Center for Applied Mathematics and Statistics

ANNUAL REPORT

1999-2000

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I. FROM THE DIRECTOR

In 1999-2000, CAMS has continued to promote and sustain research in the mathematical sciences at NJIT. This mission keeps us focussed on the enduring values of scholarship in the mathematical sciences while giving us the opportunity and challenge of moving into new areas of application. Exploring and developing new areas of application is central to the CAMS mission.

Working with William Morokoff of Goldman Sachs has allowed us to better understand financial mathematics. New grants, a new hire, and a collaboration with the Department of Biology at Rutgers-Newark are some of the markers indicating the ongoing maturation of mathematical biology in CAMS.

Doctoral students are making increasingly important contributions to CAMS research efforts.

Five CAMS-member-advised students defended doctoral theses during the 1999-2000 academic year. This accomplishment, representing the meeting of the initial goals of the doctoral program in the Mathematical Sciences for annual Ph.D. production, highlights the need for CAMS to continue and enhance its support for doctoral students at every step of the education process from recruitment to graduation.

Owing to the energetic and highly competent efforts of CAMS committees, CAMS has maintained a superb research infrastructure. The CAMS Seminar Series, moved this year to Cullimore Lecture Hall II to accommodate the growing attendance, continue to enjoy a reputation for both scientific depth and enthusiasm. The CAMS Reading Room, with the CAMS Teas, and the enhanced use of the conference room have stimulated research interactions--particularly with and among the graduate students. Seventeen research proposals were submitted in 1999-2000; we expect this number to increase significantly in 2000-2001. Applied computation still grows in intensity and importance. The speed with which new computational resources become saturated powerfully demonstrates the need to continue the dramatic growth of these resources. The approval of the M.S. in Applied Statistics and the seminar series in statistics have strengthened statistics. With this growth, we are hopeful that a robust statistics track will soon develop within the Doctoral Program in the Mathematical Sciences. High quality research posters presented as CAMS Featured Research have enhanced the CAMS/Math facilities and given students and visitors an opportunity to better understand CAMS research activities. This year we inaugurated the CAMS Lecture Note Series with "Applied Integral Equations" by Aloknath Chakrabarti.

The accomplishments of CAMS are built on the efforts and support of many individuals. CAMS is grateful to President Saul Fenster for the vision that has created an environment where the aspirations of CAMS are espoused and appreciated. Provost William Van Buskirk, Dean John Poate, and Donald Sebastian, Vice President for Technology Development and Acting Associate Provost for Research and Development, have encouraged CAMS through their strong support of scientific research. CAMS is very 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. But the essential nature of the organization is that of a voluntary association of individual researchers of many disciplines joined in a collegial collaboration to enhance mathematical work at NJIT.

CAMS undertakes a wide range of activities in pursuing its mission. CAMS brings researchers from academia, industry, and government to NJIT and other institutions by organizing interdisciplinary workshops and by bringing together researchers whose strengths are complementary and whose goals are common. In some cases, CAMS secures the appointment of Research Professors to formalize this relationship 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 dissemination of information, organization of group projects, collegial advice and assistance with application documents. Senior members of CAMS commit a significant amount of time and effort in providing guidance and advice 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 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 relationships with industry.

III. MEMBERSHIP AND VISITORS

Department of Mathematical Sciences

Ahluwalia, Daljit S. Lacker, Michael

Andrushkiw, Roman Lott-Crumpler, Dawn

Bechtold, John Luke, Jonathan

Bhattacharjee, Manish Michalopoulou, Zoi-Heleni

Blackmore, Denis Milojevic, Petronije

Booth, Victoria Nadim, Farzan

Booty, Michael Papageorgiou, Demetrius

Bose, Amit Perez, Manuel

Bukiet, Bruce Petropoulos, Peter G.

Crunk, Steven Porter, Michael

Dhar, Sunil Ray, Bonnie

Dios, Rose Siegel, Michael

Goldberg, Vladislav Stickler, David

Hile, Cheryl Tavantzis, John

Kappraff, Jay Tilley, Burt

Kondic, Lou

Kriegsmann, Gregory A.

Visiting Members

Balaji, Srinivasan Georgieva, Anna

Chakrabarti, Aloknath Muratov, Cyrill

Chaudhry, Hans Yefet, Amir

Department of Mechanical Engineering

Aubry, Nadine Rosato, Anthony

Department of Civil and Environmental Engineering

Meegoda, Jay N.

Department of Computer and Information Science

Recce, Michael

CAMS Research Professors

Erneux, Thomas Findley, Thomas

Long and Short-Term Visitors

Ariño, Miguel IESE, Barcelona, Spain

Chopra , D.V. Wichita State University, KS

Keller, Joseph B. Stanford University, CA

Whittemore, Alice Stanford University, CA

IV. SEMINARS

1999-2000 Seminar Series

September 3 **Pushpendra Singh**, Department of Mechanical Engineering, New Jersey Institute of Technology

"Direct Numerical Simulations and Modeling of Multiphase Flows"

September 10 **Peter O' Sullivan**, Bell Labs/Lucent Technologies

"Topographic Evolution Problems in Microelectronics Using Level set Methods"

September 24 **Leslie Greengard**, Courant Institute, NYU

"Nearly Singular Fields: Electrostatics and Elastostatics of Composite Materials"

October 1 **Leon Cohen**, Hunter College, CUNY

"Joint Representations in Applied Mathematics"

October 8 **Edward Coffman**, CIS Department, New Jersey Institute of Technology

"Packing Intervals and Making Reservations"

October 13 **Joseph B. Keller**, Department of Mathematics, Stanford University

"Wave Propagation-A Survey"

October 15 **Joseph B. Keller**, Department of Mathematics, Stanford University

"Numerical Methods for Problems in Infinite Domains"

October 22 **Chris Volinsky**, AT&T Bell - Labs Research

"Squashing Flat Files Flatter"

October 27 **Alice Whittemore**, Professor of Epidemiology and Biostatistics,Stanford University Medical School (Co-sponsored by Department of Preventive Medicine and Community Health, UMDNJ and the New Jersey Medical School Cancer Program)

"Genetically Tailored Preventive Strategies: An Effective Plan for the

Twenty-first Century?"

October 29 **Hristo Kojouharov**, Department of Mathematics, Arizona State

University

"Non-Standard Numerical Solution of Advection-Diffusion-Reaction Equations"

November 3 **Adi Ditkowski**, Division of Applied Mathematics, Brown University

"Stable Cartesian Grid Methods for Maxwells Equations in Complex Geometries"

November 5 **Monika Safford, MD,** Department of Medicine, UMDNJ-New Jersey

Medical School

"Performance Status of Health Care Facilities Changes with Risk Adjustment"

November 12 **CK Chu**, Department of Applied Mathematics, Columbia University

"Generating Mathematical Waves"

November 19 **Dean Foster**, Wharton School of Business, University of Pennsylvania

"Playing Games Against An Evil Nature"

December 3 **Ruben Rosales**, Department of Applied Mathematics, Massachussetts Institute of Technology

"*Non-linear Wave Interactions in Equatorial Waveguide"*

January 21 **Mark DiBattista**, Courant Institute of Mathematical Sciences, NYU

"An Equilibrium Statistical Model For The Spreading Phase of Open-Ocean Convection with Preconditioning"

January 28 **Knut Sølna**, Department of Mathematics, University of Utah

"Pulse Propagation In Multiscale Random Media"

February 2 **Marvin Nakayama,** CIS Department, New Jersey Institute of Technology

"Simulation of Processes with Multiple Regeneration Sequences"

February 4 **David Srolovitz**, Department of Physics, Princeton University

"Dislocation Dynamics in the Presence of Diffusing Impurities: Analytical and Numerical Models"

February 11 **Anette Hosoi**, Department of Mathematics, Massachusetts Institute of Technology

"Wine Tears and Other Evaporatively Driven Instabilities In Thin Films"

February 18 **Bard Ermentrout**, Department of Mathematics, University of Pittsburgh

"Global Spatial Patterning Through Distance and Delay"

February 25 **Weimin Jin,** Department of Mathematics, Indiana University,

Bloomington, IN

"Singular Perturbation and Thin-Film Blistering"

March 1 **Donald Rubin,** Department of Biostatistics, Harvard School of Public Health

"Using Propensity Scores for Causal Inferences in Nonrandomized Studies"

March 3 **Bart Ng**, Department of Mathematics, Indiana University-Purdue University at Indianapolis

"On the Spectra of Viscous Shear flows"

March 8 **Amy Shen**, Department of Theoretical and Applied Mechanics, University of Illinois At Urbana-Champaign

"Granular Wave Patterns in a Horizontal Rotating Cylinder"

March 10 **Graham Wilks**, Department of Mathematics, Duke University

"Heated Jet Assimilation into External Streams"

March 24 **Sudipto Banerjee**, Department of Statistics, University of Connecticut

"Prediction, Interpolation and Regression for Spatially Misaligned Data"

March 29 **Kesar Singh**, Department of Statistics, Rutgers University, New

Brunswick

"Of Outliers and Bootstrap"

March 31 **John Chadam**, Department of Mathematics, University of Pittsburgh

"The Exercise Boundary for an American Put Option: Analytical and Numerical Approximations"

April 3 **Daniel Goldman**, Department of Biomedical Engineering, Johns

Hopkins University

"Mathematical and Computational Modeling of Oxygen Transport in the

Microcirculation"

April 7 **Colleen M. Kirk,** Department of Mathematics, Montclair State University

"Blow-up in a Reactive-Diffusive Medium with Spatially-localized and Moving Heat Sources"

April 10 **Christopher Elmer**, National Institute of Standards and Technology,

U.S. Department of Commerce, Gaithersburg, Maryland

"An Introduction to Traveling Wave Solutions of Spatially Discrete

Bistable Reaction-Diffusion Equations"

April 12 **Debjit Biswas**, Department of Statistics, The University of Michigan, Ann Arbor

"Generalized Two-Color Urn Processes and Approximations"

April 14 **Dave McLaughlin**, Courant Institute of Mathematical Sciences, NYU

"Modeling the Primary Visual Cortex of the Macaque Monkey"

April 17 **Darren Crowdy**, Department of Mathematics, Imperial College, London, England

"2-D Fluid Dynamics and the Inverse Gravitational Problem"

April 19 **Tony Dalrymple,** Department of Civil and Environmental Engineering, University Of Delaware

"Water waves in Channels"

April 28 **Anjan Biswas,** Department of Applied Mathematics, University of Colorado, Boulder

"Dynamics of Solutions in Optical Fibers"

May 3 **Miguel Ariño,** IESE in Barcelona, Spain

"The Beveridge-Nelson Decomposition for ARFIMA Processes"

May 5 **Srinivasa S.R. Varadhan**, Courant Institute of Mathematical Sciences,

NYU

"Large Deviation from the Scaling Limits for Interacting Particle Systems"

V. CAMS MEMBER PUBLICATIONS, PRESENTATIONS, AND REPORTS

A. PUBLICATIONS

JOURNAL PUBLICATIONS

Nadine Aubry

Suppression of Vortex Shedding inspired by a low-dimensional model, (with S. Tang), Journal of Fluids and Structures, Vol. 14, pp. 443-468, 2000.

Srinivasan Balaji

Passage time moments for Multidimensional diffusions, (with S. Ramasubramanian), Journal of Applied Probability, Vol. 37, pp. 246-251, 2000.

John Bechtold

Effects of Stoichiometry on Stretched Premixed Flames, (with M. Matalon), Combustion and Flame, Vol. 119, pp. 217-232, 1999.

Manish Bhattacharjee

Stochastic Equivalence of Convex Ordered Distributions and Applications, (with R.N. Bhattacharya), Probability in Engineering & Informational Sciences, Vol. 14, pp. 33-48, 2000.

Denis Blackmore

Imbeddings of integral submanifolds and associated adiabatic invariants in slowly perturbed integrable Hamiltonian systems, (with Y. Prykarpatsky and A. Samoilenko), Rep. Math. Phys., Vol. 44, pp. 171-182, 1999.

Versal deformation of a Dirac type differential operator, (with A. Prykarpatsky), J. Nonlin. Math. Phys., Vol. 6, pp. 246-254, 1999.

Hamiltonian structure of Benney type hydrodynamic and Boltzmann-Vlasov kinetic equations on an axis and some applications to manufacturing science, (with A. Prykarpatsky and N. Bogoliubov), J. Open Systems & Information Dynamics, Vol. 6, pp. 1-39, 1999.

Transition from quasiperiodicity to chaos for three coaxial vortex rings, (with O. Knio), ZAMM, Vol. 80, pp. 126-130, 2000.

Analytical solutions for crack geometry in process zone theory in fracture mechanics, (with W. Wang and C.T. Hsu), Int. J. Solids Struc., Vol. 37, pp. 221-233, 2000.

Swept volume computation in virtual reality, (with L. Abdel-Malek, M. Leu and B. Maiteh), J. Computers & Virtual Reality, Vol. 4, pp. 286-295, 2000.

KAM theory analysis of the dynamics of three coaxial vortex rings, (with O. Knio),

Physica D, Vol. 140, pp. 321-348, 2000.

Victoria Booth

A genetic algorithm study on the influence of dendritic plateau potentials on bistable spiking in motoneurons, Neurocomputing, Vol. 26-27, pp. 69-78, 1999.

Hippocampal place cells and the generation of a temporal code, (with M. Recce and A. Bose), Neurocomputing, Vol. 32-33, pp. 225-234, 2000.

Amit Bose

A geometric approach to singularly perturbed non-local reaction diffusion equations, SIAM Journal on Mathematical Analysis, Vol. 31, pp. 431-454, 2000.

Almost-synchronous solutions for mutually coupled excitatory neurons, (with N. Kopell and D. Terman), Physica D, Vol. 140, pp. 69-94, 2000.

Hippocampal place cells and the generation of a temporal code, (with M. Recce and V. Booth), Neurocomputing, Vol. 32-33, pp. 225-334, 2000.

