouver, B.C., Canada, May 23, 2002.

Member, MITACS Annual General Meeting, University of British Columbia, Vancouver, B.C., Canada, May 23-25, 2002.

Member, Bioengineering & Life Sciences Council, NJIT.

Member, Committee for Computational Biology, Rutgers-Newark/NJIT.

Member, Scientific Advisory Panel, Fields Institute for the Mathematical Sciences, Toronto, Canada (since 2002).

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).

Organizer, Third Pacific Rim Conference on Mathematics, Vancouver, B.C., Canada, 2004 (since 2001).

Theme Leader, BioMedical Theme, Mathematics of Information Technology and Complex Systems (MITACS), Networks of Centres of Excellence, Canada (since 1998).

Member, Research Management Committee, MITACS (since 1998).

Organizer, MITACS Biomedical Theme Workshop, University of British Columbia, Vancouver, B.C. May 21-22, 2002.

Member, International Affairs Committee, Canadian Mathematical Society, 1998-2001.

Member, Synge Committee, Canadian Mathematical Society, (since 1999).

Member, Nominating Committee, Mathematics Section A, American Association for the Advancement of Science (since 1999).

Farzan Nadim

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

Demetrios T. Papageorgiou

Associate Editor, SIAM Journal on Applied Mathematics.

Member, Francois Frenkiel Award Committee.

Peter G. Petropoulos

Organized (with W. Schilders, Philips Research Labs, The Netherlands) a Mini-Symposium, titled *Finite Difference Time Domain Methods in Electromagnetics*, for the SIAM 2001 Annual Meeting, San Diego, CA, July 2001.

Member, Technical Program Committee, Fourth International Workshop on Computational Electromagnetics in the Time-Domain: TLM, FDTD and Related Techniques, Nottingham, UK, September 2001.

Thomas Spencer

Judge, 2002, Edelman Prize Competition (Appointed in January 2002 by CPMS and the President of INFORMS).

Chair, 2003 Edelman Prize Committee. (Appointed by the INFORMS Board).

Member, INFORMS Conference Advisory Council.

Member, CPMS Executive Council.

Referee, INFORMS journals: Operations Research and Interfaces.

Burt Tilley

Advisor, Consortium for Mathematics and its Applications, Interdisciplinary Contest in Mathematics Team.

VII. FUNDED RESEARCH

A. EXTERNALLY FUNDED RESEARCH

CONTINUING FUNDED PROJECTS

1. *Neural Mechanisms for Generating Temporal Coding*

   National Science Foundation: August 1, 1999 - July 31, 2002
   Amitabha Bose
   Victoria Booth
   Michael Recce

2. *Asymptotic and Singular Perturbation Methods for Bifurcation Problems with Applications*

   National Science Foundation: August 1, 1999 – February 28, 2003
   Thomas Erneux

3. *Gravity and Granular Materials*

   NASA: March 1, 2000 - October 30, 2003
   Lou Kondic
   Robert Behringer, Duke University

4. *Applied Mathematical Problems in Microwave Processing of Ceramic Materials*

   Department of Energy: August 1, 2000 - July 31, 2003
   Gregory A. Kriegsmann

5. *Microwave Processing of Ceramic Materials*

   National Science Foundation: August 1, 2000 - July 31, 2003
   Gregory A. Kriegsmann

6. *Computational Electromagnetic Methods in Microwave Material Processing*

   National Science Foundation: August 1, 1998 - July 30, 2003
   Jonathan H. C. Luke

7. *Efficient Shallow Water Matched Field Inversion*

   Office of Naval Research: January 1, 2000 - December 31, 2001
   Zoi-Heleni Michalopoulou

8. Graduate Traineeship Award: *Efficient Inversion Methods in Underwater Acoustics*

   Office of Naval Research: October 1, 1999 - September 30, 2002
   Zoi-Heleni Michalopoulou
   Xiaoqun Ma

9. Graduate Traineeship Award: *Detection and Localization in the Ocean in the presence of Coherence Loss Mechanisms*

   Office of Naval Research: October 1, 2000 - September 30, 2003
   Zoi-Heleni Michalopoulou
   Urmi Ghosh-Dastidar

10. *Regulation of Neuronal Oscillations by Synaptic Dynamics*

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

11. *Hydrodynamics of Bubble Motion and Oscillatory Flows*

    National Science Foundation: July 1, 2000 - June 30, 2003
    Demetrios T. Papageorgiou

12. *Numerical Modeling and Analysis of Transient Electromagnetic Wave Propagation and Scattering*

    Air Force Office of Scientific Research: November 1, 1998 - October 31, 2001
    Peter G. Petropoulos

13. *Free-Boundary Problems in Volatile Multi-Fluid Flows*

    National Science Foundation: July 1, 1999 - December 31, 2002
    Burt S. Tilley

PROJECTS FUNDED DURING PRESENT ACADEMIC YEAR

1. *An Experiment-Based Computational Study of Blood Flow and Transport during Sepsis*

   The Whitaker Foundation: September 1, 2001 - August 30, 2004
   Daniel Goldman

2. *Instabilities in the Flow of Thin Liquid Films*

   National Science Foundation: February 1, 2002 – January 31, 2005
   Lou Kondic

3. *Scientific Computing Research Environments for the Mathematical Sciences*

   National Science Foundation: September 1, 2001 - August 31, 2002
   Jonathan Luke
   Lou Kondic
   Victoria Booth
   Amitabha Bose
   Chris Elmer
   Dan Goldman
   Farzan Nadim
   Burt Tilley

4. *Efficient Shallow Water Matched Field Inversion*

   Office of Naval Research: January 1, 2002 - September 30, 2004
   Zoi-Heleni Michalopoulou

5. *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

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

   National Science Foundation: July 23, 2001 - July 31, 2004
   Michael Siegel

B. PROPOSED RESEARCH

PROJECTS PROPOSED DURING PRESENT ACADEMIC YEAR

1. *Path Dependent Skorohod Problem and Economic Networks*

   National Science Foundation: July 1, 2002 – June 30, 2005
   Srinivasan Balaji

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

   National Science Foundation: July 1, 2002 - August 31, 2005
   D. Blackmore
   M. Leu
   W. Regli

3. *NSF GOALI: Advanced Virtual Environments for Modeling Freeform Surfaces*

   National Science Foundation: July 1, 2002 - August 31, 2005
   M. Leu
   D. Blackmore
   B. Maiteh

4. *Center for Biometric Identification Systems*

   New Jersey Commission on Science and Technology: Aug. 1, 2002 - July 31, 2007
   F. Shih
   D. Blackmore
   T. Chang
   D. Ivanov
   C. Liu
   M. Recce
   H.Y. Lee
   S.Y. Kung

5. *Dynamic Synapses and the Generation of Neural Codes*

   National Science Foundation: July 1, 2002 - June 30, 2005
   Amitabha Bose
   Victoria Booth

6. *Time-Dependent and Multi-Dimensional Combustion Phenomena*

   National Science Foundation: July 1, 2002 - June 30, 2005
   Michael Booty

7. *Mechanical Properties of Diseased Hearts in Adaptation*

National Institutes of Health: June 15, 2002 - June 14, 2004
Hans Chaudhry
Bruce Bukiet
Arthur Ritter
Rohit Arora

8. *Left Ventricular Adaptation in Hypertension*

American Heart Association: July 1, 2002 - June 30, 2004
Rohit Arora
Arthur Ritter
Hans Chaudhry
Bruce Bukiet

9. *Differential-Difference Equations and Their Application to Crystalline Growth*

National Science Foundation: July 1, 2002 - June 30, 2005
Christopher Erhart Elmer

10. *Asymptotic and Singular Perturbation Methods for Bifurcation Problems with Applications*

National Science Foundation: August 1, 2002 - July 31, 2005
Thomas Erneux

11. *Detailed Modeling of Blood Flow and Mass Transport in the Microcirculation*

National Science Foundation: September 1, 2002 - August 30, 2005
Daniel Goldman

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

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

13. *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)

14. *Mesoscopic Models and Stochastic Simulation*

National Science Foundation: July 1, 2002 - June 30, 2005
David J. Horntrop

15. *Interface Dynamics and Pattern Formation in Thin Liquid Film Flows*

National Science Foundation: July 1, 2002 - June 30, 2005
Lou Kondic

16. *Influence of Fluid Compressibility on Multiphase Flow in Confined Geometries*

Petroleum Research Fund: July 1, 2002 - June 30, 2004
Lou Kondic

17. *Understanding and Controlling the Instabilities in the Flow of Thin Films*

Department of Energy: August 1, 2002 - July 31, 2005
Lou Kondic

18. *Optimal Patterns of Wound Closure to Maximize Strength, Foster Healing and Minimize Scar*

National Science Foundation & National Institute of Health: July 1, 2002 - June 30, 2004
Dawn Alisha Lott
Hans R. Chaudhry
Arthur B. Ritter
Kenneth G. Swan

19. *Efficient Shallow Water Matched Field Inversion*

Office of Naval Research: January 1, 2002 - September 30, 2004
Zoi-Heleni Michalopoulou

20. *Interactions of Nonlinear Waves in Dissipative and Dispersive Media*

National Science Foundation: June 1, 2002 - May 31, 2005
Robert M. Miura
Marianito Rodrigo

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

U. S. Israel Binational Science Foundation: September 1, 2002 – August 31, 2006
Yair Manor
Farzan Nadim
Eve Marder

22. *Collaborative Research: Modeling and Computational Analysis of Cell Communication in Drosophilia Oogenesis*

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

23. *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

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

National Science Foundation: July 1, 2002 – June 30, 2005
Jean-Marc Vanden-Broeck

C. EXTERNALLY FUNDED PROJECTS -- NOT THROUGH CAMS

1. *Laboratory for Electro-Hydrodynamics*

W. M. Keck Foundation: January 2000 – January 2005
Nadine Aubry
Boris Khusid
Andreas Acrivos

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

   NJ Commission on Science and Technology: December 1, 2000 – November 30, 2005
   Nadine Aubry
   E. Geskin
   Y. Kevrekidis
   B. Khusid
   P. Singh
   S. Sundaresan
   S. Mitra
   D. Hahn

3. *Ultra-Filtration of In-Service Fluids*

   US Navy: May 2001 – April 2003
   Nadine Aubry
   Boris Khusid

4. *Development of a Biocomplexity Research Program for the Analysis of Ecosystem Structure and Dynamics in Urban Salt Marshes*

   National Science Foundation: October 1, 2001 - September 30, 2002
   M. Levandowsky
   G. Benoit
   D. Blackmore
   M. Haggblom

5. *Experimental Mathematics, Science and Communications Program*

   Victoria Foundation, January 1, 2001 - December 31, 2002
   Rose Dios
   Howard Kimmel

6. *Webs and PDEs*

   Italian Mathematical Union and University of Rome, Italy: June 11 - June 17, 2002
   Vladislav V. Goldberg

7. *Laboratory Information Management System*

   NJ Department of Transportation/US Department of Transportation: April 2000 - May 2002
   J. N. Meegoda
   C. Tang

8. *Investigation of Subsurface Contamination and Effectiveness of Remediation Technologies Using Geotechnical Centrifuge Techniques*

   Research Grant Council of Hong Kong: January 2000 - December 2002
   I. M. C. Lo
   J. N. Meegoda

9. *Research, Development, Demonstration and Validation of Intelligent Systems for Conveyance and Storage Infrastructure*

   U.S. Army Environmental Center: May 2001- August 2002
   T. Juliano
   J. N. Meegoda

10. *Correlation of Surface Texture, Segregation, and Measurement of Air Voids*

    New Jersey Department of Transportation: January 2001 - May 2002
    J. N. Meegoda
    G. Rowe

11. *Mathematical Physiology*

    Natural Sciences and Engineering Research Council of Canada
    April 1, 2000 - August 31, 2001
    Robert M. Miura

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

    National Science Foundation: May 1, 2001 - April 30, 2006
    Scott Hooper
    Ron Harris-Warrick
    Jorge Golowasch
    Eve Marder
    Farzan Nadim
    Michael P. Nusbaum

13. *Large Amplitude Capillary Waves in Electrified Fluid Sheets*

    NATO: September 1, 2002 – August 31, 2004
    Jean-Marc Vanden-Broeck
    Demetrios Papageorgiou
    Touvia Miloh
    Gregory Zilman

VIII. COMMITTEE AND LABORATORY ANNUAL REPORTS

A. READING ROOM by David Horntrop

The CAMS Reading Room has continued to successfully function as a location for informal gatherings of faculty and graduate students for a wide variety of discussions. To further facilitate these interactions, weekly teas were organized on Tuesdays and Fridays throughout the academic year by David Horntrop. The opportunity for informal conversations with the CAMS colloquium speaker at the Friday teas has proved to be quite valuable. In fact, the consistently high attendance at the Friday teas has necessitated their expansion into the adjoining conference room. In addition, the involvement of the graduate students in the organization and execution of the teas has greatly increased their participation in tea and their use of the CAMS Reading Room. The success of the CAMS teas has also been a result of the support of the Mathematical Sciences and CAMS faculty as well as graduate students.