Bruce Bukiet

Adaptation of Passive Rat Left Ventricle in Diastolic Dysfunction, (with H. R. Chaudhry, A. B. Ritter, T. Findley and N. Guzelsu), Journal of Theoretical Biology, Vol. 201, pp. 37-46, 1999.

Aloknath Chakrabarti

On some general hybrid transforms, (with Hamsapriye), Journal of Computational and Applied Mathematics, Vol.116, pp. 157-165, 2000.

The role of special functions in a viscous flow problem involving two cylinders, (with Hamsapriye), Mechanics Research Communications, Vol. 27, pp.123-130, 2000.

On the solution of the problem of scattering of surface-water waves by the edge of an ice-cover, Proceedings of the Royal Society, London (Mathematical, Physical and Engineering Sciences), vol. 456, pp. 1087-1100, 2000.

Hans Chaudhry

Adaptation of passive rat left ventricle in diastolic dysfunction, (with B. Bukiet, M. Siegel, T. Findley, A.B. Ritter and N. Guzelsu), J. Theor. Biol., Vol. 201, pp. 37-46, 1999.

Non-Invasive Light Reflection Technique for Measuring Soft Tissue Stretch, (with J.Federici, N.Guzelsu, H.Lim,T.Findley and A. Ritter), Applied Optics, Vol.38, pp. 6653-6660,1999.

Rose Dios

Contributions to the Existence of Some Orthogonal Arrays, (with D. Chopra), Congressus Numerantium, Vol.141, pp.135-140, 1999.

Estimation of Optical Properties of Nearshore Water, (with S. Bagheri and C. Zetlin), International Journal of Remote Sensing, Vol.20, pp.3393-3397, 1999.

Anna Georgieva

Wave Propagation and Resonance in a 1-d Nonlinear Discrete Periodic Medium, (with T. Kriecherbauer and S. Venakides), SIAM Journal of Applied Mathematics, Vol. 60, pp. 272-294, December 1999.

Vladislav V. Goldberg

Differential Geometry of Webs, (with M. A. Akivis), Chapter 1 in: Handbook of Differential Geometry, Vol. 1, North-Holland, Amsterdam, pp. 1-152, 2000.

Lightlike hypersurfaces on manifolds endowed with a conformal structure of Lorentzian signature, (with M. A. Akivis), Acta Applicandae Mathematicae, Vol. 57, pp. 255-285, 1999.

A classification and examples of four-dimensional isoclinic three-webs, Webs and Quasigroups, Vol. 1998/1999, pp. 32-66, 1999.

On some methods of construction of invariant normalizations of lightlike hypersurfaces, (with M. A. Akivis), Differential Geometry and Applications, Vol. 12, pp. 121-143, 2000.

On four-dimensional three-webs with integrable transversal distributions, (with M. A. Akivis), Rendiconti del Seminario Matematico di Messina, Vol. Se. II 5 (20), pp. 33-52, 2000.

Algebraic aspects of web geometry, (with M. A. Akivis), Commentationes Mathematicae Universitatis Carolina, Vol. 41, pp. 205-236, 2000.

Jay Kappraff

The Hidden Pavements of Michelangelo's Laurentian Library, The Mathematical Intelligencer, Vol. 21, pp. 24-29 (1999).

Lou Kondic

Dependence of Single Bubble Sonoluminescence on Ambient Pressure, (with M. Dan and J. D. N. Cheeke), Ultrasonics, Vol. 38, pp. 566-569, 2000.

Ambient Pressure Effect on Single Bubble Sonoluminescence, (with M. Dan and J. D. N. Cheeke), Phus. Rev. Lett., Vol. 83, pp. 1870-1873, 1999.

Nonlinear dynamics and transient growth of driven contact lines, (with A. Bertozzi), Phys. Fluids, Vol. 11, pp. 3560-2562, 1999.

Dynamics of the particles on a surface: About collision induced sliding and other effects, Phys. Rev. E, Vol. 45, pp. 751-769, 1999.

Predictability and granular materials, (with R. Behringer, D. Howell, S. G. K. Tennakoon and C. Veje), Physica D, Vol. 133, pp. 1-17, 1999.

Gregory A. Kriegsmann

Scattering by Large Resonant Cavity Structures, Wave Motion, Vol. 30, pp. 329-344, 1999.

Microwave Heating of Ceramic Composite, (with J. Pelesko), I.M.A. Journal of Applied Mathematics, Vol. 64, pp. 39-50, 2000.

Acoustic Scattering by Baffled Flexible Surfaces, Journal of the Acoustical Society of America, Vol. 107, pp. 1121-1125, 2000.

Jonathan Luke

Decay of velocity fluctuations in a stably stratified suspension, Physics of Fluids, Vol. 12, pp. 1619-1621, 2000.

Jay N. Meegoda

Construction use of Vitrified Chromium Contaminated Soils, (with G. Charleston and W. Kamolpornwijit), ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol. 4, pp. 1-11, July 2000.

Remediation of Chromium Contaminated Soils -A Pilot Scale Investigation, (with Kenneth Partymiller, Marta K.Richards, W. Kamolpornwijit, W. Librizzi, T. Tate, B. A. Noval, R. T. Mueller and S. Santora), ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol. 4, pp. 7-15, January 2000.

Micro-mechanical Model for Temperature Effects of Hot Mix Asphalt Concrete, (with G. Kuo-neng), Transportation Research Record #1687, Journal of the Transportation Research Board, TRB, pp. 95-103, 1999.

Remediation of Chromium Contaminated Soils--A Bench Scale Investigation, (with W. Kamolpornwijit, D. A. Vaccari, A. S. Ezeldin, B. A. Noval, R. T. Mueller and S. Santora), ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol. 3, July 1999.

Petronije Milojevic

Existence and the number of solutions of semilinear equations and applications to boundary value problems, Electronic Journal of Differential Equations, Vol. 2000, pp. 24, 2000.

Continuation Theory for A-proper mappings and their uniform limits and nonlinear perturbations of Fredholm mappings, Set Valued Mappings with Applications in Nonlinear Analysis, pp. 71, 2000.

Cyrill Muratov

Theory of spike spiral waves in a reaction-diffusion system, (with V. V. Osipov), Phys. Rev. E, Vol. 60, pp. 242-246, 1999.

Farzan Nadim

Coordination of fast and slow rhythmic neuronal circuits, (with M. Bartos, Y. Manor, E. Marder and M.P. Nusbaum), J. Neuroscience, Vol. 19, pp. 6650-6660, 1999.

Synaptic Depression Creates a Switch That Controls the Frequency of an Oscillatory Circuit, (with Y. Manor, N. Kopell and E.Marder), Proc. Natl. Acad. Sci. USA, Vol. 96, pp. 8206-8211, 1999.

Recognition of slow processes in rhythmic networks, (with J. Golowasch and Y. Manor), Trends in Neurosciences, Vol. 22, pp. 375-377, 1999.

Demetrius Papageorgiou

Increased mobility of a surfactant retarded bubble at high bulk concentrations, (with Y. Wang and C. Maldarelli), Journal of Fluid Mechanics, Vol. 390, pp. 251-270, 1999.

Chaos in a class of solutions of the Navier-Stokes equations, (with P. Hall), Journal of Fluid Mechanics, Vol. 393, pp. 59-87, 1999.

Peter Petropoulos

Performance Evaluation and Absorption Enhancement of the Grote-Keller and Unsplit PML Boundary Conditions for the 3-D FDTD Method in Spherical Coordinates, (with N. V. Kantartzis and T. D. Tsibukis), IEEE Transactions on Magnetics, Vol. 35, pp. 1418-1421, 1999.

Asymptotic and Energy Estimates for Electromagnetic Pulses in Dispersive Media: Addendum, (with T. M. Roberts), J. Opt. Soc. Am. A, Vol. 16, pp. 2799-2800, 1999.

Reflectionless Sponge Layers as Absorbing Boundary Conditions for the Numerical Solution of Maxwell's Equations in Rectangular, Cylindrical and Spherical Coordinates, SIAM J. Applied Mathematics, Vol. 60, pp. 1037-1058, 2000.

Reflectionless Sponge Layers for the Numerical Solution of Maxwell's Equations in Cylindrical and Spherical Coordinates, Applied Numerical Mathematics, Vol. 33, pp. 517-524, 2000.

The FD-TD Method: Theory and Applications, Applied Computational Electromagnetics: State of the Art and Future Trends, NATO-ASI Series F, Vol. 171, Springer-Verlag, pp. 201-240, 2000.

Michael Porter

Application of the Parabolic Equation Method to Medical Ultrasonics, (with P. Roux, H.C. Song and W.A. Kuperman), Wave Motion V. 31, pp. 181-196, 2000.

Bonnie Ray

Size effects on common long-range dependence in stock volatilities, (with R. Tsay), Journal of Business and Economic Statistics, v. 18, pp. 254-262, 2000.

Testing for nonlinearity in a vector time series, (with J. Harvill), Biometrika, v. 86, pp. 728-734, 1999.

Anthony Rosato

Microstructure Evolution in Compacted Granular Beds, (with D. Yacoub), Powder Technol., Vol. 109, pp. 255-261, 2000.

New Mathematical Models for Particle Flow Dynamics, (with D. Blackmore and R. Samulyak), Journal of Nonlinear Mathematical Physics, Vol. 6, pp. 198-221, 1999.

Michael Siegel

Influence of surfactant on rounded and pointed bubbles in two-dimensional Stokes flow, SIAM J. Applied Mathematics, Vol. 59, pp. 1998-2027, 1999.

Cusp formation for time evolving bubbles in two-dimensional Stokes flow, J. Fluid Mech., Vol. 412, pp. 227-257, 2000.

Adaptation of passive rat left ventricle in diastolic dysfunction, (with H. R. Chaudhry, B. Bukiet, T. Findley, A. B. Ritter and N. Guzelsu), J. Theor. Biol., Vol. 201, pp. 37-46, 1999.

Amir Yefet

Strict Stability of High-Order Compact Implicit Finite-Difference Schemes-The Role of Boundary Conditions For Hyperbolic PDEs, (with S. Abarbanel and A. E. Chertock), Journal of Computational Physics, Vol. 160, pp. 67-87, 2000.

Fourth Order Accurate Compact Implicit Method for the Maxwell Equations, (with E. Turkel), Applied Numerical Mathematics, Vol. 33, pp. 113-124, 2000.

A High Order Difference Scheme for Complex Domains in a Cartesian Grid, (with E. Turkel), Applied Numerical Mathematics, Vol. 33, pp. 125-134, 2000.

PROCEEDINGS PUBLICATIONS

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Daljit S. Ahluwalia

Surface water waves against a vertical wall in the presence of an ice-cover, (with A. Chakrabarti), Advances in Fluid Mechanics-III, 2000, pp. 605-615. Proceedings of the Third International Conference on the Advances in Fluid Mechanics, Montreal, Canada, May 2000.

Roman I. Andrushkiw

Retrospective Linear Regression Analysis of Survival Data for Patients Suffering from Malignant Melanoma, (with Yu. I. Petunin, D.A. Kljushin, L.A. Naleskina and I.G. Bairamov), Proceedings of the International Conference on Applied Statistical Methods in Medical Sciences, pp. 139-157, 1999.

Srinivasan Balaji

Risk sensitive dynamic programming with unbounded cost, (with S. P. Meyn and V.S. Borkar), 38th IEEE Conference on Decision and Control, Phoenix, Arizona, pp. 1-6, 1999

John Bechtold

Some New Results on Markstein Number Predictions, (with M. Matalon), 38th Aerospace Sciences Meeting and Exhibit, Reno, pp. 1-9, 2000.

Denis Blackmore

On the Hamiltonian structure of Benney and Boltzmann-Vlasov equations, (with A. Prykarpatsky and N. Bogoliubov), Conf. on Diff. Eqs. in Honor of N.N. Bogoliubov, Kyiv, pp. 59-82, 1999.

Swept volume computation for virtual reality application of NC machining, (with B. Maiteh, M. Leu and L. Abdel-Malek), Industrial Vitual Reality Symposium, Chicago, pp. 305-405, 1999.

Bruce Bukiet

Application of Front Tracking Methods to Explosive Initiation Modeling, (with J. Starkenberg), International Workshop on New Models and Predictive Methods for Shock Waves/Dynamic Processes in Energetic Materials and Related Solids, College Park, MD, July 1999.

Aloknath Chakrabarti

Surface water waves against a vertical wall in the presence of an ice-cover, (with D.S. Ahluwalia), Advances in Fluid Mechanics-III, 2000, pp. 605-615. Proceedings of the Third International Conference on the Advances in Fluid Mechanics, Montreal, Canada, May 2000.

Rose Dios

Some Results on Orthogonal Arrays, (with D. Chopra), International Statistical Institute, Vol.1, pp.191-192, 1999.

Vladislav V. Goldberg

The geometry of lightlike hypersurfaces on manifolds endowed with a conformal structure of Lorentzian signature, (with M. A. Akivis), Satellite Conference of International Congress of Mathematicians in Berlin, Brno, Czech Republic, pp. 161-170, 1999.

Algebraic aspects of web geometry, (with M. A. Akivis), Loops'99, Prague, Czech Republic, pp. 5-6, 1999.

Algebraic aspects of the theory of 4-webs W (4, 2, r), 953rd Amer. Math. Soc. Meeting, Notre Dame, Indiana, USA, pp. 32, 2000.

Lou Kondic

A two-dimensional code for thin films, (with J. Diez and A. Bertozzi), Fluid Dynamics Conference, Parana, Argentina, pp. 35-41, 1999.

Thin liquid films: Instabilities of driven coating flows on a rough surface, (with J. Diez and A. Bertozzi), Materials Research Society Annual Meeting, Boston, pp. 213-218, 1999.

Friction-based segregation of 2D granular assembly, (with R. Behringer, S. G. K. Tennakoon and B. Painter), Materials Research Society Annual Meeting, Boston, pp. 357-362, 1999.

About computations of Hele-Shaw flow of non-Newtonian fluids, (with M. Shelley and P. Fast), Materials Research Society Annual Meeting, Boston, pp. 207-212, 1999.