B. COMMITTEE REPORTS

SEMINAR COMMITTEE REPORT by Christopher Elmer

In 2001-2002, the Colloquium Committee members were Christopher Elmer, Thomas Spencer, and Robert M. Miura. The 2001-2002 Department of Mathematical Sciences and CAMS Colloquium Series was a successful and popular event. This year our colloquium schedule expanded to include an Applied Mathematics series (Christopher Elmer), a Statistics series (Thomas Spencer), and a Mathematical Biology series (Robert M. Miura), reflecting the growing diversity of strengths within CAMS. The lectures, delivered by well-known mathematicians and engineers from academia and industry, covered a variety of fields including materials science, mathematical biology, dynamical systems, fluid dynamics, and climate modeling. The Statistics series also included the INFORMS 2001 Edelman Award Presentation.

A number of colloquia were jointly sponsored with other departments and organizations: two with the Mechanical Engineering Department, NJIT; one with the Department of Preventative Medicine and Community Health, New Jersey Medical School; one lecture with the Department of Industrial and Manufacturing Engineering, NJIT; one with the Department of Mathematics, Rutgers-Newark; and one with the Graduate Student Association, NJIT.

PUBLICATIONS COMMITTEE REPORT by Peter Petropoulos

The annual duties of the Publications Committee include overseeing the production, advertisement, and distribution of Technical Reports produced by CAMS members, and the production of the Center's Annual Report. The work of the committee is made possible by the capable support of Susan Sutton, Departmental Administrative Assistant.

Due to monetary considerations it was decided that the CAMS Technical Report Series be discontinued in its present form; starting with Fall 2002, CAMS Technical Reports will no longer be printed and bound by the Department of Mathematical Sciences. Instead, individuals will submit to Ms. Monica Figueroa, Administrative Assistant to the Department of Mathematical Sciences, an electronic copy of the manuscript to be catalogued in the Report Series which will (starting Fall 2002) reside entirely on the web page of the Department of Mathematical Sciences.

Cyrill Muratov will undertake an extensive revision of the Department of Mathematical Sciences/CAMS web pages during the 2002-2003 academic year.

C. LABORATORY ANNUAL REPORTS

COMPUTER COMMITTEE REPORT by Peter Petropoulos and Lou Kondic

For 2001-02, the Computer Committee was composed of Lou Kondic and Peter G. Petropoulos (co-chairs), and Irene Giouvanos (Systems Manager, Department of Mathematical Sciences). The tasks of the committee are to:

a) ensure smooth operations of existing common and individual computational resources within Department of Mathematical Sciences/CAMS,

b) plan for the distribution of computer resources among Department of Mathematical Sciences/CAMS faculty and graduate students who require them for research- and course-related purposes,

c) assure software maintenance is regularly performed,

d) plan the growth of computer resources in order to support the expansion of existing faculty activities into computationally-intensive research areas and accommodate new faculty,

e) reconfigure existing systems as required due to the acquisition of new equipment.

This year the committee worked towards the establishment of the network of 24 SUN workstations (under the NJIT AFS system) as the primary computing platform supporting Department of Mathematical Sciences graduate students. Through the year various problems were identified and solved.

The above effort had previously released a large number of computing platforms. This year these were integrated as the Department of Mathematical Sciences/CAMS common research computing cluster under a common file system. With the recent addition of two new computational servers (purchased using the funds from an NSF SCREMS grant), Department of Mathematical Sciences/CAMS users now have access to the following hardware: two Compaq ES40 computers (each with four 833 MHz Alpha CPU's), an SGI Origin 2000 (four 300 MHz R12000 CPU's), three SGI R10000 workstations, and six Linux workstations (each with dual Pentium3 700 MHz processors).

A new SGI R12000 workstation was generously released by Eliza Michalopoulou to replace the aging workstation which hosted the central e-mail and Web-related Department of Mathematical Sciences services that are complementary to similar University-provided services.

Throughout the year the committee has responded to a large number of problems involving common computing facilities and individual faculty computers. Also, it has assisted in the purchase of individual and common computing resources within the Department of Mathematical Sciences.

Under the supervision of Cyrill B. Muratov, the CAMS Web pages were reorganized to better present the ongoing research activities in the department (see www.math.njit.edu/CAMS/research.html). Five major research directions were highlighted. The emphasis was made on visual impact of the presentation, making it accessible to both the specialists and the general public, including prospective graduate students.

STATISTICAL CONSULTING LABORATORY by Sunil K. Dhar

The Mathematical Sciences faculty serves the NJIT community and outside individuals and organizations as statistical consultants. Here are examples of a few of them.

Date: May 01, 2002

Client: Lakshmana Madhu Pudipeddi, M.S., Information Systems, and student at NJIT
Description: Helped the student getting started with SAS
Consultant: Sunil K. Dhar

Date: November 29, 2001

Client: Professor Hira L. Koul, Department of Probability and Statistics, Michigan State University
Description: Data Simulation through excel and S-plus program code for running Least Absolute Deviation Regression
Consultant: Sunil K. Dhar

A significant portion of the resources of the Statistical Consulting lab is used towards educating graduate and Ph.D. students. There are several courses within the Mathematical Sciences that use this lab to advance the knowledge of Statistics applied to the various sciences. Here are some examples.

Professor Thomas Spencer III, guided students to do simulation work using the Statistical Consulting Lab during June of 2002. Soumi Lahiri and Ivan Zorych did some preliminary design and development of a simulation process to simulate averages of subsets of moving order statistics for sequences generated from various underlying population distributions. The purpose of this work was to provide some training on how simulation can be used for statistical analysis, and to demonstrate the viability of this approach to study the statistical properties of these particular kinds of moving averages. This work will be continued so that sources of empirical data can be used for the underlying population distributions, and to demonstrate that a simulation engine could be built to study these statistics. Long term it is hoped that we may be able to obtain funding to support this activity.

In the Math 664-102 - Methods for Statistical Consulting, Spring, 2002, which uses the lab to demonstrate S-plus and SAS software. Several students also used the Lab to make research presentation using SAS. Here is an example of a presentation by one of the students in the Math 664 class, Ivan Zorych. Title: Tires Tests and Design of Experiments. Abstract: Basic ideas of ANOVA are considered. They are illustrated by the example of a single-factor experiment with 4 levels. The single-factor ANOVA, Randomized Blocks design, and Latin Square design are applied to engineering problem of choosing the best tire brand. It appears that different designs give absolutely different answers for this problem. That stresses the importance of choosing the proper statistical model.

IX. CURRENT AND COLLABORATIVE RESEARCH

A. CURRENT RESEARCH ACTIVITIES

Daljit S. Ahluwalia

The research of Daljit Singh 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, thermal management, etc. 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.

Srinivasan Balaji

The research of Srinivasan Balaji is broadly in the area of probability, in particular, stochastic processes with special emphasis on the stability and asymptotics of diffusions. His studies mainly are concerned with recurrence, transient and positive recurrence of reflecting diffusions in domains such as quadrants and orthants and passage time moments for multidimensional diffusions. His studies in the area of Markov chains cover the topics such as multiplicative ergodicity, the Poisson equation and large deviation of empirical measures. His research on computational learning theory concerns PAC learnability under a family of probability measures. His current projects include the analysis of duality between failure rate and mean residual life of lifetime distributions, the role of sticky diffusions in default risk modeling, and possible applications of Markov chain Monte Carlo methods to finance.

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

The primary focus of the research by Manish C. Bhattacharjee is on applied probability with particular emphasis on reliability theory and corresponding statistical issues arising in stochastic modeling of system performance and degradation. His studies in statistical reliability theory covers the topics of nonparametric classes of survival distributions, their closure properties under formation of systems with similarly aging components, related characterization problems, repairable systems and non-traditional applications of reliability theoretic methods and ideas to other areas such as (i) queueing - in operations research, (ii) branching processes in applied probability, and (iii) modeling economic inequality. His current projects include investigation of conditions for shape-duality between hazard rate and mean residual life functions, and closure properties of randomly stopped sums with geometric stopping times that arise in many applications, such as in queueing, ruin probability problems in actuarial science and shock models of failure.

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 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, and collaborative studies on bubble dynamics and slow, localized thermal waves in material processing.

Amitabha Bose

The research of Amitabha Bose focuses on the area of dynamical systems and their applications to non-linear waves and mathematical neurophysiology. His work on non-linear waves involves proving existence and stability of pulse solutions to non-local reaction diffusion equations arising in microwave heating applications. 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 synaptic depression in the gastric mill system of crustaceans, ripple wave formation in the rat hippocampus and firing rate and phase based changes in multi-compartment pyramidal cells.

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 studies biological systems with regard to stresses in the heart. His current focus in biology concerns flow in the lungs with the goal of improving medical treatments. Professor Bukiet is also interested in understanding and optimizing aspects of baseball from a mathematical modeling perspective.

Hans Chaudhry

The research of Hans Chaudhry has mainly focused on the modeling and analysis of physical and physiological problems in continuum mechanics, especially solid mechanics incorporating large elastic deformations. His studies in large elastic deformations cover stress and strain analysis in cardiovascular system, human skin and low back dysfunction. He and his collaborators from NJIT have recently given a sound mathematical basis for heart reduction surgery in patients suffering from myocardial cardiomyopathy. In-vivo comparisons of his results on dogs are being investigated by a team of doctors from UMDNJ. He along with his other collaborators from NJIT have also discovered the optimal patterns of suturing wounds of complex shapes to maximize strength, foster healing and minimize scars by employing finite element techniques. These results are also being investigated by experts in the surgery department of UMDNJ.

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 the 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 the generalized discrete analog 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 has also 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.

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 submanifolds with degenerate Gauss maps, construction of invariant normalizations of lightlike submanifolds, finding a classification of multidimensional four-webs, and solving Belousov's problem of existence of reducible and irreducible n-quasigroups.

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.

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 of 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.

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 a microwave cavities.

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 for estimation of parameters such as source location and physical properties of the propagation medium. The research involves numerical modeling of sound propagation and the development of signal processing methods for the estimation process. Current projects include time delay estimation from received time series for use in inversion, multiple source localization, and inversion in the presence of coherence loss mechanisms.

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 involves 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 BVP's for (contingent) ordinary and elliptic PDE's, to periodic and BVP's 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 a spectrum of areas in applied mathematics, especially in mathematical biology. 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. This work involves detailed investigations into the determination of membrane electrical properties, subthreshold resonance, signal propagation on dendrites, and mechanisms leading to bursting activity. His studies on spreading cortical depression, and more generally intercellular communication via ion flows, includes analysis and simulations of mathematical models, and the study of diffusion of ions in the brain using a lattice gas algorithm. Several other projects under study are glass microelectrode formation, direction reversal in Brownian ratchets, and coupled neuronal networks.

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

Peter G. Petropoulos

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

conditions are employed, development of numerical techniques to simulate pulse propagation in Cole-Cole dielectrics, analysis of perfectly matched absorbing boundary conditions in relation to exact absorbing boundary conditions, and the development of fourth-order accurate schemes in the presence of curved boundaries.

Marianito Rodrigo

The research of Marianito Rodrigo is on the analysis of nonlinear partial differential equations, in particular, reaction-diffusion systems and nonlinear wave equations. He is also interested in developing methods for finding explicit solutions of these systems. He has also worked on the analysis of some reaction-diffusion systems arising in neurophysiology and population ecology. His current projects include studies on spatially-discrete reaction-diffusion systems and coagulation-diffusion equations of cluster growth.

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. His current projects include analytical studies of the evolution of slender axisymmetric bubbles with surfactant, pinch off (topological singularities) in slender bubbles, and the singular effects of surface tension in the dynamics of two-finger competition in Hele-Shaw flow.

Thomas Spencer

The research of Thomas Spencer III has focused on the applications of statistics, and operations research to large scale business problems, especially those that arise out of operational issues in call centers. For his work on simulating call centers, he received the Franz Edelman Award in 1993 from the Institute of Operations Research and the Management Sciences. He also has done work on the distributions of waiting times associated with sequences of exchangeable random variables. In addition he has an active interest in statistics and probability in sports, and the analysis of sports data.

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 had application in electromagnetics, acoustics and elasticity. It included some problems in inverse scattering. The diffusion problems included 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.

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.

Burt S. Tilley

The research of Burt S. Tilley has focused on the modeling and analysis of free boundary problems that arise in multi-fluid/media applications. Models of these phenomena are derived by taking advantage of the disparate space and time scales through a systematic asymptotic analysis, and then numerical methods are used to simulate the dynamics. Examples include the stability and pattern formation of the interface between two immiscible, incompressible viscous fluids in an inclined channel, heat transfer due to the fluid motion of a contact line on an oscillating, heated substrate, stability and nonlinear evolution of a thin inviscid liquid dielectric sheet in the presence of an axial electric field, and microwave-enhanced chemical vapor infiltration. Current projects, in addition to extensions of the above work, include the evolution of critical layers in countercurrent two-layer flows, nonlinear elastic/fluid interactions, and a nonlinear description of transitions to slugging in core-annular flows.

B. SELECTED RESEARCH RESULTS

Manish C. Bhattacharjee and Srinivasan Balaji

Victoria Booth and Amitabha Bose

Daniel Goldman

David J. Horntrop

Lou Kondic

Gregory A. Kriegsmann

Robert M. Miura

Cyrill Muratov

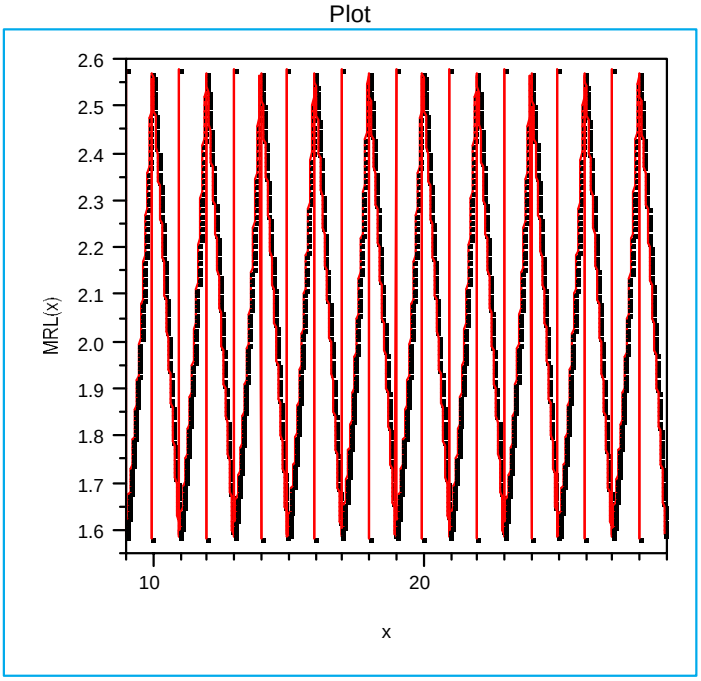
Demetrius T. Papageorgiou

Peter G. Petropoulos

M.C. Bhattacharjee and S. Balaji

Title: Shape of the Mean Residual Life Function

The Mean Remaining Life function MRL(x) is an indicator of the performance profile of equipment/system, as it ages. In most situations, the MRL is either eventually monotone, or converges to a limit as the system ages. This need not be the case, however .The following model of an equipment reliability function exhibits an oscillating MRL (plot shown for $x \leq 29$).



The Mean Remaining Life function $MRL(x) \equiv E(X-x \mid X > x)$ at *age* x , is :

$$E(X - x \mid X > x) = \begin{cases} (\lceil x \rceil - x) + (1 - e^{-1})^{-1}, & \text{if } \lfloor x \rfloor \bmod 2 = 0, \\ 1 + (1 - e^{-1})^{-1} e^{-(\lceil x \rceil - x)}, & \text{otherwise.} \end{cases}$$

The above MRL function , corresponds to a survival distribution model, given by :

$$\text{Reliability at age } x \equiv P(X > x) = \begin{cases} e^{-n}, & \text{if } 2n \leq x < (2n+1), \\ e^{-(x-n-1)}, & \text{if } (2n+1) \leq x < (2n+2). \end{cases} \quad (n=0,1,2,\ldots)$$

$$= \begin{cases} e^{-\lfloor x/2 \rfloor}, & \text{if } 2n \leq x < (2n+1), \\ e^{-\lceil x/2 \rceil}, & \text{if } (2n+1) \leq x < (2n+2). \end{cases}$$

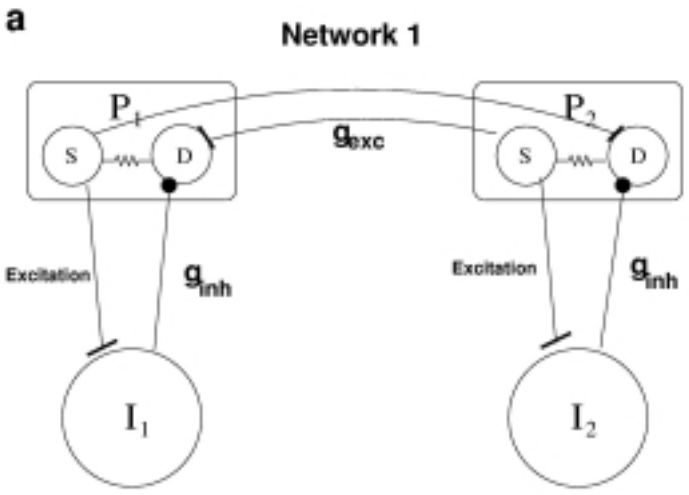
The above summary of results is part of ongoing work on the shape duality between the MRL and hazard functions of survival distributions.

Victoria Booth and Amitabha Bose

Title: Near-Synchronous Bursting in Hippocampal Pyramidal Cell Model Networks

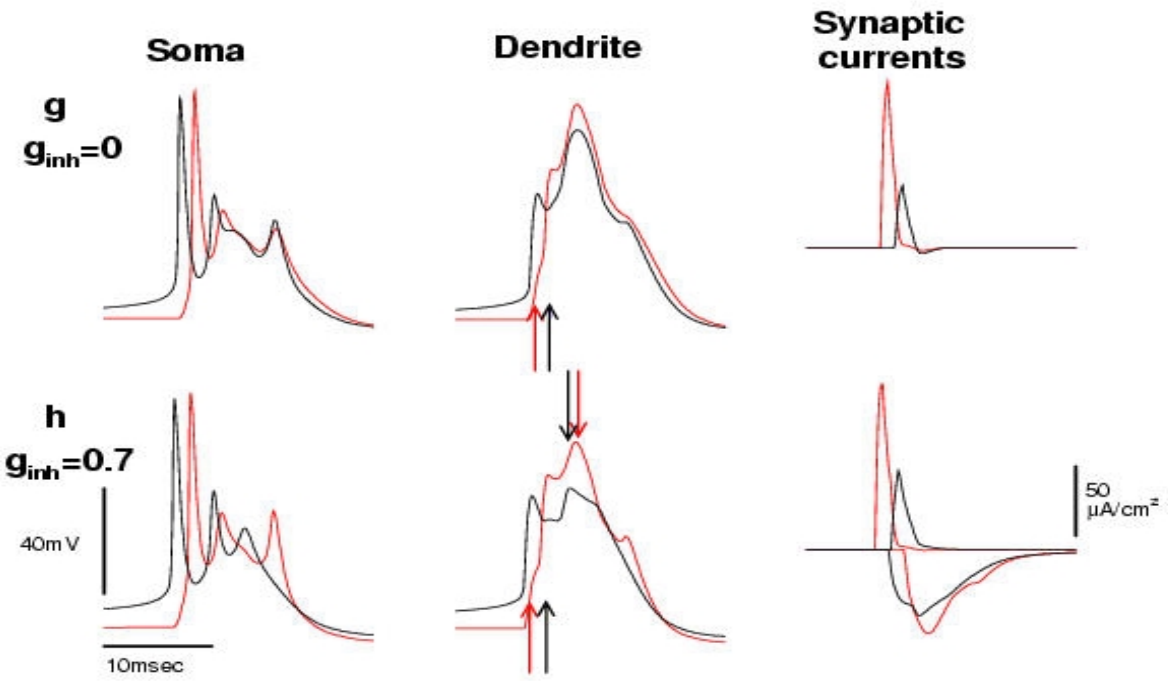
Although neuroscientists are far from figuring out how the brain stores, transmits and recalls information, it has become clear that information processing is most likely achieved through synchronous firing of neurons within as well as across regions of the brain. While ``synchronous firing'' suggests that the voltage changes in cells are identical and simultaneous, in experimental recordings of neurons and in mathematical models of neuronal networks, the neuronal voltage traces are only approximately synchronous with differences varying between 1 - 5 msec. The recurrent excitatory synaptic connections among ``synchronously firing'' neurons provide the stimuli to drive the collective firing but often don't reveal why voltage changes in different neurons are not identical. We investigated the effect of the location of the synaptic connection on the neuron and the effects of additional synaptic inputs on synchronous firing in small networks of hippocampal pyramidal cells and interneurons (Fig 1). Instead of firing discrete voltage spikes, these pyramidal cells fire a burst of spikes with a complex profile that results from the interplay of voltage changes in the somatic and dendritic regions of the cell. We analyzed the bursting of two pyramidal cells (P1 and P2) and determined that the excitatory synaptic inputs between the two cells introduced differences in dendritic voltage changes that prevent the two cells from perfectly synchronizing (Fig 2, top traces). We prove that the perfectly synchronous solution is unstable and that the near-synchronous solution is, in fact, stable. These stability results remain true when the pyramidal cells receive additional inhibitory synaptic inputs from local interneurons (I1 and I2, Fig 2 bottom traces). By understanding how and why various patterns of synchronous firing can arise in a neuronal network, we can better determine the amount of information a network can process.

Figure 1



Booth and Bose (continued)