Experimental observation of the effect of ambient pressure on single bubble sonoluminescence, (with M. Dan and J. D. N. Cheeke), Joint Conference of ASA, EAA and DAGA, Berlin, Germany, pp. 1-6, 1999.

Gregory A. Kriegsmann

Microwave Joining of Two Long Hollow Tubes: A Mathematical Estimate of Required Power, (with R. Silberglitt), Seventh International Conference on Microwave and High Frequency Heating, Valencia, pp. 501-506, 1999.

Zoi-Heleni Michalopoulou

Matched arrival processing for efficient inversion in underwater acoustics, (with X. Ma), Oceans 99, Seattle, pp. 1577-1580, 1999

Demetrius Papageorgiou

The linear stability of a two-phase compound jet, (with A. Chauhan, C. Maldarelli and D. Rumschitzki), Symposium on Nonlinear Singularities in Deformation and Flow, Haifa, Israel, 1999

Mobility control of surfactant-retarded bubbles at small and order one Reynolds numbers, (with Y. Wang and C. Maldarelli), IUTAM Symposium on Nonlinear Waves in Multiphase Flows, University of Notre Dame, South Bend, Indiana, 1999

Peter Petropoulos

A Non-Dissipative Staggered Fourth-Order Accurate Explicit Finite Difference Scheme for the Time-Domain Maxwell's Equations, (with A. Yefet), Proceedings of the 16th Annual Review of Progress in Applied Computational Electromagnetics, Monterey, Vol. 2, pp. 906-916, 2000

Michael Porter

Performance measurements of a diverse collection of undersea, acoustic, communication signals, (with V. K. McDonald, J.A. Rice and P.A. Baxley), OCEANS '99 MTS/IEEE: Riding the Crest into the 21st Century, V. 2, pp. 1002-1008, 1999.

Performance of conventional and model-based trackers for towed-arrays, (with P. Hursky, K. Heaney and J.P. Ianniello), Proceedings of the Technical Workshop on Submarine Acoustic Superiority, held at NUWC, Newport, RI, April 2000.

Proceedings of the Fifth European Conference on Underwater Acoustics, Lyon (2000):

Estimating equivalent bottom geoacoustical parameters from broadband inversion,

(with X. P. Demoulin, L. Pelissero, Y. P. Stephan, S. Jesus and E. Coelho).

Relating the channel to acoustic modem performance,

(with V. McDonald, J. Rice and P. Baxley).

Comparison of beam tracing algorithms, (with P. Baxley and H. Bucker).

Amir Yefet

A Non-Dissipative Staggered Fourth-Order Accurate Explicit Finite Difference Scheme for the Time-Domain Maxwell's Equations, (with P. G. Petropoulos), Proceedings of the 16th Annual Review of Progress in Applied Computational Electromagnetics, Monterey, Vol. 2, pp. 906-916, 2000.

B. PRESENTATIONS

Nadine Aubry

July 1999: Department of the Navy, Maryland

Flow Control for Fast Hydrofoils

November 1999: 52nd Annual Meeting of the Division of Fluid Dynamics, New Orleans

Active Feedback Control of the Instability leading to Vortex Shedding

June 2000: IUTAM Symposium on Bluff Body Wakes and Vortex Induced Vibrations, Marseille, France

Closed Loop Control of Wake Flows

June 2000: Fluids 2000 Conference and Exhibit, Denver

Reactive Flow Control of a Wake Flow based on a reduced model

John Bechtold

November 1999: APS Division of Fluid Dynamics, New Orleans

Effects of Stretch on Confined Premixed Flames

January 2000: Some 38th Aerospace Sciences Meeting and Exhibit, Reno

Some New Results on Markstein Number Predictions

Denis Blackmore

October 1999: Rensselaer Mathematics Colloquium, Troy, USA

Dynamics of Vortex Rings

April 2000: Annual Meeting of GAMM, Gottingen, Germany

Hamiltonian structure for Vortex Filament Flows

Victoria Booth

May 2000: Nonlinear Analysis: 2000, New York

Hippocampal place cells and the generation of temporal codes

Amit Bose

October 1999: CMBN Neuroscience Day, Newark, NJ

Phase precession and phase locking of hippocampal pyramidal cells

December 1999: Group Meeting, CMBN, Rutgers University at Newark

Phase precession and phase locking of hippocampal pyramidal cells

March 2000: Applied Mathematics Seminar, Stevens Institute of Technology

Non-local reaction diffusion equations for microwave heating applications

March 2000: PDE Seminar, University of Connecticut

Non-local reaction diffusion equations for microwave heating applications

May 2000: Nonlinear Analysis 2000, New York

Using synaptic depression to switch between distinct oscillatory modes

Aloknath Chakrabarti

March 2000: Department of Mathematics, Texas A&M University, College Station,Texas

Singular integral equations in water wave problems

March 2000: Department of Mathematics, University of Central Florida, Orlando, Florida

Singular integral equations in water wave problems

May 2000: Third International Conference in Fluid Mechanics, Montreal, Canada

Surface water waves against a vertical wall in the presence of an ice-cover (with D.S. Ahluwalia)

Hans Chaudhry

July 1999: Faculty workshop, Dept of Mathematical Sciences, NJIT

Introduction to biomechanics and its applications to cardiovascular system and the human skin

Rose Dios

August 1999: Conference of the International Statistical Institute, Helsinki, Finland

On Some Orthogonal Arrays

Anna Georgieva

October 1999: SIAM Southeast Regional Mathematics in Industry Workshop, North Carolina State University, Raleigh, NC

Modeling of Formaldehyde Uptake in the Upper Respiratory Tract of Rodents and Humans

March 2000: PDE seminar, Boston University

1:2 Resonance Mediated Second Harmonic Generation in a 1-d Nonlinear Discrete periodic Medium

Vladislav V. Goldberg

August 1999: LOOPS'99, Prague, Czech Republic

Algebraic aspects of web geometry

April 2000: 953rd American Mathematical Society Meeting, Notre Dame, Indiana

Algebraic aspects of the theory of 4-webs W (4, 2, r)

Jay Kappraff

July 1999: Bridges Conference, Southwestern College, Winfield, Kansas

Plenum talk: Systems of Proportion in Design and Architecture and their Relationship to Dynamical Systems Theory

May 2000: Recent Trends in Geometry and Symmetry, U. of Wisconsin, Madison, Wisconsin (invited)

Theories of Proportion as seen through the Arithmetic of Nichomachus

Lou Kondic

August 1999: Interfaces for the Twenty-First Century, Monterey, USA

Fingering instability of Thin Liquid Films

November 1999: Division of Fluid Dynamics, APS, New Orleans

About computations of thin film flows

May 2000: Nonlinear Analysis 2000, New York

Instabilities in the flow of thin liquid films

May 2000: Third SIAM Conference on Mathematical Aspects of Materials Science, Philadelphia, PA

1) *Pattern formation in thin film flows*

2) *Hele-Shaw flow of Shear-Thinning Fluids*

Gregory A. Kriegsmann

July 1999: Workshop on Partial Differential Equations and Their Applications, IMPA, Rio de Janeiro, Brazil

Pattern Formations in Microwave Heated Ceramics

September 1999: Seventh International Conference on Microwave and High Frequency Heating, Valencia Spain

Microwave Joining of Two Long Hollow Tubes: A Mathematical Estimate of Required Power

November 1999: Department of Mathematics, Georgia Tech., Atlanta, GA.

Pattern Formation in Microwave Heated Ceramic Cylinders and Slabs

December 1999: DOE Workshop on Computational Complexity in Physical Systems,

Los Alamos, USA

Pattern Formation in Microwave heated Ceramic Cylinders and Slabs

March 2000: Department of Mathematics, University of Texas, Austin, TX

Pattern Formation in Microwave Heated Ceramic Cylinders and Slabs

April 2000: Second World Congress on Microwave Processing, Orlando, Fl.

Pattern Formation in Microwave Heated Ceramic Slabs

Dawn Lott-Crumpler

October 1999: MathFestIX, Houston, Texas, USA

Optimal patterns of suturing wounds of complex geometry - Finite element technique

November 1999: MAA NJ Section Meeting, Jersey City, New Jersey, USA

Optimal patterns of suturing wounds of complex shapes - Finite element technique

January 2000: Joint Mathematics Meeting, Washington, D.C., USA

Optimal patterns of suturing wounds of complex shapes - Finite element technique

May 2000: Nonlinear Analysis 2000, New York, New York, USA

Optimal patterns of suturing wounds of complex shapes to foster healing

Jonathan Luke

January 2000: AFOSR Electromagnetics Conference 2000, San Antonio, USA

Scattering from Inhomogeneous Dispersive and Dissipative Media Using a Green's-Function-Based Finite-Difference Method

April 2000: Second World Congress on Microwave & Radio Frequency Processing, Orlando, USA

Microwave Joining of Two Long Hollow Tubes: An Asymptotic Theory and Numerical Simulation

Jay N. Meegoda

November 1999: Technical Presentation to US Army Corps of Engineers, Waterways Experimental Station (invited)

Micromechanical Modeling of Asphalt Concrete

December 1999: Technical Presentation to US National Science Foundation (invited)

Geotechnology for the New Millennium

April 2000: presentation to the Glenwood Elementary School, Short Hills, NJ

Earthday and Biodiversity

April 2000: Technical Presentation to US National Science Foundation (invited)

Environmental Engineering Research and Education"

April 2000: Ninth Annual UNI-TECH Conference

1) Fractionation and Segregation of Suspended Particles Using Acoustic and Flow Fields

2) Remediation of Heavy Metal Contaminated Soils Using Colloidal Silica

3) A Feasibility Study to Extract Iron and Chromium from Chromium Contaminated Soils

May 2000: Presentation to the Glenwood Elementary School, Short Hills, NJ

Pebbles, sand and silt

Zoi-Heleni Michalopoulou

October 1999: IEEE Workshop on Underwater Acoustics Signal Processing, Rhode Island,USA

Marine mammal signal processing: accounting for the underwater channel effects

May 2000: 139th Meeting of the Acoustical Society of America, Atlanta, USA

A Bayesian approach to model based source localization using arrival time information

Cyrill Muratov

May 2000: 3rd SIAM Conference on Mathematical Aspects of Materials Science, Philadelphia, USA

Theory of Phase Separation Kinetics in Polymer-Liquid Crystal Systems

May 2000: Nonlinear Analysis 2000, New York, USA

Collective dynamics of Turing patterns in reaction-diffusion systems

Farzan Nadim

November 1999: Computational Neuroscience Forum, NYU, New York, USA

Synaptic Depression Creates a Switch That Controls the Frequency of an Oscillatory Circuit

April 2000: East Coast Nerve Net, Woods Hole, USA

2 depressions are better than 1

Demetrius Papageorgiou

July 1999: IUTAM Symposium on nonlinear waves in multiphase flows, South Bend,

Indiana, USA

Bubble motion in surfactant solutions

July 1999: VI Workshop on Partial Differential Equations: Theory, Computation and Applications, Rio de Janeiro, Brazil

Chaotic solutions in a class of Navier-Stokes solutions

November 1999: Annual Meeting of the American Institute of Chemical Engineers, Dallas, Texas, USA

An experimental study of increased mobility of a rising bubble with a surfactant laden interface at high bulk concentrations of surfactant

May 2000: Third SIAM Conference on Mathematical Aspects of Materials Science, Philadelphia, USA

Using surfactants to control the formation and size of wakes behind moving bubbles at order one Reynolds numbers

Peter Petropoulos

June 1999: 5-Day Graduate Seminar, Department of Electrical Engineering, Electrophysics Section, National Technical University of Athens, Greece

FD Methods for Electromagnetics

July 1999: ICIAM 99, Edinburgh, Scotland

The Reflectionless Sponge Layer ABC: A Review

January 2000: AFOSR Annual Electromagnetics Workshop, San Antonio, TX

A Fourth-Order FDTD Scheme for CEM

Michael Porter

August 1999: ONR 32 Workshop on Acoustic Communications Interoperability, Cataumet, MA.