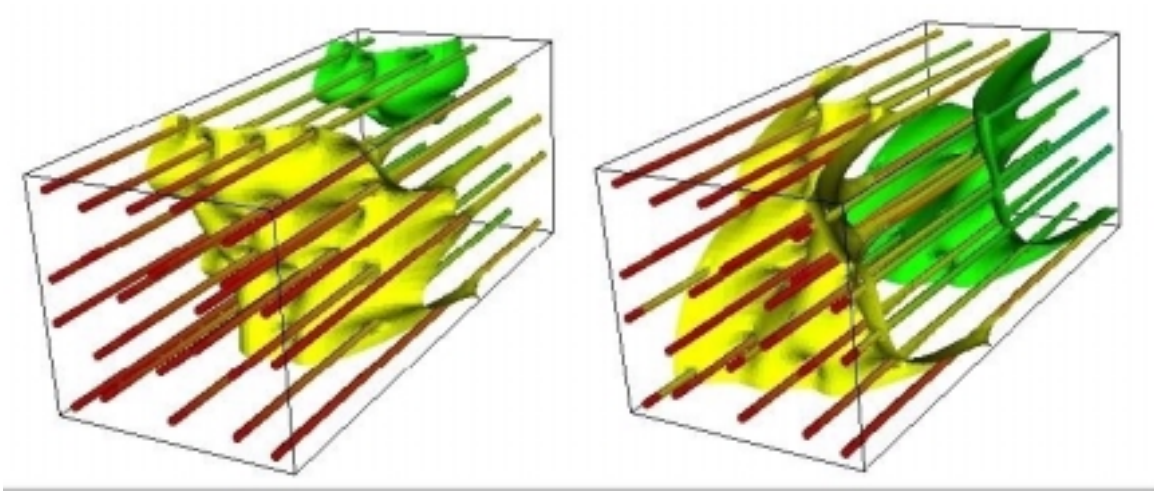
Figure 2



Daniel Goldman

Title: Microvascular Oxygen Transport During Sepsis

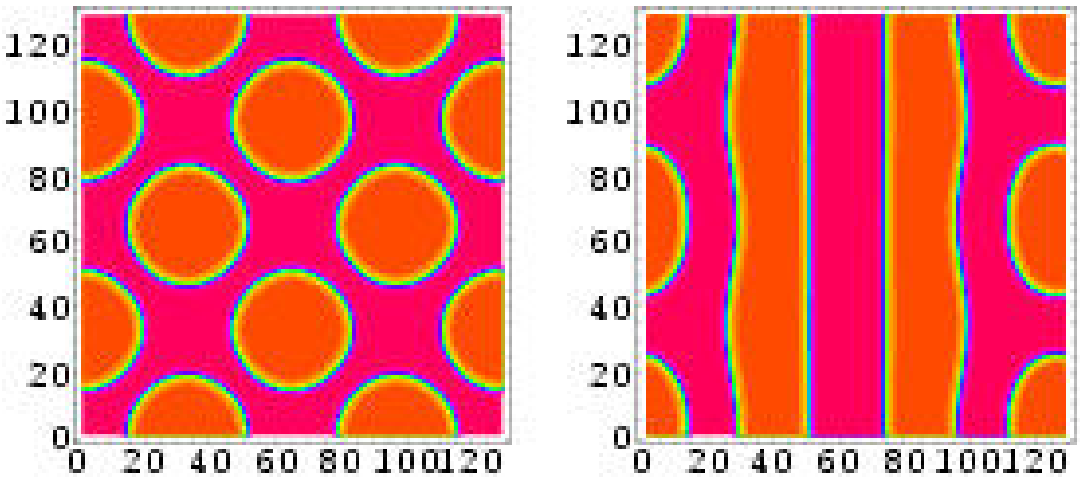
We are performing numerical simulations of oxygen transport in the microcirculation under normal and septic conditions in order to determine how observed changes in blood flow distributions affect tissue oxygen delivery. In particular, we are interested in how sepsis increases the spatial heterogeneity of oxygen transport and produces localized tissue hypoxia. Shown are the calculated oxygen distributions inside a three-dimensional array of capillaries and in the surrounding tissue, where red and blue represent high and low oxygen concentrations, respectively. On the left, a normal capillary blood flow distribution produces only a small region of relatively low oxygen (green isosurface), while on the right a maldistribution of blood flow due to sepsis results in a large volume of poorly oxygenated tissue. In collaboration with experimentalists, results such as these are currently being used to understand how sepsis causes tissue damage leading to decreased oxygen extraction capability.



David J. Horntrop

Title: Mesoscopic Models for Pattern Formation in Materials

The formation of large scale patterns as a result of interactions on the molecular level is a phenomenon that has been observed in many physical problems in materials science. An understanding of the pattern selection mechanism will prove to be important in the creation of advanced materials such as superconductors as well as the design of catalytic surface reactors. Through both analysis and computations, we are using mesoscopic models to study such systems. The plots below are contour plots resulting from computational studies, where orange represents regions of high concentration and hot pink represents regions of low concentration. Even though similar initial concentration fields were used in both situations, very different patterns of concentration were observed at long times. On the left, isolated circular regions of high concentration are surrounded by regions of low concentration; on the right, there are stripes as well as round regions of high concentration.



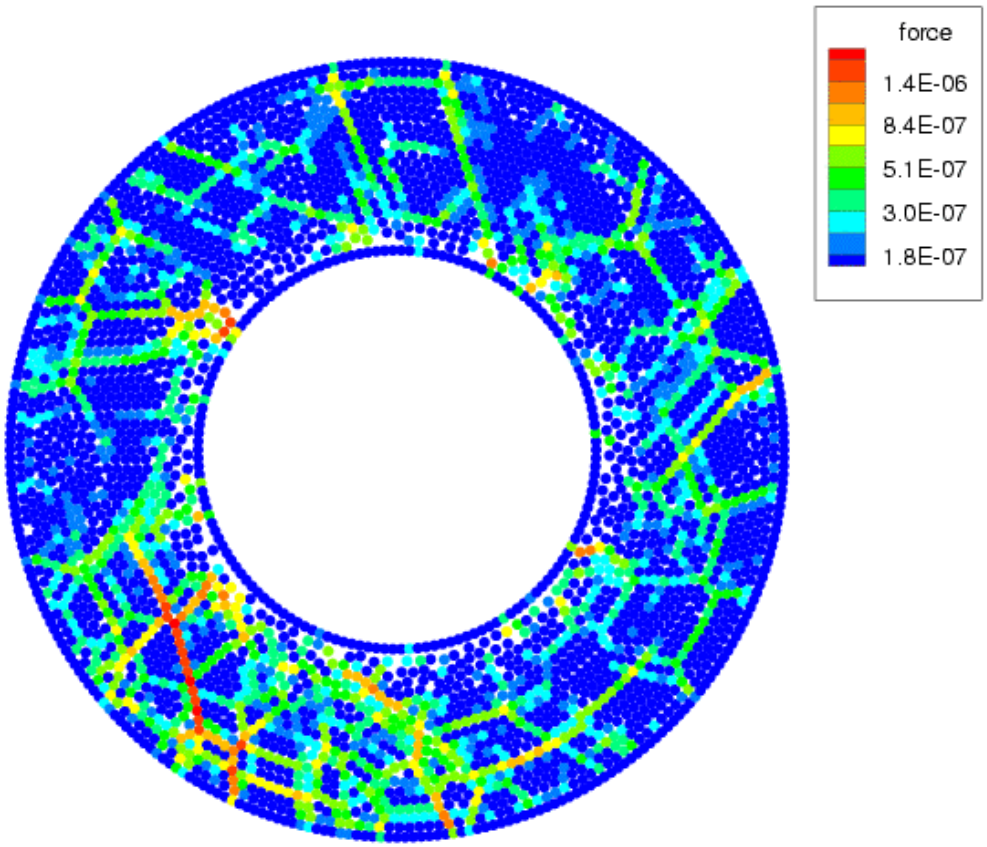
Lou Kondic

Title: Sheared Granular Materials Between Two Cylinders

Granular materials are difficult to model due to large fluctuations that prevent formulation of continuous theories based on microscopic averaging. For this reasons, discrete element (molecular dynamics, MD) simulations are often an indispensable tool in analyzing these systems.

Currently, I am developing MD simulations of a granular system sheared between two concentric cylinders. The figure below shows the force that granular particles experience as they are being sheared by the rotating inner wheel. The fluctuations mentioned above are evident in this figure in the form of well-developed `force chains', that also have been observed in the experiments by my collaborators at Duke University, led by Robert Behringer. Animations of this flow are available at http://math.njit.edu/~kondic/granular/couette.html.

These simulations are currently being extended to the third space dimension where I will concentrate in particular on the influence of gravity on the dynamics of the system. This research, supported by NASA, will provide important guidances to the planned space station experiments which are also currently under preparation.



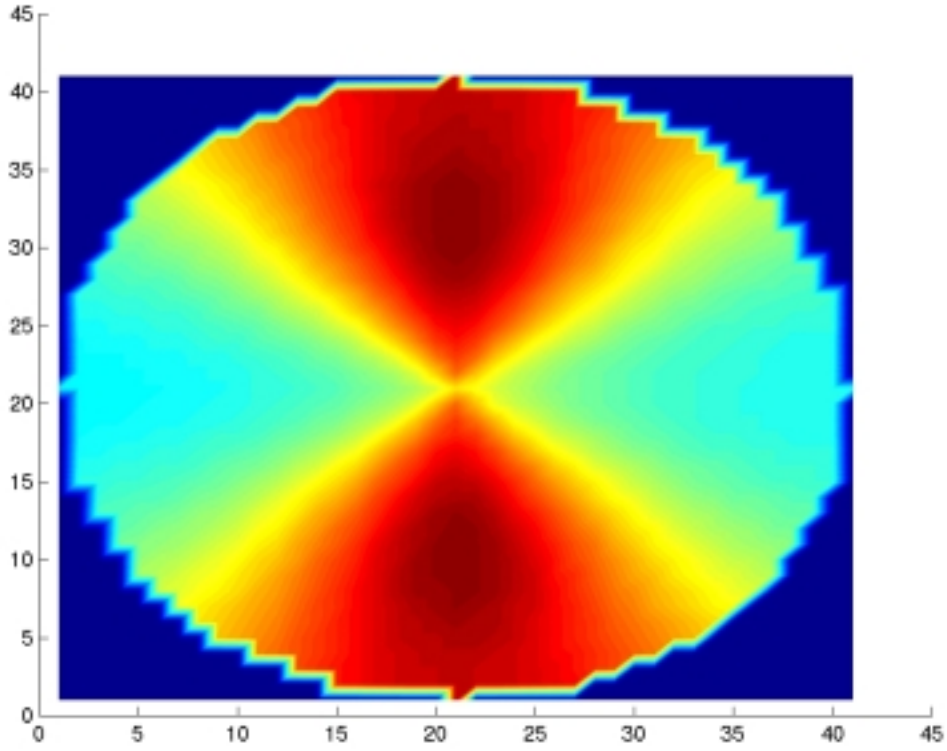
Gregory A. Kriegsmann

Title: Microwave Heating of Silicon Wafers in Cylindrical TM Cavities: A Mathematical Model

Recent experiments have shown that silicon wafers can be rapidly heated, with moderate power, in cylindrical TM_{111} and TM_{101} cavities. The implications of these experiments suggest that microwave heating may be an efficient mechanism for two important materials applications; annealing single wafers and bonding several wafers together.

We have recently constructed a mathematical model of this heating process which takes the form of a two dimensional diffusion equation that describes the evolution of the wafer temperature. This equation contains both radiative and convective loss terms which describe heat transfer on the wafer surfaces, and a source term which takes into account the modal pattern of the cavity and the detuning of the cavity in the initial portion of the heating process. We have developed an alternating-direction finite difference algorithm to produce accurate approximations of the temperature distribution. The results of numerical simulations are in excellent qualitative agreement with experiments. Specifically, rapid heating is described on the time scales seen experimentally, the functional dependence of the maximum wafer temperature on the input power is in agreement with experiments, and temperature variations of the silicon wafer, driven by the dominate mode of the cavity, are specifically obtained.

In the figure below we have shown the surface temperature of a wafer in a TM_{111} cavity where the red regions are the hottest. This preferential heating is caused by the modal structure of the electric field within the cavity.



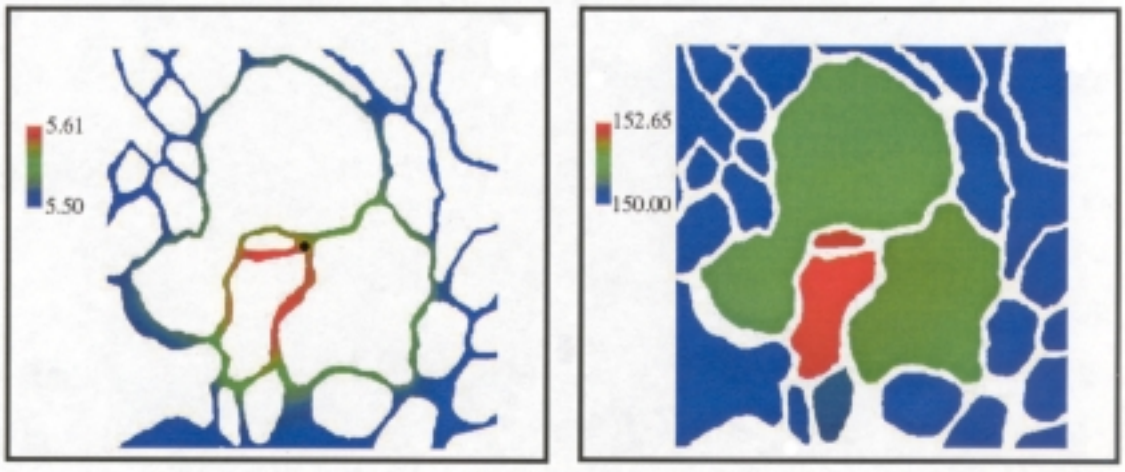
Robert M. Miura

Title: Ion Diffusion in the Brain (with Y.Q. Wang)

Brain function is determined to a large extent by the movement of ions across neuronal membranes, e.g., to generate action potentials, and by the diffusion of ions in the extracellular and intracellular spaces, i.e., outside and inside neurons, respectively. The major ions in the brain are sodium, potassium, chloride, and calcium. Experiments have clearly shown that the ionic state of the brain cell microenvironment plays an important role in the functioning of neurons in the brain. For example, spreading cortical depression, a slowly propagating wave in the cortex of various brain structures, has been implicated in classic migraine and is associated with nonlinear diffusion waves in the visual cortex.

The specific problem under study is to determine how localized increases or decreases in ion concentrations spread through brain tissue. The spread of ions through the brain can be treated as a flow through a porous medium where the neurons and glia cells play the roles of solid matter and ions spread by diffusion through the intervening regions, called the extracellular space. The complication, as noted above, is that ions also can cross the cellular membranes. Such flows have been modeled using a continuum approach since the scale of the waves measured in the brain are long compared to cell size. Because of the relatively narrow and tortuous passages between cells, one needs to properly compute the tortuosity, a geometric measure of the distance traveled by ions as compared to straight line distances, and the volume fraction, the fraction of the total tissue volume consisting of the extracellular space.

We now are developing a particle method, called the lattice Boltzmann method, for a detailed study of the flow of ions in brain tissue. This is a computer-intensive method that can be used to generate ion concentration profiles and then can be compared with results from experiments and from the continuum model. An example of a simulation is shown in the figures below. Initially, the ionic concentrations are set at the usual background levels. Then a source of potassium ions is injected into the extracellular space (left panel) at the black dot near the center of the panel for a certain period of time and mimics ion injection from a micropipette. The injection is stopped and the ions are allowed to diffuse through the extracellular space as well as cross the cellular membranes. The resulting distributions of potassium ions in the extracellular space and in the intracellular space (right panel) at some later time are shown below.



Cyrill Muratov

Title: Modeling and Computational Analysis of EGF Receptor-Mediated Cell Communication in Drosophila Oogenesis (joint work with S. Y. Shvartsman and D. A. Lauffenburger)

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. We are 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.

We have 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. Our 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, in choosing the parameters of the model, we were guided by the available biochemical information about the relevant time and length scales, etc., of the involved processes.

Muratov (continued)

We performed extensive computational analysis of the proposed model. The figure below presents a summary of our analysis of the signaling patterns.

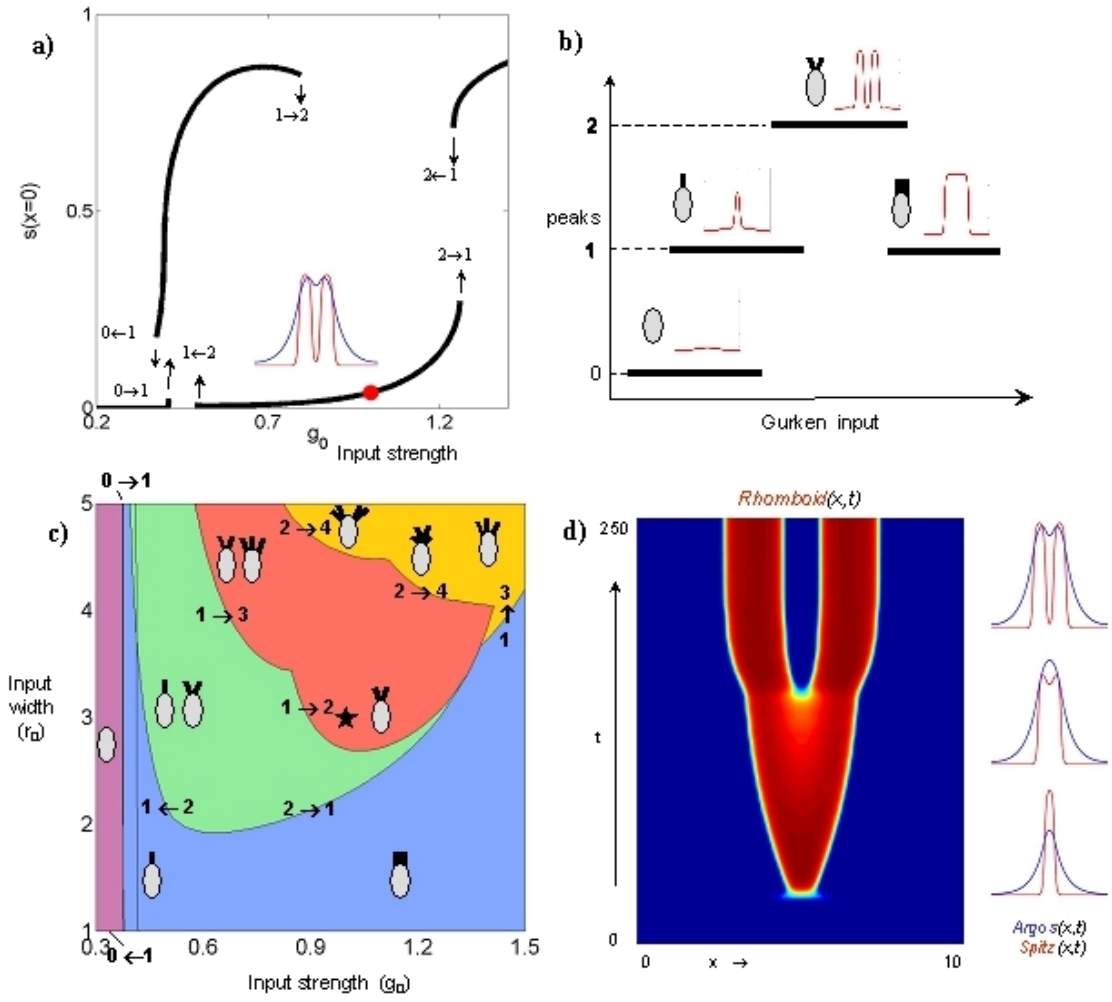


Figure: (a) Steady state bifurcation diagram showing the hysteretic transitions between branches with zero, one, and two peaks. Only the stable solutions are shown. (b) This sequence of hysteretic transitions can be used to account for a number of observed phenotypic transitions. (c) Two-parameter bifurcation 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.

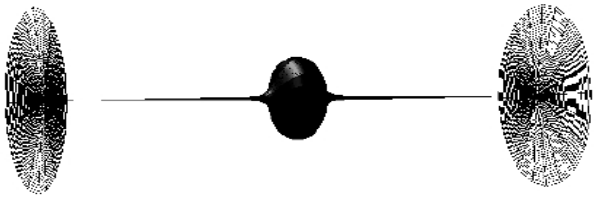
Demetrius T. Papageorgiou

Title: Breakup of a Viscous Thread of Fluid Due to Capillary Instability

Figures 1 and 2 show a numerical simulation of the breakup of a viscous thread of fluid due to capillary instability. A perfectly cylindrical thread of liquid (viscous or inviscid) is unstable to wavy interfacial disturbances of wavelengths which exceed the undisturbed thread circumference. This linear instability is quickly overtaken by nonlinear effects which lead to the disintegration of the thread into droplets. A numerical simulation of the formation of main and satellite drops is shown in the figures. The pinching event manifests itself as a finite-time singularity of the governing equations and computations become increasingly difficult near this point. The computation was stopped just before pinching and Figure 1 shows a far view of the phenomenon, while Figure 2 shows an enlarged view of the satellite. The calculations were based on a long wave one-dimensional model system and were carried out using a collocation method with adaptive grids. Insoluble surfactants can be included into the long wave theory; their effect on the pinching dynamics and satellite drop formation have been studied extensively by Craster, Matar and Papageorgiou (Physics of Fluids, Vol. 14(4), pp. 1364-1376, 2002). It is found that surfactants can be used to decrease the volumes of satellite droplets by more than 50 %. Such controls are useful in applications. We are currently studying drop formation in surfactant covered compound jets.

Figure 1

Figure 2



Peter G. Petropoulos

Title: Analysis of Discrete Perfectly Matched Layers in Cylindrical Coordinates

We have completed an analysis of the perfectly matched layer in cylindrical coordinates discretized with a staggered second-order accurate finite difference time domain method. For fixed discretization parameters, layer width, and a quadratic loss function, we find the numerical reflection produced by the discrete layer is accurately predicted by our analysis in terms of the maximum value of the loss in the layer. Figure 1 shows the geometry of the problem, and Figure 2 compares results from our analysis with numerical simulations of the problem. Using these results, we have been able to predetermine the parameters used in the perfectly matched layer to achieve the same error as that produced by an exact absorbing boundary condition as shown in Figure 3; as a reference we give in this figure the error that results when a standard absorbing boundary condition is employed.

Fig. 1

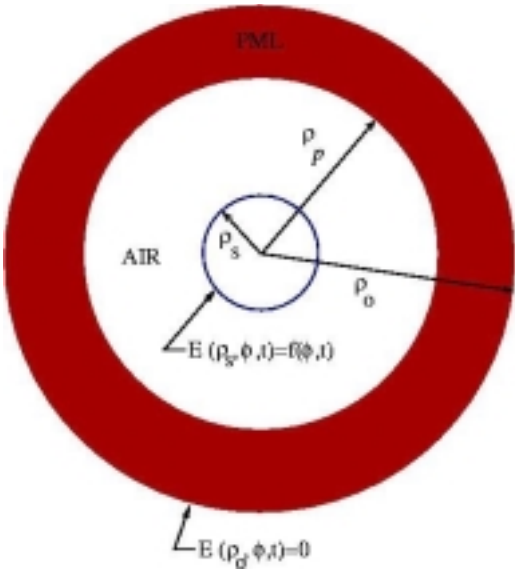
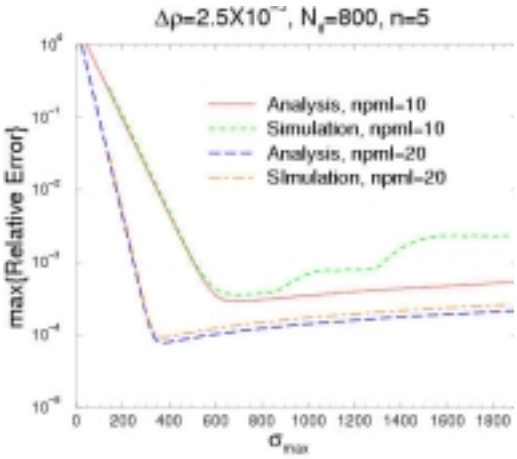


Fig. 2



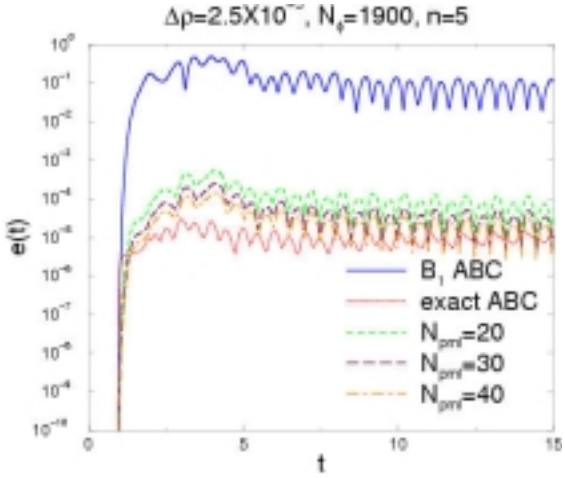


Fig. 3

C. COLLABORATIVE RESEARCH

Roman Andrushkiw

Study of interface dynamics in quasistationary Stefan problems, V.Gafiychuk, A. Shnyr (Institute Applied Problems of Mechanics and Mathematics of the National Academy of Sciences of Ukraine, Lviv)

Study of modified nearest neighbor recognition method for breast cancer diagnosis. Statistical tests for comparing two probabilities and their application to cancer risk analysis. Y. Petunin, D. Klyushin (Kyiv National Taras Shevchenko University, Kyiv, Ukraine), and N. Boroday (R.E. Kavetsky Institute of Oncology and Radiology of the National Academy of Sciences of Ukraine, Kyiv)

Srinivasan Balaji

Limiting distributions for sums of exchangeable random variables, Thomas Spencer (Department of Mathematical Sciences, NJIT)

Waiting times for exchangeable sequences, Thomas Spencer (Department of Mathematical Sciences, NJIT)

On first exit time problems and their applications to wireless communications, Ali Abdi (Department of Electrical and Computer Engineering, NJIT)

Pairing human and machines in medical detection problems, Cheikna Sylla (Department of Management Sciences, NJIT)

On the duality between mean residual life and failure rates, Manish Bhattacharjee (Department of Mathematical Sciences, NJIT)

Optimal trading with minimal assumptions, John Price (University of New South Wales, Australia)

John Bechtold

Flame/flow interactions in premixed combustion, M. Matalon (Northwestern University)

Radiation-driven flows, P. Ronney (University of Southern California)

Oscillations and extinction in diffusion flames, C. K. Law (Princeton University)

Denis Blackmore

Biocomplexity in urban salt marshes, M. Levandowsky (Pace Univ.), G. Benoit (Yale), M. Haggblom (Rugers Univ.).