ModemEx'99 Results and ModemFest'99 Plans

September 1999: ONR 321OA Workshop on Shallow-Water Acoustic Modeling, Naval Postgraduate School, Monterey, CA

Acoustic Communication Modeling and ModemEx'99 Analysis

Bonnie Ray

July 1999: Workshop on Time Series Econometrics, Arrabida, Portugal

Modeling ARFIMA Processes with added noise

November 1999: Statistics Seminar Series, Michigan State University

Bayesian change-point estimation for long-range dependent processes

November 1999: Statistics and Operations Research Seminar Series, Stern School of Business, New York University

Bayesian change-point estimation for long-range dependent processes

December 1999: Chemical, Civil, and Environmental Engineering Seminar Series, New Jersey Institute of Technology

Nonparameteric time series-regression methods for environmental and climatological Data

April 2000: INTERFACE 2000, New Orleans, LA

Forecasting in the supply chain: A review

April 2000: Workshop on Model Selection and the Bootstrap, Columbia University

Lag selection for nonlinear time series

Anthony Rosato

July 1999: *ICIAM99*, Edinburgh, Scotland

Dynamical Features of Vibrating Granular Beds

April 2000: Purepac Pharmaceuticals (Elizabeth, NJ), (6-hour overview)

1) Segregation in Granular Flows

2) *Packing of Particles*

Michael Siegel

July 1999: IUTAM Symposium on nonlinear waves in multi-phase flow, South Bend, IN, USA

Cusp formation and tip-streaming instabilities for time evolving interfaces in 2-D Stokes flow

February 2000: Applied Mathematics Colloquium, University of Delaware, Newark, DE, USA

Cusp formation and tip-streaming instabilities for time evolving interfaces in Stokes flow

John Tavantzis

May 2000: MELECON 2000, Cyprus

Parking Reservation Formulation

Burt Tilley

August 1999: Interfaces of the Twenty-First Century, Monterey, CA, USA

Potential Flow instabilities in thin fluid sheets

April 2000: Second World Congress on Microwave and Radio Fequency Processing, Orlando, FL, USA

Microwave-Enhanced CVI: A Moving Interface Model

May 2000: Third SIAM Conference on Mathematical Aspects of Materials Science, Philadelphia, PA, USA

Microwave-Enhanced CVI: A Moving Interface Model

Amir Yefet

March 2000: The 16th Annual Review of Progress in Computational Electromagnetics, Monterey, California

A Non-Dissipative Staggered Fourth-Order Accurate Explicit Finite Difference Scheme for the Time-Domain Maxwell's Equations

C. CAMS TECHNICAL REPORTS

REPORT 9900-1 A. Yefet and P. G. Petropoulos

A Non-Dissipative Staggered Fourth-Order Accurate Explicit Finite Difference Scheme for the Time-Domain Maxwell's Equations

REPORT 9900-2 D. A. Lott-Crumpler and H. R. Chaudhry

Optimal Patterns for Suturing Wounds of Arbitrary Configuration: Finite Element technique

REPORT 9900-3 M. A. Akivis and V. V. Goldberg

On Four-Dimensional Three-Webs with Integrable Transversal Distributions

REPORT 9900-4 J. H. C. Luke

Decay of Velocity Fluctuations in a Stably Stratified Suspension

REPORT 9900-5 A. Bose and M. Recce

Phase Precession and Phase Locking of Hippocampal Pyramidal Cells

REPORT 9900-6 M. Recce, A. Bose and V. Booth

Hippocampal Place Cells and the Generation of a Temporal Code

REPORT 9900-7 Z.-H. Michalopoulou

On the estimation of the ocean impulse response

REPORT 9900-8 D. A. Lott-Crumpler, S. S. Antman and W. G. Szymczak

Numerical methods for the quasilinear wave equation: Antiplane shearing of nonlinearly elastic bodies

REPORT 9900-9 G. A. Kriegsmann

Acoustic scattering by baffled flexible surfaces: The discrete optical theorem

REPORT 9900-10 C. B. Muratov and V. V. Osipov

Spike autosolitons in the Grey-Scott model

REPORT 9900-11 M. A. Akivis and V. V. Goldberg

On some methods of construction of invariant normalizations of lightlike hypersurfaces

REPORT 9900-12 M. A. Akivis and V. V. Goldberg

Algebraic aspects of web geometry

REPORT 9900-13 A. Bose and G. A. Kriegsmann

Large Amplitude Solutions of Spatially Non-homogeneous Non-local Reaction Diffusion Equations

REPORT 9900-14 C. B. Muratov

On the well-posedness of the equations for the smoothed phase space distribution function and irreversibility in classical statistical mechanics

REPORT 9900-15 M. Siegel

Cusp formation for time evolving bubbles in two-dimensional Stokes flow

REPORT 9900-16 A. Georgieva, J. Kimbell and P. Schlosser

Distributed-parameter model for formaldehyde uptake and distribution in rat nasal lining

REPORT 9900-17 D. Blackmore, R. Samulyak, R. Dave and A. Rosato

Dynamics of a two species oscillating particle system

REPORT 9900-18 D. Blackmore, R. Samulyak and M. Leu

Singularity theory approach to swept volumes

REPORT 9900-19 D. Blackmore and O. Knio

KAM theory analysis of the dynamics of three coaxial vortex rings

REPORT 9900-20 D. Blackmore, R. Samulyak and R. Dave

Approximate inertial manifolds in finite differences for granular flow dynamical systems

REPORT 9900-21 Y. Mykytiuk, A. Prykarpatsky and D. Blackmore

The Lax solution to a Hamilton-Jacobi equation and its generalizations. Part 2.

REPORT 9900-22 M. Vidyasagar, S. Balaji and B. Hammer

Closure properties of uniform convergence of empirical means and PAC learnability under a family of probability measures

REPORT 9900-23 P. S. Milojevic

Existence and the number of solutions of semilinear equations and applications to boundary value problems

REPORT 9900-24 P. S. Milojevic

Continuation theory for a-proper mappings and their uniform limits and nonlinear perturbations of fredholm operators

REPORT 9900-25 J. A. Diez, L. Kondic and A. L. Bertozzi

Global models for moving contact lines

REPORT 9900-26 B. S. Tilley, S. H. Davis and S. G. Bankoff

Unsteady Stokes Flow near an oscillating, heated contact line

REPORT 9900-27 C. B. Muratov

A quantitative approximation scheme for the traveling wave solutions in the Hodgkin-Huxley model

REPORT 9900-28 F. Nadim and Y. Manor

The role of short-term synaptic dynamics in motor control

REPORT 9900-29 B. Tilley and G. A. Kriegsmann

Microwave-enhanced chemical vapor infiltration: a sharp interface model

D. CAMS LECTURE NOTES

No. 1 Professor Aloknath Chakrabarti

Applied Integral Equations

VI. CAMS MEMBER EXTERNAL ACTIVITIES AND AWARDS

A. FACULTY

Daljit S. Ahluwalia

Member, United States National Committee/Theoretical and Applied Mechanics, National Research Council.

Editorship, Mathematical Sciences Research Hot-Line International Journal.

Nadine Aubry

Interdisciplinary Grants in Mathematical Sciences Panel, Member (1999).

Organizer and Chairperson of the mini-symposium on Electro-Hydrodynamics at the 1999 American Physical Society (APS)/Division of Fluid Dynamics Meeting.

Acrivos Prize Committee, American Physical Society (APS), Member.

Member of the National Research Council (NRC) Panel for the NASA Administrator's Fellowship Program, Washington, DC, March 28, 2000.

Information Technology Research (ITR) Proposal Panel, National Science Foundation (NSF), Member, June 5-6, 2000.

John Bechtold

Participant in IMA Workshop on Low-Speed Combustion 9/27-10/1 1999.

Chair, Session on Laminar Flames, 38th Aerospace Sciences Meeting and Exhibit, Reno NV, January, 2000.

Victoria Booth

Member of Mathematics Department Advisory Committee, Passaic County Community

College

Aloknath Chakrabarti

Published book, "Water Wave Scattering by Barriers," (with B.N. Mandal), WIT Press, Southampton, UK, 2000.

Vladislav V. Goldberg

Editorial Board, Journal Webs and Quasigroups, Tver State University, Russia

Jay Kappraff

Book Review of "The Number Nine" by Cecil Balmond, Nexus Journal, March 2000 (an electronic journal available at www.nexusjournal.com).

Gregory A. Kriegsmann

Editor in Chief: SIAM Journal on Applied Mathematics

Editorial Board Member: IMA Journal of Applied Mathematics

Editorial Board Member: Journal of Engineering Mathematics

Member, Board of Directors, Society of Engineering Sciences

Dawn Lott-Crumpler

Advisor: Enhancing Diversity through Graduate Education

Committee Chairperson, Mentor: Association for Women in Mathematics

NAM's Award of Appreciation: National Association of Mathematicians (October, 1999)

Jay N. Meegoda

Editorial Board member ASTM Geotechnical Testing Journal

Associate Editor of the ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management

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

Member of ASCE Blue Ribbon Review Panel of ASCE Monograph "Subsurface Remediation: contamination by Organic Pollutants"

Petronije Milojevic

Editorial Board, Communications on Applied Nonlinear Analysis

Editorial Board, Facta Universitatisis

Peter Petropoulos

Guest Editor of a special issue of the International Journal of Numerical Modelling: Devices, Circuits and Fields titled ``Absorbing Boundary Conditions for Computational Electromagnetics''.

Michael Porter

Edited the following volume: A. Caiti, S. Jesus, J-P. Hermand, M.B. Porter (Eds.) Experimental Acoustic Inversion Methods, Kluwer (2000).

Published the new edition of the following book: F. Jensen, W. Kuperman, M. Porter and H. Schmidt, Computational Ocean Acoustics, American Institute of Physics, New York (1994),

Springer-Verlag, (2000).

Technical committee for International Conference on Physics in Signal and Image Processing (to be held in Marseille, 2000).

Technical committee for International Conference on Theoretical and Computational Acoustics (to be held in Beijing, 2001).

Bonnie Ray

Associate Editor, Journal of Computational and Graphical Statistics

Associate Editor, The American Statistician

Associate Editor, International Journal of Forecasting

Organizing Committee, Interface 2000

ASA Committee on Statisticians in Defense and National Security

Faculty Affiliate, Los Alamos National Laboratory

Anthony Rosato

Assistant Editor, *Mechanics Research Communications*, Elsevier, 1997 - present

B. STUDENTS

Undergraduate Student Achievements:

Jeffery Fernandez: REU Summer 2000: Carnegie Mellon University

Sara del Valle: REU Summer 2000: Cornell University

Sarabjit Singh, Stephen Nauyoks, Jasraj Kohli, Priyal Gogri, and Amirali Vastani attended the Moravian College Conference in Spring 2000. Professor Lott-Crumpler supervised the event.

Jasraj Kohli was a Scientific Computing Assistant during Spring 2000, working for faculty of the Department on data from the Santa Barbara Experiment.

Hiren Gajipara: internship with GE, Fall 1999

Geoffrey Cox: internship with ILEX, Summer 2000

Jasraj Kohli: internship with IBM, Summer 2000

Danish Quadri: co-op with Globix, Spring 2000

Vikas Gupta: accepted permanent position with ILEX

Ketsia Mesidor: teaching internship in East Orange, NJ school district

Steven Arturo: accepted to several Ph.D. programs in Chemical Engineering

Dalia De and Sara del Valle: pursuing BS/MS degrees at NJIT

The following graduates of the undergraduate applied math program are currently pursuing doctoral studies:

Michelle DeBonis: California Institute of Technology

Brandy Rapatski: University of Maryland

Hoa Tran: NJIT

Shirley Yap: University of Pennsylvania

Graduate Student Achievements:

Eliana Antoniou

Winner of the Constance A. Murray Scholarship for 1999-2000.

Xiaoqun Ma

Research grant from the Office of Naval Research "Efficient shallow water matched field inversion", full two-year support 1999-2001.

Stuart Walker

July 26-August 4, 1999, Attended Industrial Mathematical Modelling Workshop 99, NC

State University, Raleigh NC. Worked in group which considered Monte Carlo method for determining photon trajectories through a fluid filled cylinder containing a spherical object. Has applications for medical imaging problems.

October 9-12, 1999, Attended SIAM Southeast Regional Mathematics in Industry Workshop, NC State University, Raleigh, NC.

January 2000, Attended the Joint SIAM/MAA/AMS Mathematics meeting in Washington DC.

April 2-6, 2000, Attended American Ceramic Society 2nd World Congress on Microwave and Radio Frequency Processing, Orlando FL.

VII. FUNDED RESEARCH

A. EXTERNALLY FUNDED RESEARCH

CONTINUING FUNDED PROJECTS

1. *Mathematical Models of Premixed Flames*

National Science Foundation: July 1, 1998-June 30, 2001

John Bechtold

2. *Reactive Models for Front-Tracking Simulations*

Batelle (Army Research Lab): April 1, 1998-September 30, 2000

Bruce Bukiet

3. *NASA Student Launch Program*

NASA: June 1, 1997-May 30, 2000

Bruce Bukiet

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

Department of Energy: February 1, 1994-July 30, 2000

Gregory A. Kriegsmann

5. *Scattering by Large Complex Structures*

Air Force Office of Scientific Research: February 1, 1996-January 30, 2001

Gregory A. Kriegsmann

Jonathan Luke

Cheryl Hile

6. *Computation of high gradient phenomena in solid mechanics*

National Science Foundation: July 1, 1998-June 30, 2001

Dawn A. Lott-Crumpler

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

National Science Foundation: July 1, 1998-June 30, 2000

Jonathan Luke

Zoi-Heleni Michalopoulou

Dawn A. Lott-Crumpler

Demetrius T. Papageorgiou

Michael Siegel

8. *Ocean Acoustics and Signal Processing for Robust Detection and Estimation*

ONR: June 1, 1997-May 31, 2000

Zoi-Heleni Michalopoulou

9. *Surface tension driven flows*

National Science Foundation: July 1, 1997-June 30, 2000

Demetrius Papageorgiou

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

Air Force Office of Scientific Research: November 1, 1998-October 31, 2001

Peter Petropoulos

11. *Broadband inversion in shallow water*

ONR: October 1, 1998-September 30, 2000

Michael Porter

12. *Computationally Intensive Methods for Time Series Analysis with Environmental and Economic Applications*

National Science Foundation: July 1, 1996-June 30, 2001

Bonnie Ray

13. *Surfactant effects in viscous fingering*

National Science Foundation: July 1, 1997-June 30, 2000

Michael Siegel

PROJECTS FUNDED DURING PRESENT ACADEMIC YEAR

1. *Neural mechanisms for generating temporal coding*

National Science Foundation: August 1999-June 2002

Victoria Booth

Amitabha Bose

Michael Recce

2. *Gravity and Granular Materials*

NASA: March 2000-November 2003

Lou Kondic

3. Applied Mathematical Problems in Microwave Processing of Ceramics

Department of Energy: July 1, 2000-June 30, 2003

Gregory A. Kriegsmann

4. *Microwave Processing of Ceramic Materials*

National Science Foundation: July 1, 2000-June 30, 2003

Gregory A. Kriegsmann

5. *Efficient Inversion in Underwater Acoustics*

ONR: October 1999-September 2002

Xiaoqun Ma

Zoi-Heleni Michalopoulou

6. *Efficient Shallow Water Matched Field Inversion*

ONR: January 2000-December 2001

Zoi-Heleni Michalopoulou

7. *Research Fellowship in Neuroscience*

Alfred P. Sloan Foundation: September 1, 1999–August 31, 2001

Farzan Nadim

8. *Regulation of Neuronal Oscillation by Synaptic Dynamics*

National Science Foundation: September 1, 2000-August 31, 2001

Farzan Nadim

9. *Hydrodynamics of Bubble Motion and Oscillatory Flows*

National Science Foundation: June 1, 2000-May 31, 2003

Demetrius Papageorgiou

10. *Assessment of Climatic and Human Activities on Shoreline Change*

NJ Sea Grant Development Funding Program: March 2000-February 2001

Nancy L. Jackson

Bonnie K. Ray

11. *Free boundary problems in volatile multi-fluid flows*

National Science Foundation: July 1999-June 2002

Burt Tilley

B. PROPOSED RESEARCH

PROJECTS PROPOSED DURING PRESENT ACADEMIC YEAR

1. *Interfaces Between Mathematical Sciences and Biological Sciences*

   Burroughs Wellcome Fund

   Daljit S. Ahluwalia (Co-Director) and G. Miller Jonakait (Co-Director, Biological Sciences

   Department, Rutgers University, Newark, NJ)

Jonathan Luke (Associate Director)

2. *Development of Virtual Reality Environment for Design Model Creation*

National Science Foundation

M. Leu

D. Blackmore

J. Liou

3. *Analysis and Computation of the Dynamics of Vortex Filaments*

National Science Foundation

D. Blackmore

O. Knio

4. *An atlas for optimal patterns of suturing wounds of complex shapes to foster healing, based*

on stress analysis

U.S. Army Medical Research and Materiel Command

Hans R. Chaudhry

Dawn A. Lott-Crumpler

5. *The impact of residual stresses on cardiac function in heart reduction surgery: A mathematical analysis*

National Institute of Health

Hans R. Chaudhry

Bruce Bukiet

6. *Interface Dynamics and pattern formation in thin liquid film flows*

National Science Foundation

Lou Kondic

7. *Gravity and Granular Materials*

NASA

Lou Kondic

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

Department of Energy

Gregory A. Kriegsmann

9. *Microwave Processing of Ceramic Materials*

National Science Foundation

Gregory A. Kriegsmann

10. *Solvability and a number of solutions of nonlinear operator equations and applications to boundary value problems*

National Science Foundation

Petronije Milojevic

11. *Spiking Excitable Systems*

National Science Foundation

Cyrill Muratov

12. *Regulation of Neuronal Oscillation by Synaptic Dynamics*

National Science Foundation

Farzan Nadim

13. *Regulation of Neuronal Oscillation by Synaptic Dynamics*

NIH

Farzan Nadim

14. *Hydrodynamics of Bubble Motion and Oscillatory Flows*

National Science Foundation

Demetrius Papageorgiou

15. *Addition of a Post-Doctoral Fellow to existing Grant*

AFOSR

Peter Petropoulos

16. *Assessment of Climatic and Human Activities on Shoreline Change*

Environmental Protection Agency

Bonnie K. Ray

Nancy L. Jackson

17. *Tip streaming dynamics in free surface flow with surfactant*

National Science Foundation

Michael Siegel

C. EXTERNALLY FUNDED PROJECTS -- NOT THROUGH CAMS

1. *Numerical Simulations of the Aerodynamics Through Fans*

AlliedSignal, Inc.: May 1999-August 1999

Nadine Aubry

Pushpendra Singh

2. *Electro-separation for on-line monitoring and cleaning of in-service fluids*

Office of Naval Research: March 1999-March 2001

Nadine Aubry

Boris Khusid

3. *Establishment of a laboratory for Electro-Hydrodynamics of Suspensions*

W. M. Keck Foundation: January 2000-January 2005

Nadine Aubry

Boris Khusid

4. *Particulate Flow Control*

Kleissler Company: May 2000-May 2001

Nadine Aubry

5. *Study of Composite Materials*

Honeywell, Inc: February 2000-January 2001

Nadine Aubry

6. *Precollege Experimental Mathematics*

Victoria Foundation: January 1999-December 2000

Rose Dios

Howard Kimmel (Precollege Programs)

Exxon Corporation: January 1999-December 2000

Rose Dios

Howard Kimmel (Precollege Programs)

7. *Investigation of Subsurface Contamination and Effectiveness of Remediation Technologies*

Using Geotechnical Centrifuge Techniques

Research Grant Council of Hong Kong: January 2000-December 2001

I. I.M.C. Lo

Jay N. Meegoda

8. *Ultrasound to Decontaminate Dredged Sediments*

National Science Foundation: May 1997-May 2000

Grant # CMS-9700318

Jay N. Meegoda

9. *Laboratory Information Management System*

New Jersey Department of Transportation: April 2000-December 2001

Jay N. Meegoda

C. Tang

10. *Evaluation of Ensol Technology*

NewCo, NJ: July 1999-July 2000

Jay N. Meegoda

11. *ASEE Summer Sabbatical (1999)*

Underwater Acoustic Communications

Michael Porter

12. *TIDE: Transportation Information and Decision Engineering Center*

New Jersey Department of Transportation: January 2000-Dec. 2000

John Tavantzis, Team Member.

VIII. CAMS COMMITTEE AND LABORATORY ANNUAL REPORTS

A. READING ROOM

Reading Room Report by Lou Kondic

After extensive renovation, the CAMS reading room became fully available this academic year. It is now fully utilized as a space where faculty and graduate students have a chance to meet and

exchange ideas. To enhance this interaction, ``tea & cookie'' hour has been organized (by S. Crunk and L. Kondic). The tea hour has been held four days a week (Monday - Thursday), and it has been immediately accepted by the CAMS members as a welcome break from usual teaching and research activities. It should be emphasized that this activity would not be possible without a number of volunteers from the Department of Mathematical Sciences and CAMS who put significant effort in organizing the tea time on weekly basis.

During this year, we also expanded the collection of research texts available in the reading room, following on the requests of our graduate students. We are sure that this and other improvements (such as making reading room available for longer hours), will encourage our students to utilize this space on an even more regular basis.

B. CAMS COMMITTEE REPORTS

Seminar committee report by Michael Siegel

The 1999-2000 seminar series of the Department of Mathematical Sciences was characterized by its diversity of topics. Distinguished speakers from industry and academics lectured on mathematics as applied to problems in a number of fields, including computer science, materials science, fluid dynamics, neurobiology, and finance among others. A separate Wednesday seminar series featured talks in the areas of statistics, biostatistics and epidemiology. Two of the biostatistics talks were held jointly with the Department of Preventive Medicine and Community Health at UMDNJ-New Jersey Medical School. A complete list of seminars may be found on pages six through eight.

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 efforts of the Committee are aided by the Computer Systems Administrator (I. Giouvanos), and by the Departmental Administrative Assistant (S. Sutton).

This year the committee continued maintaining/updating the web pages created last year for the purpose of making the titles/abstracts of the CAMS Technical Reports available to a wide Internet audience.

Aided by one student helper, the committee revised the web-forms that (since last year) are used by individual CAMS members to enter their contributions towards the CAMS Annual Report.

Finally, under the supervision of Prof. C. Muratov, the committee and the student helpers completed a redesign of the Departmental Web pages. Currently we are revising the pages according to input received by the Mathematical Sciences faculty.

RESEARCH COMMITTEE REPORT by Denis Blackmore

Committee activities in the Fall semester were centered on research proposal preparation. We provided advice to newer faculty members concerning proposal writing, reviewed their proposals and helped them familiarize themselves with the Fastlane submission process. In all, six high quality proposals were submitted to the NSF and other funding agencies.

In the Spring semester, the main order of business was helping newer faculty members prepare SBR proposals. The proposals were reviewed and critiqued, and budget guidelines were explained. As a result of our efforts, five excellent proposals were submitted.

C. LABORATORY ANNUAL REPORTS

COMPUTER COMMITTEE REPORT by Peter Petropoulos

Since January 2000 the computer committee has achieved the following:

a. Updated/installed LaTeX-related software on all Windows NT computers in the Department.

b. Resolved problems related to the SGI server running the Legato backup software. Some problems remain, particularly with backing up Windows NT and some Linux computers. The Systems Administrator is working towards a solution.

c. Installed and configured the Linux operating system on three new PC's for Profs. Georgieva, Papageorgiou, and Bechtold.

d) Conducted an informal seminar/help session on webpage authoring for faculty and staff.

e) Purchased and configured two 2-processor PC's for scientific computing use.

f) Redistributed 3 older workstations for use by the Graduate students.

g. Two older PC's were updated with the Linux operating system for the purpose of further enhancing the computational facilities available to the Graduate students.

h. Upgraded the computational resources available in the Statistics Lab with the addition of a new Gateway server machine, and a reconfiguration of pre-existing PC's and workstations.

i) Developed plans for significant enhancement of compute servers.

Statistical Consulting Lab Committee by Sunil Dhar

1. Client: Arthur Plourde, Triton Development,

Subject : Modeling baseball data. Distribution fitting, (e.g. Poisson or over dispersed

Poisson, etc.), and logistic regression. (Start date: June 2000)

Consultant: Professor Bruce Bukiet and Professor Steven M. Crunk

2. Client : Mr. William Anderson, Director - Admissions, NJIT.

Subject : Consulting advice provided on "Non-parametric Analysis of Variance" for his Ph.D.

dissertation.

Consultant: Professor Bhattacharjee

3. Evaluated Medical Decision-Making software, MEDICALWARE, to teach students. Client: Gururajan Rao. Part of Ph.D. student's dissertation at Graduate School of Management, Rutgers, UMDNJ and NJIT. Helped with questionnaire design, comparisons for two teaching methods via multivariate hypothesis tests. (start date 3/29/99 - 9/13/99).

   Consultant: Dr. S. Dhar

4. Veterans Affairs Medical Center, East Orange and the Department of Neuroscience to analyze diabetes data. Data management and merging performed for data sources from various VA centers, using generalized mixed and repeated measure models via SAS, EXCEL (summer 1998- March 2000)

   Consultant: Dr. S. Dhar

5. Analyzed longitudinal data for assessing the Neuropsychological functioning, Psychiatric Status, Disability and Employment Status in Chronic Fatigue Syndrome. Missing data was imputed and logistic regression models built and non-parametric methods were implemented to analyze the data.

Consultant: Dr. S. Dhar

D. **CAPSTONE LABORATORY**

The NSF Capstone Lab (supported by an NSF ILI grant) houses Silicon Graphics workstations and equipment for physical experiments. These items are used by undergraduate students for research projects in the Capstone course in applied mathematics and statistics. During the academic year 1999-2000, two student groups completed projects. The projects, directed by Professors M. Siegel and F. Nadim, are described in more detail below.

Student Project: Experimental realization of Dirichlet and Neumann problems in two-dimensions using resistance paper.

Advisor: Prof. Siegel

Students: Steven Arturo, Erik Bole, Sara Del Valle, Ketsia Mesidor, Chris Rodigues, Reynaldo Tapia, and Amirali Vastani

Graduate Student Assistant: Hoa Tran

Professor Siegel's students performed experiments using resistance paper, with the goal of visualizing solutions to a variety of Dirichlet and Neumann type boundary value problems in two dimensions. The students constructed mathematical models of the experiments, as well as analytical and numerical solutions to the models.

In the experiments, a special ``silver pen'' (containing silver particles in a suspension liquid) is used to form conducting domains on the resistance paper. A battery connected across the conducting domains then produces a potential drop between the domains. The potential drop, or voltage, satisfies the Dirichlet problem for Laplaces equation. By constructing domains with simple geometries (e.g. with rectangular or circular symmetry) the corresponding mathematical problem can be solved via separation of variables. This often leads to an infinite series solution which can be evaluated numerically. For more complicated domains, the Dirichlet problem must be solved numerically. The students developed a ``random walk'' routine for solving the Dirichlet

problem in complicated geometries.

The students also obtained experimental realizations of Neumann problems by cutting out regions from the resistance paper. The electric field evaluated at the edge of a cut-out was

found to be tangential to the boundary of a cut-out. Therefore, the gradient of the electric

potential has zero component in the direction normal to the cut-out boundary. This is a Neumann

boundary condition. The students performed experiments with mixed Dirichlet and Neumann type boundary conditions, and obtained either exact analytical solutions (via separation of variables) or approximate numerical solutions (using the random walk method) to compare with the experimental results.

A sample of the results is shown in figures 1 and 2 below. In figure 1A, the equipotential lines for an experiment in a rectangular domain are shown. In the experiment, the side walls and bottom wall of the domain were set at ground, whereas the top wall was at a potential of 12V. The equipotential lines (shown as dots) were plotted with the aid of a voltmeter. In this simple geometry an infinite series solution may be obtained via separation of variables. A numerical

evaluation of the infinite series leads to figure 1B, which is in good agreement with experiment.

Figure 1C shows the results of the random walk algorithm applied to this geometry. The ``noisiness'' which is inherent in such a numerical routine is apparent from the figure. This experiment provides an interesting avenue to explore ``Gibbs phenomena'', which manifests itself in the upper corners of the rectangle.

Figure 2A shows an experimental setup leading to a mixed type problem. In the experiment, a battery is connected across the two vertical silver lines, leading to a potential drop of 12V across the lines. A circular cut-out is made in the center of the figure. The experiment is the electrostatic analogue of two dimensional potential flow about a circular cylinder. The figure shows the equipotential lines (dotted lines running vertically) as well as electric field lines.

A model of the experiment in 2A was constructed by the students, and solved analytically. Figure 2B shows the streamlines from the analytical solution (these are parallel to the electric field

lines) and in 2C the equipotential lines are plotted. A comparison with 2A reveals good qualitative agreement.