New Gabor-like wavelets and face recognition systems, C. Liu (NJIT), F. Shih (Computer Science Department, NJIT).

Vortex-shock wave interactions, L. Ting (Courant Inst.).

Vortex filament dynamics and kinematics, O. Knio (Johns Hopkins).

Vortex dynamics and stability on a sphere, C. Lim (RPI).

Chaotic vortex dynamics on a sphere, J. Tavantzis (Department of Mathematical Sciences, NJIT).

Dynamical systems models for phyllotaxis, J. Kappraff (Department of Mathematical Sciences, NJIT).

Galton's board dynamics, A. Rosato (Mechanical Engineering Department, NJIT).

Deformation of bubbles in three-dimensional viscoelastic flows, P. Singh (Mechanical Engineering Department, NJIT).

Dynamics of suspended particles in acoustic and flow fields, J. Meegoda (Civil Engineering Department, NJIT), N. Aboobaker (NJDOT).

Periodic orbits of Hamiltonian systems, C. Wang (Department of Mathematical Sciences, NJIT).

Dynamics of discrete population models, J. Chen (Univ. of Delaware).

Computational topology of swept volumes, M. Leu (Univ. of Missouri-Rolla), W. Regli (Drexel), B. Maiteh (Delphi Automotive Systems).

Infinite-dimensional integrable dynamical systems and quantum computing, A. Prykarpatsky (Krakow Univ. of Mining and Metallurgy), V. Samoilenko (Kiev Univ.), U. Taneri (Eastern Mediterranean Univ.).

Victoria Booth

Spinal neurotrama and neuroplasticity, R. Jung (University of Kentucky)

Role of depressing synapses in rhythmic neuronal networks, A. Bose (Department of Mathematical Sciences, NJIT), F. Nadim (Rutgers University-Newark & Department of Mathematical Sciences, NJIT), Y. Manor (Ben-Gurion University, Israel).

Amitabha Bose

Short-term synaptic dynamics promote phase maintenance in multi-phasic rhythms, Yair Manor (Ben-Gurion University of the Negev, Bersheeva, Israel), Farzan Nadim and Victoria Booth (Department of Mathematical Sciences, NJIT).

Determination of voltage-gated ion current distributions from single point current- and voltage-clamp measurements, Jorge Golowasch (Rutgers University at Newark), Farzan Nadim, Robert Miura and Marianito Rodrigo (Department of Mathematical Sciences, NJIT)

Bruce Bukiet

Mechanical properties of diseased hearts during adaptation, Hans R. Chaudhry (Department of Mathematical Sciences, Department of Biomedical Engineering and Center for Applied Mathematical Sciences, NJIT), Rohit Arora and Arthur Ritter (UMDNJ)

Human performance of motor control and sensory organization, Hans Chaudhry (Department of Mathematical Sciences, Department of Biomedical Engineering and Center for Applied Mathematical Sciences, NJIT), T. Findley (VA Medical Center, East Orange, NJ)

Mathematical modeling of the cofflator, Hans Chaudhry (Department of Mathematical Sciences, Department of Biomedical Engineering and Center for Applied Mathematical Sciences, NJIT), S. Kirshblum (Kessler Institute for Rehabilitation, West Orange, NJ)

Hans Chaudhry

Mechanical properties of diseased hearts during adaptation, Bruce Bukiet (Department of Mathematical Sciences and Center for Applied Mathematical Sciences, NJIT), Rohit Arora and Arthur Ritter (UMDNJ).

Non-linear analysis of optimal patterns for suturing wounds of complex shapes, Dawn Lott, (Department of Mathematical Sciences and Center for Applied Mathematical Sciences, NJIT), K.G.Swan and Arthur Ritter from (UMDNJ).

Mathematical modeling to evaluate low back dysfunction, T. Findley (VA Medical Center East Orange, New Jersey), J. Mertz (Engineer, New Jersey) and M. Warner (UMDNJ).

Human performance of motor control and sensory organization, T.Findley (VA Medical Center, East Orange, New Jersey)

Christopher Elmer

Anisotropy, propagation failure, and wave speedup in traveling waves of discretizations of a nagumo PDE, E.S. Van Vleck (Colorado School of Mines).

Computation of mixed type functional differential boundary value problems, K.A. Abell (University of Sussex, Brighton, U.K.), A.R. Humphries (University of Sussex, Brighton, U.K.), and E.S. Van Vleck (Colorado School of Mines).

Differencing of reaction-diffusion equations with smooth bistable nonlinearities, E.S. Van Vleck (Colorado School of Mines).

Anna Georgieva

Time-dependent airflow, J. Kimbell (CIIT Centers for Health Research)

Inhibition of vascular endothelial growth factor receptors, Prasad Ramakrishna (Physiome Sciences).

Vladislav Goldberg

Varieties with degenerate Gauss maps, M. A. Akivis (Jerusalem Institute of Technology)

Linearization problems for webs, M. A. Akivis (Jerusalem Institute of Technology) and V. V. Lychagin (University of Tromso, Norway)

Almost Grassmann structures, H. Sato (Nagoya University, Japan)

Almost Grassmann structures and special metrics, R. Deszcz, M. Glogowska (Academia of Agriculture, Wroclaw, Poland) and F. Defever, L. Verstraelen (Catholic University of Leuven, Belgium)

Webs and PDEs, A. Prastaro (University of Rome, Italy)

Daniel Goldman

Modeling transport in the rat EDL microcirculation during sepsis, C. Ellis and R. Bateman (University of Western Ontario, Canada)

Modeling oxygen transport in the rat EDL microcirculation under normal conditions, C. Ellis, R. Bateman (University of Western Ontario, Canada) and A. Popel (Johns Hopkins University)

Modeling oxygen transport by capillaries and capillary networks in the presence of hemoglobin-based blood substitutes, A. Popel, A. Vadapalli, and N. Tsoukias (Johns Hopkins University)

Roy Goodman

Bragg gratings in optical fiber communications, Michael Weinstein and Richard Slusher (Bell Laboratories)

Dynamical systems modeling of wave-defect interactions, Philip Holmes (Princeton University), Michael Weinstein (Bell Laboratories)

David J. Horntrop

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

Lou Kondic

Flow of thin liquid films, J. Diez (University del Centro, Pinto, Argentina)

Discrete modeling of granular materials, R. Behringer (Duke University)

Dawn Lott

Application of quantitative image analysis to studying calcium diffusional processes in heart muscle cells, John Tavantzis (Department of Mathematical Sciences, NJIT) and Joshua Berlin (UMDNJ)

Two dimensional elastic-viscoplastic model for determining optimal patterns of suturing in skin, Hans R. Chaudhry (Department of Mathematical Sciences, NJIT)

On the use of infinite elements for the determination of optimal patterns of wound closure, Hans R. Chaudhry (Department of Mathematical Sciences, NJIT)

Numerical calculations of steady slender bubbles with surfactant, Michael Siegel (Department of Mathematical Sciences, NJIT)

Zoi-Heleni Michalopoulou

Pulse dispersion in the ocean, Leon Cohen (Hunter College, City University of New York)

Source localization in the Haro Strait, Charles Gaumond (Naval Research Laboratory)

Multipath identification, John Spiesberger (University of Pennsylvania)

Robert M. Miura

Perturbation analysis of traveling waves of spreading cortical depression, H. Ikeda (Toyama University, Japan).

Lattice Boltzmann method applied to ion diffusion in the brain, Y.Q. Wang (Pacific Institute for the Mathematical Sciences, Canada) and H. Huang (York University, Canada).

Synchronous phase-clustering states in networks of excitatory neurons with nonuniform coupling, Y.Q. Wang (Pacific Institute for the Mathematical Sciences, Canada) and Y.X. Li (University of British Columbia, Canada).

Temporal summation of EPSPs in pyramidal neurons, A. Desjardins (Harvard University/MIT), Y.X. Li (University of British Columbia, Canada), S. Reinker (University of British Columbia, Canada), and R. Neuman (Memorial University, Canada).

Glass microelectrode formation, H. Huang (York University, Canada), W.P. Ireland (University of Prince Edward Island, Canada), and E. Puil (University of British Columbia, Canada).

Stochastic resonance, S. Reinker and E. Puil (University of British Columbia, Canada).

Auditory thalamic neurons and tinnitus, A. Chavez-Ross, I. Ran, and E. Puil (University of British Columbia, Canada).

Determination of membrane electrical properties, V. Booth, A. Bose, J. Golowasch, F. Nadim, and M. Rodrigo (NJIT).

Farzan Nadim

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

Configuration of circuit dynamics by modulatory fibers, M. P. Nusbaum (University of Pennsylvania Medical School, Philadelphia, PA), Y. Manor (Ben-Gurion University, Beer-Sheva, Israel).

Determination of voltage-gated ion current distributions from single-point currents and voltage-clamp measurements, J. Golowasch, A. Bose, M. Rodriguez and R. Miura (NJIT, Newark, NJ).

Demetrios T. Papageorgiou

Theory and experiment on the motion of a bubble with an adsorbed surfactant monolayer, Charles Maldarelli (City College of New York) and Ravichandra Palaparthi (Orica Inc., Colorado).

Chaotic flows in pulsating cylindrical tubes, Philip Hall and Mark Blyth (Imperial College, London, England).

Large amplitude capillary waves in electrified fluid sheets, Jean-Marc Vanden-Broeck (University of East Anglia, Norwich, England).

Michael Siegel

Evolution of material voids for highly anisotropic surface energy, M. Miksis and P. Voorhees (Northwestern University)

Simulation of surfactant mechanics within a volume-of-fluid method, Ashley James and John Lowengrub (University of Minnesota)

Effects of small surface tension in Hele-Shaw multifinger dynamics: an analytical and numerical study, E. Paune and J. Casademunt, (University of Barcelona)

Exact solutions for a single bubble in a nonlinear far-field flow, D. Crowdy (Imperial College)

Singular solutions and ill-posedness for the Muskat problem, R. Caflisch (UCLA) and S. Howison (Oxford University)

Burt Tilley

Two-layer flows in inclined channels, L. Kondic (Department of Mathematical Sciences, NJIT), J. Diez (University del Centro, Pinto, Argentina)

Microwave heating of laminates, G. A. Kriegsmann (Department of Mathematical Sciences, NJIT)

Evolution of Holmboe waves in two-layer flows, P. Huerre (Ecole Polytechnique)

X. STUDENT ACTIVITIES

A. UNDERGRADUATE ACTIVITIES

Amitabha Bose, Director of Undergraduate Studies

Pi Mu Epsilon:

The New Jersey Kappa Chapter of Pi Mu Epsilon inducted 7 members on April 24, 2002: Marcia Cunha ('02), Carmina Mevs, Robert Miller, Jonathan Porus, Danish Qadri ('02), Tsezar Seman ('02), Brandy Sneed ('02)

Research Presentations:

Tsezar Seman ('02) attended the 13th Annual St. Josephs University Sigma Xi Student Research Symposium in April 2002 in Philadelphia. He has been working with Prof. Kondic and presented their joint research entitled "Simulation of pattern formation in fluid flow by diffusion limited aggregation".