Fig. 1A

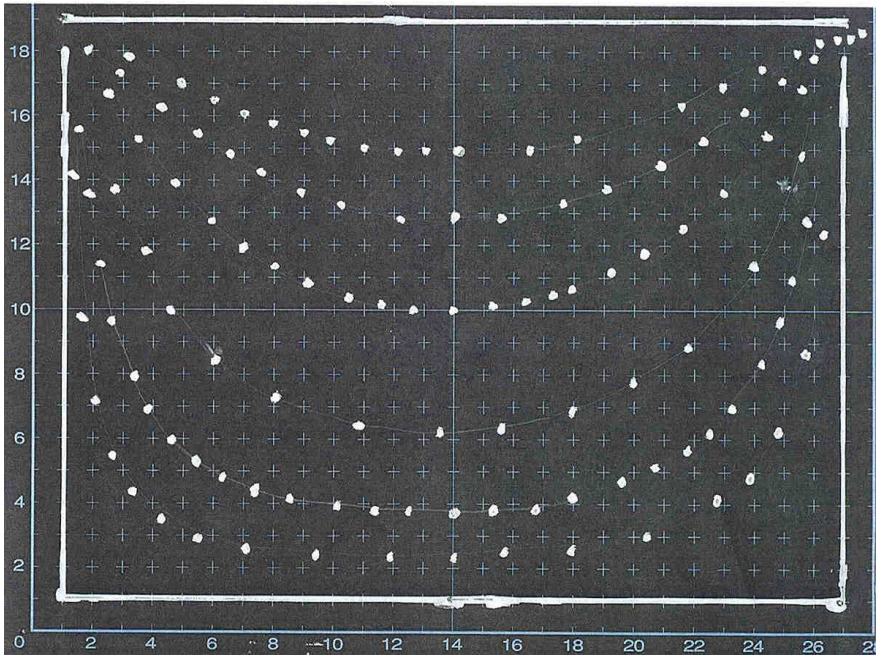

Fig. 1B

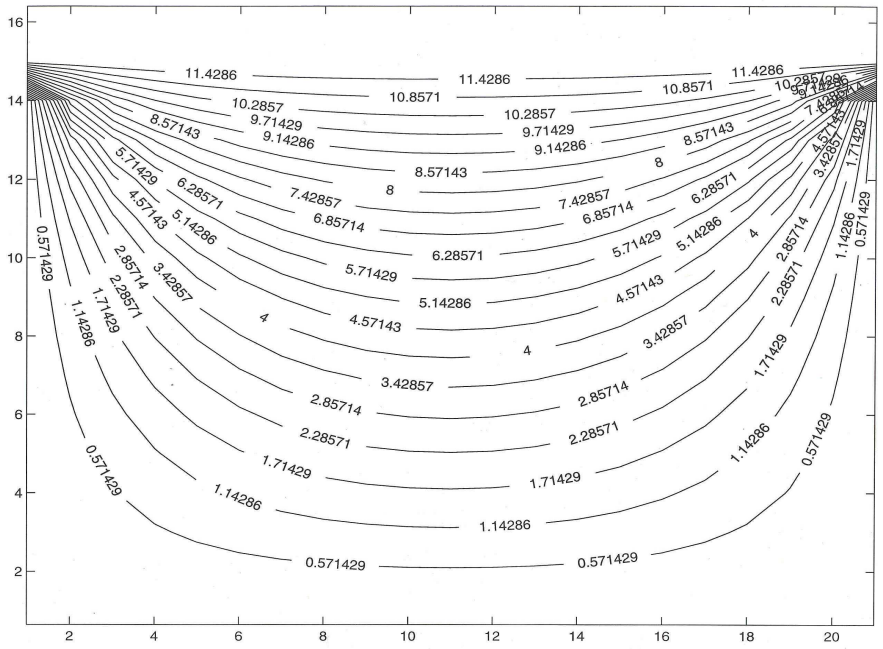
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Fig. 1C

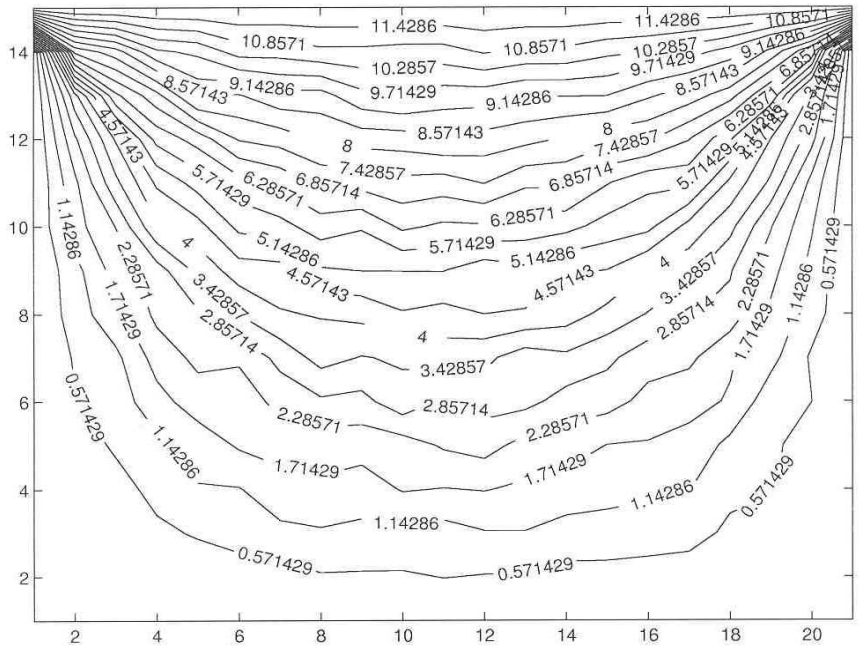
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Fig. 2A

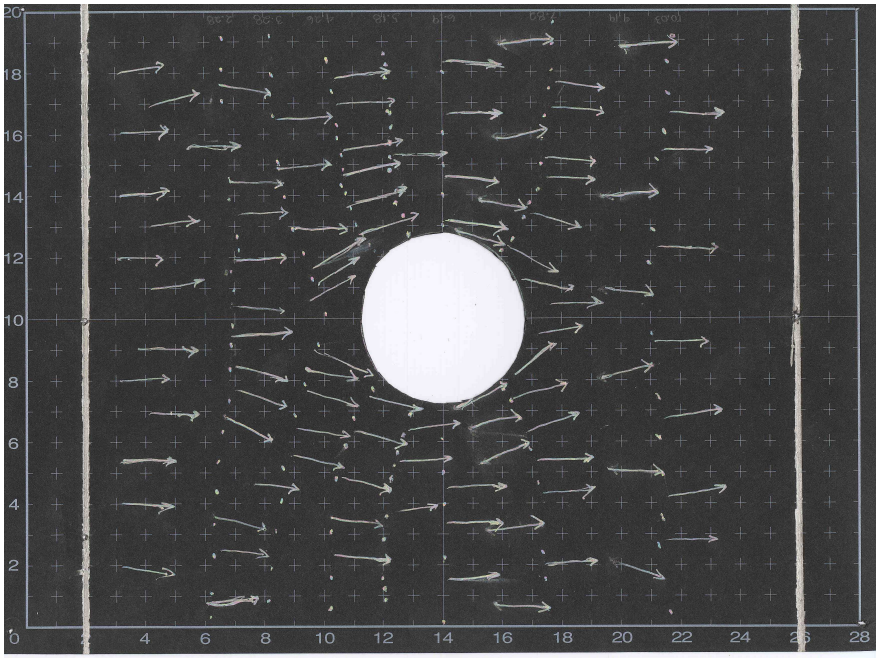
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Fig. 2B

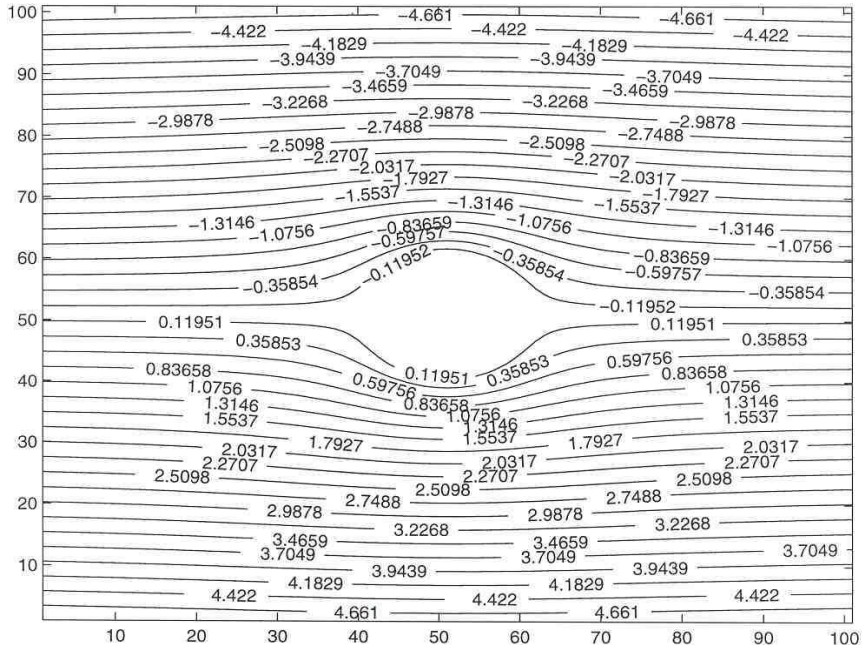
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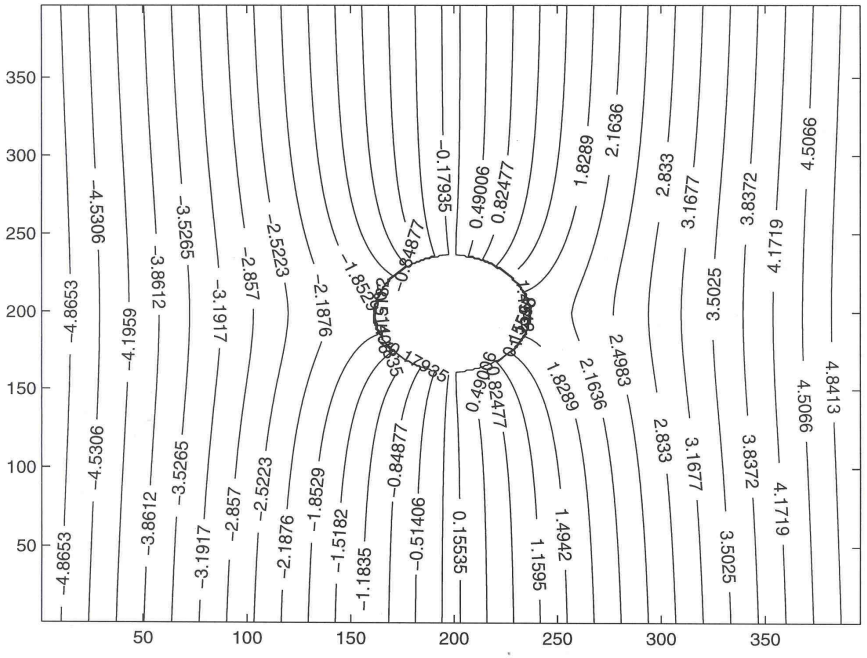
Fig. 2C



The students in the neurobiology section of the Capstone lab examined neuronal oscillations in the crab motor-pattern generator. They obtained recordings from oscillatory neurons and nerves of the crab in the Nadim laboratory and used these data to build models of the oscillations. Using intra- and extracellular amplifiers and a data-acquisition system, the students obtained electrophysiological recordings of the concerted activity of a small neuronal network in which all synaptic connections are known.

The student projects involved two types of modeling. One group of students described the statistics of activity patterns of the nerves and produced simulated data using statistical auto-regressive equations. The other group built a biophysical model of the 3-phase oscillations observed experimentally using current-balance equations for the nonlinear ionic currents underlying the network activity. These are a set of coupled ordinary differential equations

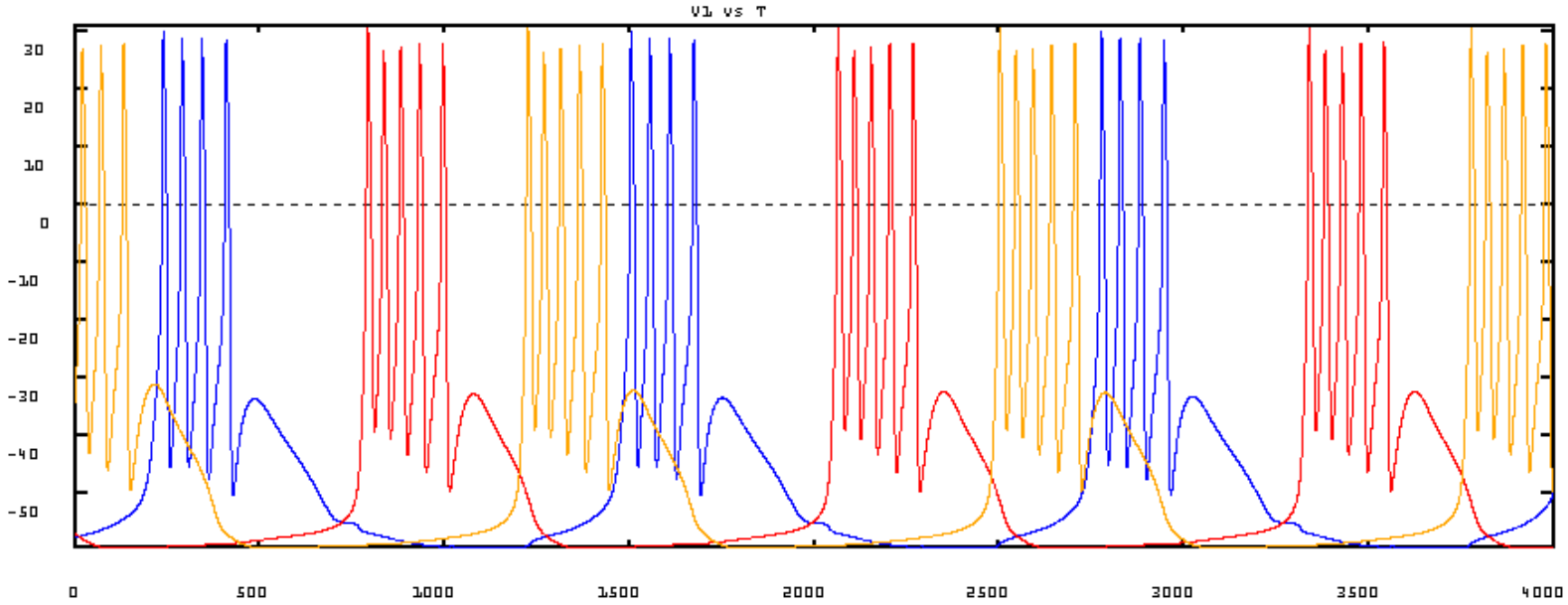
$$C_m \frac{dV_m}{dt} = I_{ext} - I_{Ca} - I_K - I_x - I_{leak}$$

$$I_x = \bar{g}_x \cdot x \cdot y \cdot (V - E_x)$$

$$\dot{x} = \frac{x_\infty(V) - x}{\tau_x}$$

$$\dot{y} = \frac{y_\infty(V) - y}{\tau_y}$$

where C_m and V_m are, respectively, the neuron membrane capacitance and potential, and x_{ion} and y_{ion} describe the probability of the activation of each ionic current. The students studied the solutions of these equations using dynamical systems phase-space analysis tools and also by numerical integration. The voltages of the 3-cell network are shown versus time in the figure below.



IX. RESEARCH WITHIN CAMS

A. CURRENT RESEARCH ACTIVITIES

Srinivasan Balaji:

Selected research problems of which some are near completion.

1. Optimal trading with minimal Assumptions (With John F.Price, UNSW, Sydney, Australia)

(2) On the Duality between failure rates and Mean Residual life functions

(With Prof. Manish Bhattacharjee)

(3) Sticky diffusions and Stochastic volatality models

(with Federico Marchetti, Politechnico Di Milano, Milan, Italy)

4. Applications of Reinforcement learning to Portfolio management (with Tomasz Bielecki,

NEIU, Chicago)

5. Recurrence and transience of diffusions in the quadrant with variable drift.

John Bechtold:

My research has involved the mathematical modeling of premixed flame propagation. I have developed two new models of flame propagation in near-stoichiometric mixtures. These models are now being used to investigate the effects of fuel-air mixture composition on flame dynamics.

Denis Blackmore:

Dynamics of Vortex Filament Flows. Dynamics of Point Vortices on a Sphere. Dynamics of Particulate Flows. Integral Invariants of Finite-Dimensional Reductions of Infinite-Dimensional Dynamical Systems. Segregation of Particulates via Acoustic and Flow Fields. Generalizations of the Poincare-Birkhoff Theorem. Dynamical Models of Phyllotaxis.

Amit Bose:

I have primarily been working on modeling the dynamics of networks of neurons for a variety of applications. With Victoria Booth and Michael Recce, I have developed models for the phase precession of hippocampal place cells. With Farzan Nadim, I have been modeling the effect of a depressing synapse in the gastric mill system of crabs to understand the origins of bistability. With Steve Kunec, I have been conducting a theoretical study about how networks of self-inhibitory neurons synchronize.

In other work, Greg Kriegsmann and I developed geometric techniques to analyze spatially non-homogeneous non-local reaction diffusion equations. We were able to establish criteria for the existence and stability of large amplitude pulse solutions.

Bruce Bukiet:

This past year my research has been focused in two main areas.

In the area of detonation dynamics, my work (with Dr. John Starkenberg of Army Research Laboratory in Aberdeen Maryland) has been concerned with modeling the behavior of detonation waves using a discrete mixture equation of state. Using this model, one can study the build up of a detonation wave induced by a shock wave. The front tracking method for gas dynamics is being

Extended to handle the problem of a flyer plate impacting on an explosive material.

In the area of biomechanics, I have continued to study residual stresses (with Prof. Chaudhry) and their influence on blood flow and stresses in arteries and in the heart.

Hans R. Chaudhry:

Professor Hans Chaudhry, along with his team from NJIT (Dr. B. Bukiet, Dr. M. Siegel, Dr. J. Federici and Dr. D. Lott-Crumpler) and UMDNJ (Dr. T. Findley, Dr. A. Ritter and Dr. M. Guzelsu) made contribution to biomechanics by analyzing stresses and strains in the cardiovascular system and the skin, using the methods of nonlinear elasticity. He focused his research mostly on the role of residual stresses in heart muscles and arteries and investigating the optimal pattern

for suturing wounds in surgical procedure. He also analyzed the stress distribution in endothelium cells under the influence of shear stresses induced by blood flow.

Vladislav V. Goldberg:

In 1999-2000 academic year I continued to study differential geometry of webs (in particular, I classified and gave numerous examples of 4-dimensional isoclinic webs and studied 4-dimensional webs with integrable transversal distributions) and algebraic aspects of web geometry. The second direction of my reserach was the study of geometry of lightlike hypersurfaces on manifolds endowed with pseudoconformal structures, in particular, pseudoconformal structures of signature (2, 2).

Lou Kondic:

My research during this academic year concentrated on the dynamics of thin liquid films. In particular, I have been exploring the problem of contact line instability of the gravity driven thin film flow. Fully nonlinear time-dependent simulations of these systems have already produced some quite interesting results concerning the nature of the contact line instability. For example, now we are able to understand the shapes of the patterns which develop under different experimental conditions, as a thin films flows down an inclined plane. This research is going to be expanded so to include other related problems, such as thermally driven flows, and flows of non-Newtonian films.

Gregory A. Kriegsmann:

Professor Kriegsmann's research activities for the year remain focused in two areas of wave propagation. In the first, he continues to develop asymptotic and numerical methods to quantitatively describe microwave heating processes that arise in the sintering, joining, and fabrication of ceramics. In the second, he continues to develop hybrid numerical methods for describing the scattering of electromagnetic waves from large resonant structures, such as jet engine ducts.

Dawn A. Lott-Crumpler:

Professor Dawn A. Lott-Crumpler has worked on the following projects during the 1999-2000 academic year: (1) Characterization of shocks during antiplane motions in elastoplastic materials in collaboration with S.S. Antman and W.G. Szymczak, (2) The study of deformation and mechanical properties of human skin; in particular, to determine the stress incurred in wound closure suturing. In this project, the optimal pattern of suturing wounds in human abdominal skin is determined (for a triangular wound) as well as the effects of suturing density on wound closure stresses (in collaboration with H.R. Chaudhry) (3) Characterization of the effects of strain-gradient regularization on the development and propagation of shear bands in viscoplastic materials.

Jonathan Luke:

Professor Luke's research activities have been in two areas: electromagnetics and sedimentation. In electromagnetics, he has investigated the interaction of electromagnetic waves with complex materials including numerical methods for simulating such interactions. In sedimentation, he has studied the influence of sedimentation dynamics on velocity fluctuations in a suspension and the effects of inertia on the dynamics of macro-particles settling in highly viscous liquids.

Zoi-Heleni Michalopoulou:

My research activities during the past year focused on the selection of features from measured acoustic fields for fast solutions of inverse problems. We are currently working with time arrival information extracted from acoustic data using Monte Carlo methods.

Cyrill Muratov:

Asymptotic theory of traveling waves in the model of nerve conductance. Singular perturbation techinques for reaction-diffusion systems. Variational characterization of the traveling waves in reaction-diffusion systems of gradient type. Homogenization of Liuovulle equations for Hamiltonian dynamical systems and the origins of dissipation. Kinetic models of polymer-liquid crystal systems.

Farzan Nadim:

I have continued research on short-term synaptic dynamics. This research is in collaboration with Dr. Yair Manor of Ben-Gurion University in Israel. Currently 2 of my graduate students and 1 student of Dr. Manor are working on this project. My graduate students are focusing on 2 sets of experimental measurements of synaptic activity during neuronal oscillations. Dr. Manor's student is performing a modeling project and Dr. Manor and I are performing a set of experiments

coupling biological and computer-modelled neurons in real time. We have submitted an abstract to the Soc. for Neuroscience annual meeting and an abstract to the Computational Neuroscience Meeting on this project.

I have also continued collaboration with Dr. Michael P. Nusbaum of the University of Pennsylvania Medical School on interactions between fast and slow neuronal processes. The experiments of this project are performed in Dr. Nusbaum's laboratory and one of my graduate students is modeling the network under study. We have submitted 2 abstracts to the Soc. for Neuroscience annual meeting on this project.

I have started a new collaboration with Dr. Amitabha Bose of our department. We are modeling the effect of synaptic dynamics on networks of excitatory and inhibitory neurons. We have submitted an abstract to the Soc. for Neuroscience annual meeting and an abstract to the Computational Neuroscience Meeting on this project.

Demetrius Papageorgiou:

Several collaborations have started or continued with other CAMS members. The nonlinear stability of electrified liquid sheets has been studied by derivation of long wave nonlinear models and study of singularity formation leading to the disintegration of the sheet. The work is in collaboration with Professors Tilley and Petropoulos and a graduate student is being supervised on this topic. In collaboration with Professor Siegel, I am looking at the effects of insoluble surfactants on the nonlinear stability of core-annular flows. A Ph.D. student is being supervised by us on this project.

Peter Petropoulos:

Engineers who use computational electromagnetics codes have objected to fourth-order accurate schemes as a replacement of the industry workhorse second-order accurate Yee scheme because of a) difficulty in implementing absorbing boundaries due to the extended spatial stencil, b) lack of an approach to model heterogeneous dielectrics while maintaining the order of accuracy of the scheme. The first objection was addressed by us in JCP, v. 139, pp. 184-208 (1998). With analysis and numerical experiments we have shown that the obvious treatment of dielectric interfaces results in a loss of at least two orders of global accuracy for an explicit staggered fourth-order scheme. Our new treatment restores the fourth-order convergence globally and improves the error level in comparison to the Yee scheme. This work, done jointly by Amir Yefet, addresses the second (and final) objection to high-order schemes, and paves the way towards full acceptance of fourth-order schemes for engineering computations.

With Prof. D. T. Papageorgiou we derived the equations governing large amplitude deformations of the surface (including surface tension) of a two-dimensional jet stressed by an axial electric field. A numerical scheme to follow the evolution of the fluid surface is under construction. Currently we are validating the code against results obtained by Pugh & Shelley (CPAM, 51: 733-795 (1998)); they studied a different problem (no electric field) but our equations reduce to theirs when the electric field strength is zero.

Michael Siegel:

A large part of my research over the past year has been concerned with characterizing the steady state configurations and transient dynamics of bubbles acted on by insoluable surfactant. The emphasis is on obtaining analytical results for highly deformed bubbles, including exact solutions for two dimensional flows and asymptotic results (employing slender body theory) for axisymmetric flows. The analytical results are particularly important in cases where the bubble approaches or achieves a cusped shape, since numerical methods cannot resolve such pointed bubbles in detail. A related project with D. Papageorgiou and graduate student S. Kas-Danouche, involves surfactant effects in two-fluid, core annular flow. I am also involved in some work on surface tension effects in Hele-Shaw flow, building upon some earlier research. The temporal evolution of a crystal dendrite and the mathematically analogous problem of a time evolving Hele-Shaw finger subject to anisotropic surface tension are considered in collaboration with S. Tanveer and M. Kunka. Surface tension effects in finger competition are being studied in collaboration with E. Paune and J. Casademunt. Finally, I have initiated work on a problem in biomechanics with H. Chaudhry and A. Ritter. In particular, we are investigating the deformation of endothelial cells under the influence of blood shear flow.

Burt Tilley:

My research interests involve interfacial motion in fluid dynamics and mathematical modeling. During the year, several projects were considered. Firstly, we investigated the fluid motion and heat transport near a contact line on an oscillating, heated plate, in collaboration with Professors S.H Davis and S.G. Bankoff at Northwestern University. Other projects include the modeling and simulation of microwave-enhanced chemical vapor infiltration processes, in collaboration with G.A. Kriegsmann. Further, I am investigating the interfacial dynamics between two volatile fluids in an inclined channel, and the stability of these flows to localized disturbances.

B. SELECTED RESEARCH RESULTS

Amitabha Bose

Bruce Bukiet

Lou Kondic

Gregory A. Kriegsmann

Dawn A. Lott-Crumpler and Hans R. Chaudhry

Jonathan H.C. Luke

Zoi-Heleni Michalopoulou

Cyrill Muratov

Demetrius Papageorgiou

Michael Siegel (with J. Casademunt and E. Paune)

Burt Tilley

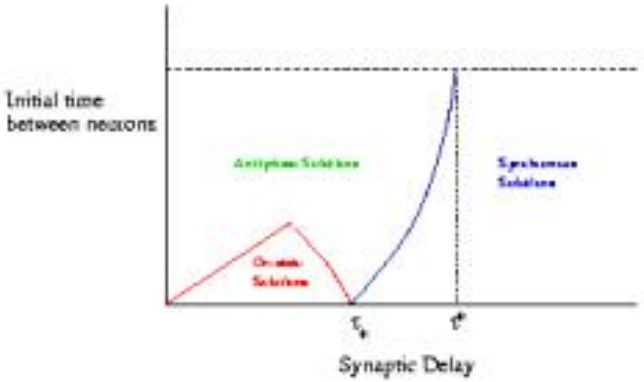
Amir Yefet and Peter G. Petropoulos

Amitabha Bose

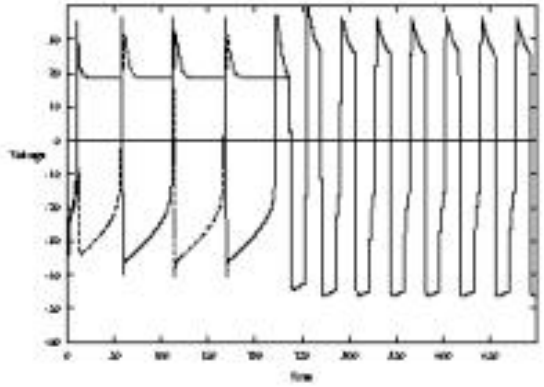
Amitabha Bose

Networks of inhibitory neurons exist in various parts of the central nervous system such as the hippocampus and thalamus. Understanding the dynamics of inhibitory networks is of critical importance for assessing the role of these neurons in controlling network behavior during such diverse activities as movement, sleep and digestion. Steve Kunec and I have studied how the output of mutually coupled, self-inhibitory neurons depends on the synaptic delay between cells. We have

shown that the size of the synaptic delay determines the existence and stability of solutions. For large delays, only the synchronous solution is stable. For small delays, there is no synchronous solution, but a stable anti-phase and a stable on-state solution exists. For this case, if the initial conditions of the neurons are too close, then the network ceases to oscillate and stays 'on' at a high voltage level. For intermediate delays, the anti-phase and synchronous solutions are both stable. There are two advances in this work. First, we are the first to show that networks of mutually coupled inhibitory neurons can display stable synchronous oscillations in the presence of only one slow current. Prior studies have required two slow currents. Secondly, our work shows how bistability of solutions arises in such networks and how the central nervous system can use this bistability to achieve different dynamic objectives.