Math Club:

The undergraduate math club, SUMS, hosted an integration competition entitled "Integration Conspiracy." The competition was open to all NJIT students and cash prizes were awarded (compliments of the Math dept.) Prof. Bechtold served as faculty advisor to SUMS. Winners were:

1st place: Chintan Shah
2nd place: Samuel Ayele
3rd place: Priyal Gogri

Scholarships:

The Department awarded several merit-based scholarships for AY 2001-2002. They were:

Mathematical Sciences Award: Roman Onik ('02)
Gary Thomas Award: Geoffery Cox
Actuarial Sciences Award: Marcia Cunha ('02)
Simon Cohen Award: Aleksandr Livshits
Santokh S. and Labh K. Ahluwalia Award: Tsezar Seman ('02)
Daljit S. and Devinder K.Ahluwalia Scholarship for Applied Math: Priyal Gogri ('02); Elaine Bochniewicz; Sarbjit Singh ('02)

Alumni:

Tsezar Seman ('02) will join the MS program in Applied Math at NJIT in Fall 2002; and Priyal Gogri ('02) will join the MS program in Applied Statistics at NJIT in Fall 2002.

Roman Onik ('02), Petter Otterstedt ('02), Drew Clepper ('02), and Sarabjit Singh ('02) have all been accepted in the MS program in Computer Science at NJIT for Fall 2002.

The following graduates of the Applied Math program are currently pursuing doctoral studies:

Steven Arturo ('00): NJIT, Jeremy Carlo ('01): Columbia University, Pritam Dodeja ('01): NJIT Brandy Rapatski ('98): U. of Maryland, Hoa Tran ('98): NJIT, Shirley Yap ('99): U. of Pennsylvania.

Capstone Laboratory Projects:

The NSF Capstone Lab (which was supported by a National Science Foundation ILI grant) houses four SUN workstations as well as three Pentium III based PCs. New additions to the available experimental equipment include a Hele-Shaw cell with supporting equipment that allows for a number of experiments to be performed. During the academic year 2001-2002, two student groups completed projects. The projects, directed by Professors John Bechtold and Lou Kondic, are described in detail below.

CAPSTONE PROJECT I: Instabilities of Two-Fluid Flow in Hele-Shaw Geometry

Advisor: Lou Kondic

Students: Michael Czajka, Peter del Roso, Jasraj Kohli, Alexsandr Livshits, Peter Otterstedt, Gregory Roustad, Tsezar Seman
Graduate Student Assistants: Stephen Kunec and Hoa Tran

When a low viscosity fluid (for example, water) is injected into a more viscous one, such as glycerin, an instability occurs. Figure 1 shows an example of this instability (often called a Saffman-Taylor instability) in the Hele-Shaw geometry, where blue water is injected into a colorless glycerin. One important reason for studying this problem is that it is closely related to many technologically relevant ones, such as flow in porous media.

The main purpose of this project was to understand the characteristics of the emerging patterns. A variety of techniques were used to achieve this goal:

- a number of experiments were performed, where fluids, injection rates, and separation between the plates were varied.

-students derived a governing equation (Darcy's law) that models the dynamics in Hele-Shaw flow. Then, they performed a linear stability analysis, and compared their results to the experimental ones.

-numerical simulations of the governing equation were performed. The results of the simulations were then compared to both experiments and the linear stability analysis.

-in a different, but related direction, discrete simulations based on random walkers (diffusion limited aggregation) were formulated. These simulations produced elaborate patterns, shown in Fig. 2, which are rather similar to the experimental ones shown in Fig. 1. To quantify this similarity, the Hausdorff dimensions of both experimental and numerical results were computed and compared.

This rather large project was performed by coordinated efforts of two student groups that presented their work at the joint seminar at the end of the semester.

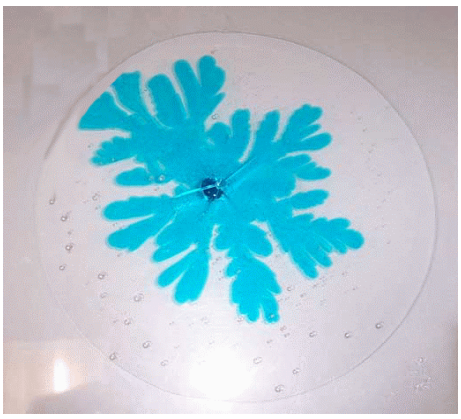


Figure 1

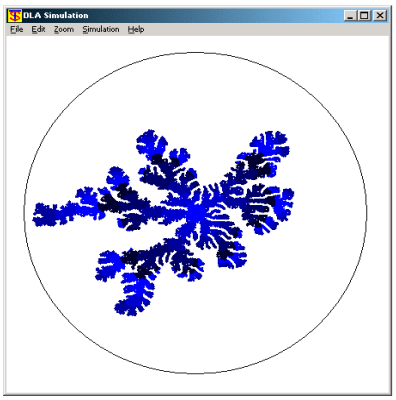


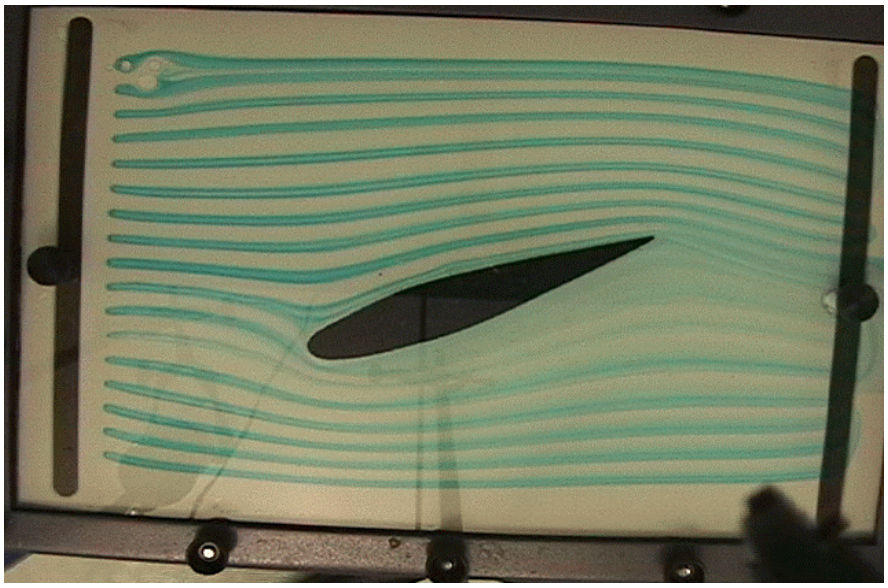
Figure 2

CAPSTONE PROJECT II: Hele-Shaw Flow Past an Airfoil

Advisor: Lou Kondic

Students: Elaine Bochniewicz, Ebenezer Nukpezah, Afsaneh Taherisefat, Lily Chang
Graduate Student Assistants: Stephen Kunec and Hoa Tran

This project used our newly acquired Hele-Shaw setup to analyze flow around obstacles in a highly controlled environment. The experiments included flow around a cylinder, flow around a blunt body, and flow around an airfoil under different angles of attack. The figure below shows an example of this flow, where the streamlines of the flow are visualized using ink sources distributed at the entrance to the flow domain (left-hand side of the figure).



The experimental results served as a motivation for studying mathematical tools that are needed to understand the flow patterns. Furthermore, modifying experimental conditions (such as flow rate) allowed for discussion of the applicability of the theoretical results to the experiments. The students involved in this project applied methods from complex analysis (conformal mapping) as well as systematic reduction of Navier-Stokes equations in Hele-Shaw geometry to analyze the results. Both experimental and theoretical results were presented at the seminar attended by faculty and graduate students from the Department of Mathematical Sciences.

CAPSTONE PROJECT III: Hele-Shaw Flows: Sources and Sinks

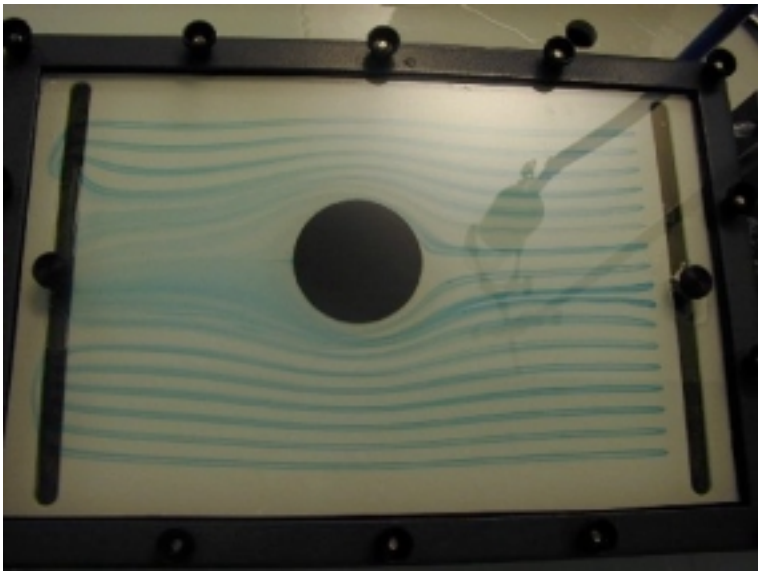
Advisor: John Bechtold

Students: Gexin Li, Roman Onik, Sarabjit Singh, Teanna Smith
Graduate Student Assistants: Stephen Kunec and Hoa Tran

Students performed laboratory experiments and complementary theoretical analysis to investigate the flow of a viscous fluid through a Hele-Shaw cell. Particular emphasis was placed on flows with sources and sinks. Such flows are relevant to the study of 2D flows past obstacles, and injection of fluid into a blood stream. A typical 2D flow over a cylinder is shown in Figure 1.

Students were able to create a sink of fluid by connecting a vacuum pump to a small orifice on the underside of the Hele-Shaw cell. The cell was also equipped with three-way taps to regulate the flow and generate sources of fluid in the interior of the flow. In this way, source and sink flows were studied in various combinations, including a doublet. Flow over a doublet models ideal flow over a cylinder, and potential theory was used to construct solutions describing these flows. Differences between the ideal flow and real viscous flows, as shown in Figure 1, were analyzed. The students presented their results in a special Applied Mathematics Seminar on May 2, 2002.

Figure 1



CAPSTONE PROJECT IV: Flow Through a Diffuser

Advisor: John Bechtold

Students: Jeffrey Macalalad, Stephen Nauyoks, Danish Qadri, Richard Williams
Graduate Student Assistants: Stephen Kunec and Hoa Tran

Students performed laboratory experiments and complementary theoretical analysis to investigate the flow of a viscous fluid through a diffuser. Diffusers are channels with an expanding cross-section; they are used to slow down a flow, and thus increase the pressure. This can have important consequences in a number of technological applications, including supersonic air-breathing engines, wind tunnels, and aerodynamic design of race cars.

Students analyzed the 2D features of diffuser flows by conducting experiments in a Hele-Shaw cell. Rubber obstructions were placed between the plates of the cell to create a diffuser cross-section, and colored dye was injected to help visualize the flow. By varying diffuser dimensions and flow rate, students recorded changes in the flow field and observed flow separation. Both numerical and asymptotic methods were used in a theoretical study of this system. In particular, boundary layer analysis provided an estimation for the separation point along the diffuser wall. The students presented their results in a special Applied Mathematics Seminar on May 13, 2002.

CAPSTONE PROJECT V: Fluid Flow Through an Orifice

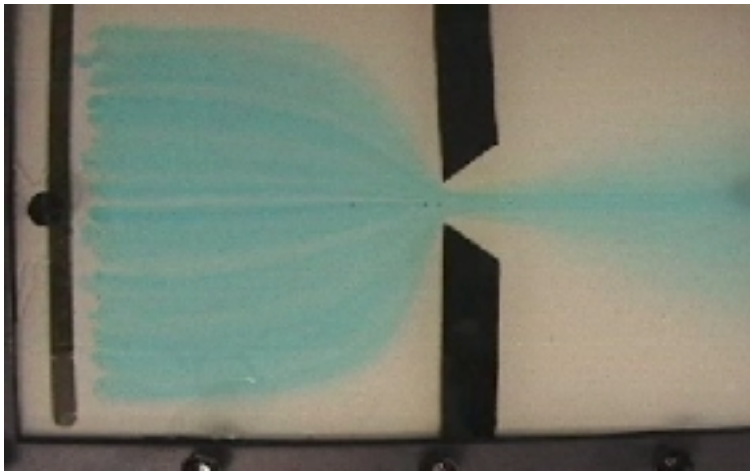
Advisor: John Bechtold

Students: Anuj Daftari, Priyal Gogri, Drew Klepper, Kinlung Lau, Michelle Melucci
Graduate Student Assistants: Stephen Kunec and Hoa Tran

Students performed laboratory experiments and complementary theoretical analysis to investigate the flow of a viscous fluid through an orifice. This configuration has a number of industrial and medical applications, including the design of flow meters, and heart ailments resulting from punctured or damaged valves.

In order to analyze the 2D features of these flows, the students conducted experiments in a Hele-Shaw cell, which consists of two narrowly-spaced glass plates through which water was pumped. Rubber obstructions were placed between the plates to create an orifice, and colored dye was injected to help visualize the flow. Streamlines of a typical flow through an orifice are shown in Figure 2. Students observed significant differences between the real (viscous) flow and an ideal (potential) flow. Theoretical analyses were pursued in which conformal mapping and boundary layer techniques were used to construct solutions describing the flow field. The students presented their results in a special Applied Mathematics Seminar on May 2, 2002.

Figure 2



B. GRADUATE STUDENT RESEARCH PROGRAMS

Michael Booty, Director of the Graduate Program

Ph.D.s Awarded:

Helen Martynov, August 2001.
Thesis: Asymptotic methods in applied waveguide problems.
Advisor: G.A. Kriegsmann.

Ray Addabbo, January 2002.
Thesis: The structure and stability of expanding and converging
near-stoichiometric flames.
Advisor: J.K. Bechtold.
Current Position: Professor of Mathematics, Queen's College of Aeronautics, New York

Eliana Antoniou, January 2002.
Thesis: A new theory of premixed flames in near-stoichiometric mixtures.
Advisor: J.K. Bechtold.
Current Position: Assistant Professor, William Paterson University, Wayne, New Jersey

Stephen Kunec, May 2002.
Thesis: Temporal synchronization of CA1 pyramidal cells by high-frequency,
depressing inhibition in the presence of intracellular noise.
Advisor: A. Bose.
Current Position: Postdoctoral Fellow, Program for Mathematical and Computational Neuroscience, Center for Biodynamics, Boston University, Boston, Massachusetts

Said Kas Danouche, May 2002.
Thesis: Nonlinear interfacial stability of core-annular film flows in
the presence of surfactants.
Advisor: D.T. Papageorgiou; Co-Advisor, M.S. Siegel.
Current Position: Assistant Professor, Universidad de Oriente, Cumana, Sucre, Venezuela

Knograt Savettaseranee, May 2002.
Thesis: Instability of electrified viscous films.
Advisor: D.T. Papageorgiou.
Current Position: Member of the Faculty, Department of Mathematics, Kasetsart University, Bangkok, Thailand

At this point in time (May 2002), we have just graduated our 20th doctoral student in Mathematical Sciences. Over the last three years, an average of five students have graduated with a doctorate each academic year.

Report of the Ph.D. Qualifying Exam Committee by D. T. Papageorgiou

In August 2001, qualifying exams were given in analysis and in linear algebra/numerical methods. Of the nine students taking the analysis exam six passed with grade A and three failed with grade B; of the eight students taking the linear algebra/numerical methods exam four passed with grade A and four failed with grade B.

In January 2002, all three parts of the qualifying exam were given. Of the three students taking the analysis exam two passed with grade A and one failed with grade B; in applied mathematics, all six students taking the exam passed with grade A; in linear algebra/numerical methods, all three students taking the exam passed with grade A.

The applied mathematics exam is usually offered in May but has been postponed in 2002. Only two students had taken the courses to be examined, and they requested that the exam be postponed to August. Thus, all three parts of the qualifying exam will be offered in August 2002.

Presentations:

Lyudmyla Barannyk

November 2001: American Physical Society (APS) Division of Fluid Dynamics 54th Annual Meeting, San Diego, California
Strongly nonlinear interfacial waves of a two-fluid system with surface tension: Solitary and traveling waves. Session on Interfacial Instabilities. (with D.T. Papageorgiou)

Stephen Kunec

February 2002: Center for Biodynamics, Boston University (Invited seminar)

May 2002: Fourth International Conference on Dynamical Systems and Differential Equations, University of North Carolina at Wilmington
Temporal synchronization of CA1 pyramidal cells by high-frequency, depressing inhibition in the presence of intracellular noise.

Urmi Ghosh-Dastidar

November 2001: Oceans 2001 Conference, Honolulu, Hawaii
New approaches for detection and estimation in underwater acoustics (poster).

Said Kas-Danouche

November 2001: American Physical Society (APS) Division of Fluid Dynamics 54th Annual Meeting, San Diego, California
Effect of surfactants on the nonlinear interfacial stability of core-annular film flow. Session on Interfacial Instabilities. (with D.T. Papageorgiou and M. Siegel).

Xiaoyun Sun

November 2001: American Physical Society (APS) Division of Fluid Dynamics 54th Annual Meeting, San Diego, California
Electro-magnetic control of vortex shedding. Session on Turbulence Control. (with N. Aubry).

Publications:

D. Blackmore, J. Chen, J. Perez, and M. Savescu. *Dynamical properties of discrete Lotka-Volterra equations*. Chaos, Solitons, and Fractals, Vol 12, 2553-2568, 2001.

R. Addabbo, J.K. Bechtold, and M. Matalon. *Wrinkling of spherically expanding flames*. Proceedings of the Combustion Institute, 2002.

Y. Wang, D.T. Papageorgiou, and C. Maldarelli. *Using surfactants to control the formation and size of wakes behind moving bubbles at order-one Reynolds numbers*. Journal of Fluid Mechanics, Vol 453, 1-19, 2002.

Z-H. Michalopoulou and Michele Picarelli. *A Gibbs sampling approach to maximize a posteriori time delay and amplitude estimation*. Proceedings of ICASSP 2002, Orlando Florida, May 2002.

Graduate Student Achievements:

Urmi Ghosh-Dastidar was awarded the Constance A. Murray Women's Scholarship of NJIT in September 2001.

Lyudmyla Barannyk and **Tetyana Segin** attended a series of three consecutive events organized by the Pacific Institute for the Mathematical Sciences of Canada (PIMS) in May 2002. These were:

- The Fifth PIMS Graduate Mathematics Modelling Camp, May 18-23, held at Simon Fraser University, Burnaby, BC;
- The MITACS Third Annual General Meeting, May 23-25, University of British Columbia, Vancouver;
- The Sixth PIMS Industrial Problem Solving Workshop, May 27-31, University of British Columbia, Vancouver, BC, Canada.

Lyudmyla Barannyk was reelected to serve a second year as President of the NJIT Graduate Student Association (GSA) for the academic year 2002-2003, and **Tetyana Segin** was reelected to serve a second year as Secretary of the GSA. **Lyudmyla Barannyk** received a GSA award from the Dean of Student Services for Outstanding Leadership by a Graduate Student in 2001-2002.

Summer Research Program:

Each summer since 1994, CAMS has run a research program for graduate students. In 2002, the program features individual supervised research projects, student organized seminar series, a three-part intensive class in core areas of mathematics, and computational projects for first year students. The participants this year were Christina Ambrosio, Lyudmyla Barannyk, Oleksandr Barannyk, Jyoti Champanerkar, Urmi Ghosh-Dastidar, Arnaud Goullet, Muhammed Hameed, Francis Kariuki, Nicholas Kintos, Soumi Lahiri, Valery Lukyanov, Yuri Mileyko, Michele Picarelli, Mucahit Polat, Mehmet San, Zeliha Senturk, Tetyana Segin, Xiaoyun Sun, Hoa Tran, Lin Zhou, Ivan Zorych.

In addition to individual research projects, students participate in a summer seminar series. The seminar series, organized by Lyudmyla Barannyk and Hoa Tran, offered two seminars each week One of the weekly seminars is given by a faculty member on a fundamental area of applied mathematics, such as mathematical biology, fluid dynamics, electromagnetics, underwater acoustics, and wave propagation. The second seminar is given by a graduate student on their specific area of research. Each seminar is followed by informal discussion. The seminar series helps to spark interesting dialogue between students and faculty, and supplements the students' appreciation for the breadth of applied mathematics.

The list of seminars is:

Friday, May 24, 2002
Bruce Bukiet
Title: Mathematical Modeling of Baseball

Wednesday, May 29, 2002
Xiaoyun Sun
Title: Control of Vortex Shedding from Cylinder by Electromagnetic Field

Friday, May 31, 2002
Amitabha Bose
Title: Phase Constancy in Neuronal Networks

Tuesday, June 4, 2002
Stephen Kunec
Title: Temporal Synchronization of Pyramidal Cells by High-Frequency, Depressing Inhibition

Friday, June 7, 2002
Anil C. Wijeyewickrema (Department of Civil Engineering, Tokyo Institute of Technology)
Title: Dispersion of Extensional Waves in Pre-stressed Imperfectly Bonded Incompressible Elastic Layered Composites
[Co-sponsored by the Civil and Environmental Engineering, Mechanical Engineering, and Mathematical Sciences Departments]

Tuesday, June 11, 2002
Lyudmyla Barannyk
Title: The Flow of an Evaporating Thin Film Liquid

Friday, June 14, 2002
Darkov Volkov
Title: Scattering by Smooth Objects in 2D Waveguides. Discrete Conservation Laws

Tuesday, June 18, 2002
Hoa K. Tran
Title: Existence and Uniqueness of Electromagnetic Energy Density for Dispersive Media

Friday, June 21, 2002
Denis Blackmore
Title: A Hamiltonian Vortex Ring Model for Vortex Breakdown

Tuesday, June 25, 2002
Urmi Ghosh-Dastidar
Title: A New Approach in Estimation in Underwater

Friday, June 28, 2002
Manish C. Bhattacharjee
Title: Composition of Coherent Structures

Tuesday, July 2, 2002
Ivan Zorych
Title: Tires Tests and Design of Experiments

Tuesday, July 9, 2002
Tetyana Segin
Title: Stability of Two Fluid Channel Flow

Wednesday, July 10, 2002
David Horntrop
Title: New Simulation Techniques for Mesoscopic Models

Friday, July 12, 2002
John Bechtold
Title: New Models of Premixed Flames in Near-Stoichiometric Mixtures

Tuesday, July 16, 2002
Arnaud Goullet
Title: Mixing Enhancement by Dual Speed Rotating Stirrer

Friday, July 19, 2002
Demetrius Papageorgiou
Title: Dynamics and Rupture in Surface Tension Flows

Tuesday, July 23, 2002
Valery Lukyanov
Title: Diffraction by a Semi-Infinite Array of Cylinders

Friday, June 26, 2002
Thomas Spencer
Title: An Excursion into Probability or Why You "Shouldn't" Gamble, but with a Strategy If You "Must"

Tuesday, July 30, 2002
Christina Ambrosio
Title: An Introduction to Computational Neuroscience

Friday, August 2, 2002
Daniel Goldman
Title: Oxygen Transport in the Microcirculation during Sepsis and Vasomotion

Tuesday, August 6, 2002
Oleksandr Barannyk
Muhammad Hameed
Title: Finite Difference Methods for Laplace Equation

Francis Kariuki
Mucahit Polat
Zeliha Senturk
Title: Numerical Methods for Boundary Value Problems

Friday, August 9, 2002
Lou Kondic
Title: Instabilities, Pattern Formation, and `Topological' Changes in the Flow of Thin Liquid Films

The more advanced graduate students, i.e., those who have completed the doctoral qualifying exams, have the opportunity to pursue their research unimpeded by other commitments such as classes and teaching. Students at an earlier stage in the doctoral program take one or more parts of a three-part class that is designed to consolidate and build on their abilities in core areas of mathematics and applied mathematics. In the summer 2002, studies in Real and Complex Analysis were organized by Marianito Rodrigo, studies in Applied Mathematics were organized by Michael Booty, and studies in Linear Algebra and Computational Projects were organized by Lou Kondic. Classes in each subject area run for six weeks distributed over the twelve week duration of the summer program, and are supplemented by office hours.

The computational projects are intended for graduate students who are between their first and second semester of graduate level numerical methods classes. We find that the projects provide an invaluable opportunity to improve practical computational skills such as code writing, running and debugging, as well as an opportunity to consolidate understanding of concepts and theory.

All students taking part in the summer program write a brief, scientific report about the work they accomplish during the summer.

CAMS

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