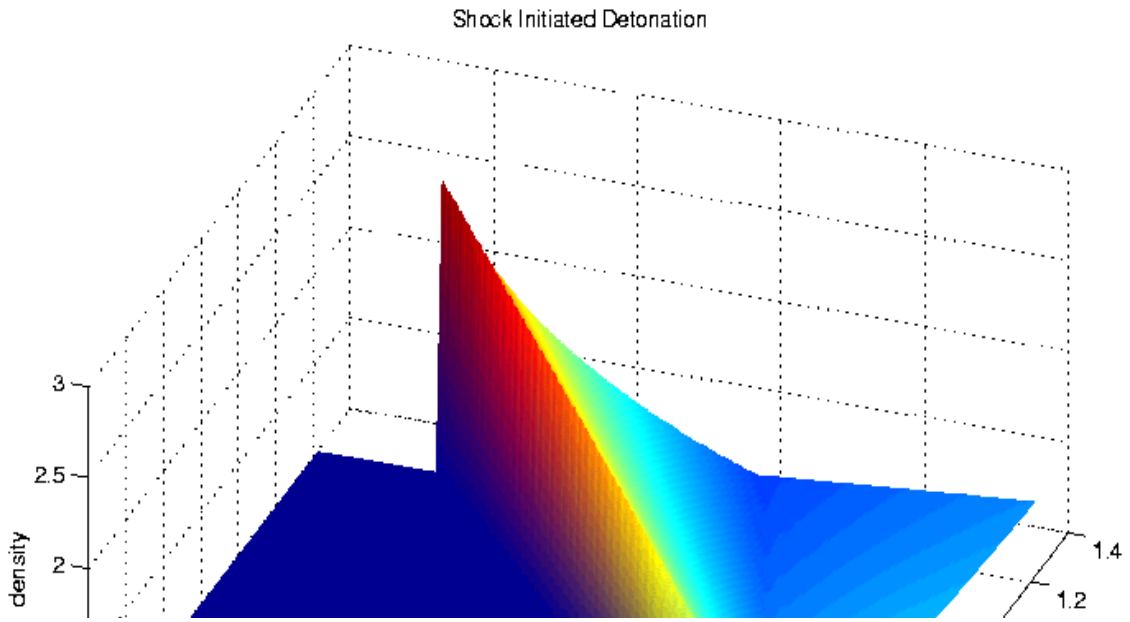


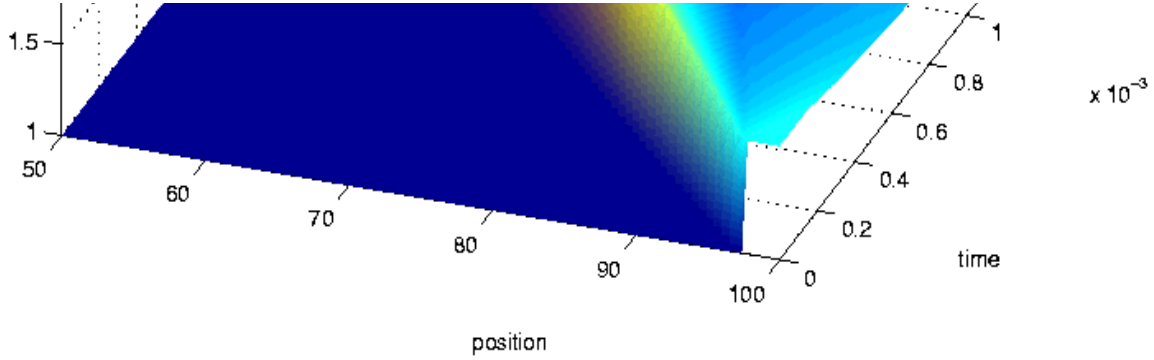
The above figure shows a bifurcation diagram relating synaptic delay to the basin of attraction of solutions for a two cell network of mutually coupled, self-inhibitory neurons. For delays $\tau < \tau_*$, there exists bistability between the on-state and anti-phase solutions. For $\tau_* < \tau < \tau^*$, there is bistability between the anti-phase and synchronous solutions. Finally, if $\tau > \tau^*$, the synchronous solution is the globally attracting stable solution.



The figure shows voltage traces of the two cell network. From $t = 0$ to $t = 200$, the network displays anti-phase oscillations since the delay is small. At $t = 225$, we increased the delay, and the cells immediately synchronize.

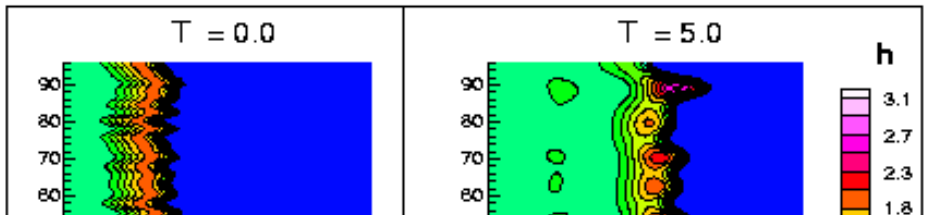
Bruce Bukiet





Density versus position and time for initiation of detonation of a polytropic gas mixture using a discrete mixture equation of state model. The mixture is shocked at the right end and the detonation is building up with time.

Lou Kondic



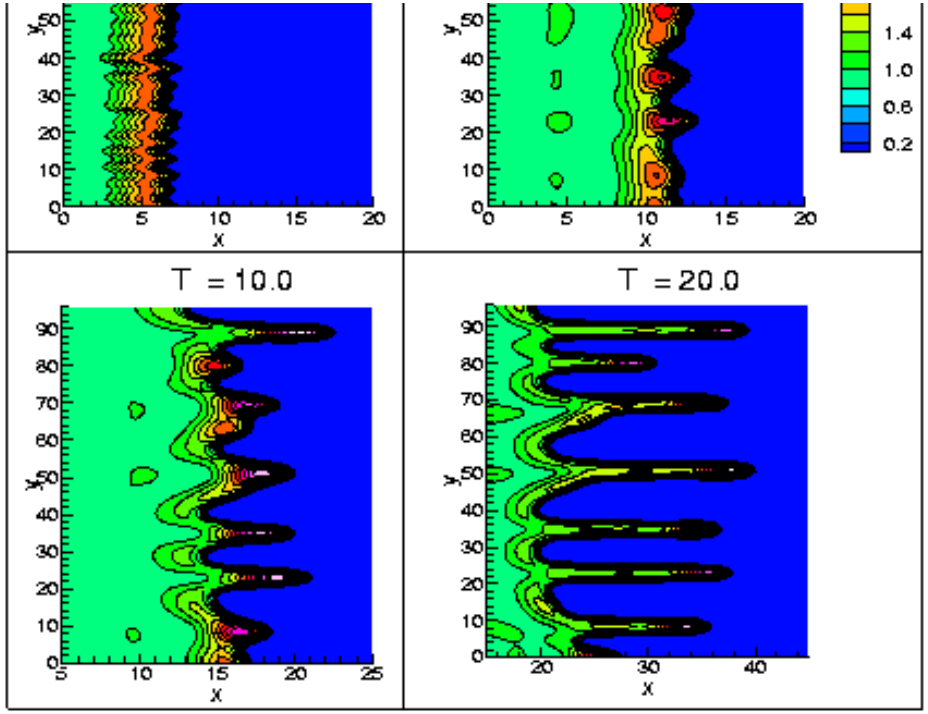


FIG. 1. Fluid flow down a vertical plane; h is fluid thickness.

The flow of thin films is relevant in a number of different fields, such as engineering (microchip production), biology (lining of mammalian lungs), and chemistry (flow of surface active materials). The dynamics of the fronts of these films is not very well understood. In many situations, the fronts become unstable, leading to the formation of finger-like rivulets (such as shown in the figure), saw-tooth patterns, or, in the case of surfactant flow, dendritic tip-splitting petals.

This research (performed in collaboration with Javier Diez), centers on the computational analysis of the dynamics of the contact line, where liquid, gas, and solid phase meet, in the context of the fluid flow down an inclined plane. Within the framework of lubrication (long-wave) approximation, which assumes that the out-of-plane coordinate is much shorter than the in-plane coordinates, the problem is formulated in terms of a nonlinear fourth order PDE of diffusion type. We have developed computational methods for solving this equation, paying particular attention to the issues related to accuracy, stability and efficiency.

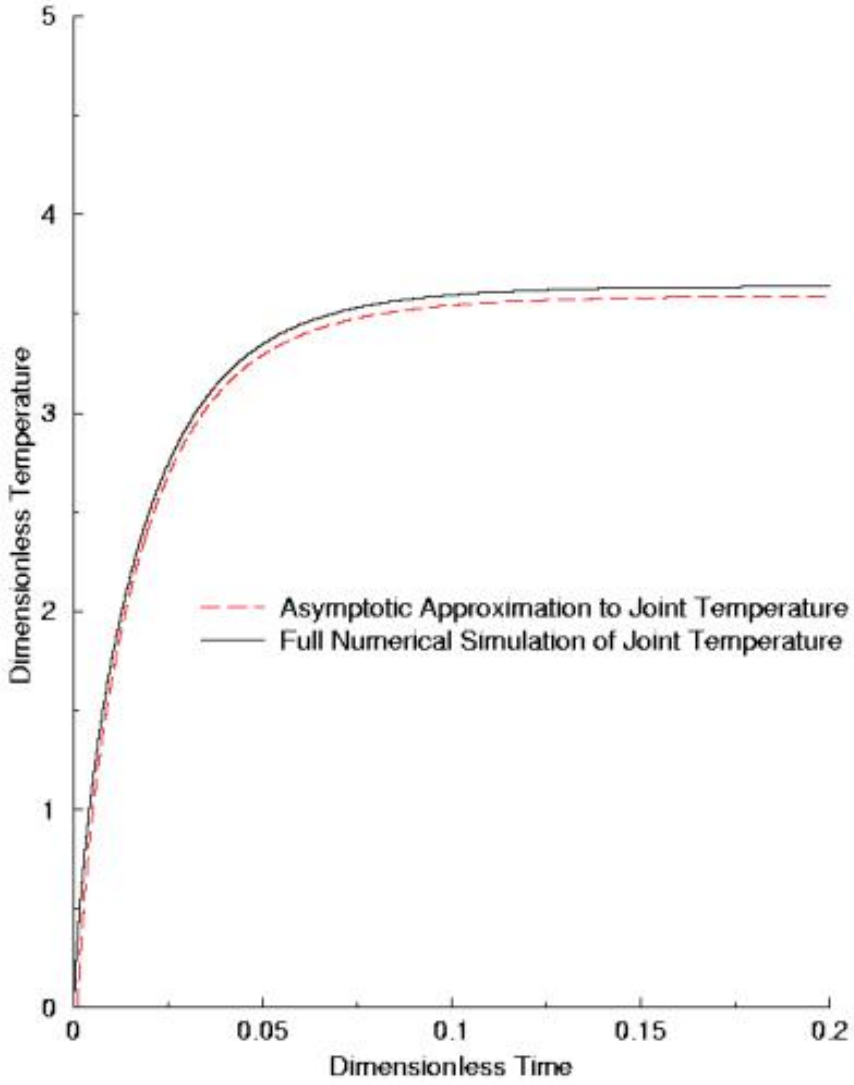
Figure shows an example of our computational results for spreading of a fluid down a vertical plane in the $+x$ direction at four different times (Additional plots and movies can be found at http://m.njit.edu/~kondic/thin_films). At $t = 0$, the initial profile has been perturbed by a large number of harmonic perturbations of different wavelengths characterized by random amplitudes. In the physical experiments the source of these perturbations could be, e.g., surface inhomogeneities.

As time progresses, these perturbations evolve to long rivulets, as in experiments. In the future, I plan to expand this research so to analyze other related problems, such as thermally driven flows, and flows of non-Newtonian fluids.

Gregory A. Kriegsmann

Microwave Joining of Two Long Hollow Tubes

We have recently analyzed a nonlinear heat equation which models the microwave assisted joining of two large *SiC* tubes [**1**]. By exploiting the small fineness ratio of the structure and disparate time scales we have systematically deduced an asymptotic theory for this problem. Specifically, a one-dimensional nonlinear heat equation is described which governs the temperature in the "outer" region. This is a numerically well posed problem and it is efficiently solved using standard methods. This solution is not valid in the "inner" region which includes the microwave source. An inner asymptotic approximation is derived to describe the temperature in this region. This approximation yields two unknown functions which are determined from matching to the outer solution. The asymptotic approximation to the temperature at the but-joint of the two *SiC* tubes is shown in the Figure along with the numerical results computed from the full problem; the agreement is excellent. Since the full problem is numerically ill conditioned, the asymptotic theory yields enormous savings in computational time and effort.



[1] G. A. Kriegsmann and J. H. C. Luke, Microwave Joining of Two Long Hollow Tubes:

An Asymptotic Theory and Numerical Simulations, Journal of Engineering Mathematics, in press.

Optimal patterns for suturing wounds of complex shapes to foster healing

D. A. Lott-Crumpler[1] and H. R. Chaudhry[1,2]

Stress is one of the many biological factors that plays an important role in wound healing. It is therefore essential to analyze stresses around the wound closure. The objective of this research is to determine the regions of high stresses and the most optimal pattern of suturing wounds of complex shapes. Since regions of high stresses in surgical closures produce adverse affects on healing and scar production, this work of predicting areas of high stresses is useful in indicating regions of slow healing in wounds. It is hypothesized that the most optimal pattern of suturing wounds is that pattern which will produce minimum principal stresses. The finite element method (FEM) is utilized to compute the principal stresses and displacements resulting from suturing fusiform, elliptical and triangular wounds in human abdominal skin. The most optimal suturing pattern for the triangular wound is determined and is shown in Figure 1.

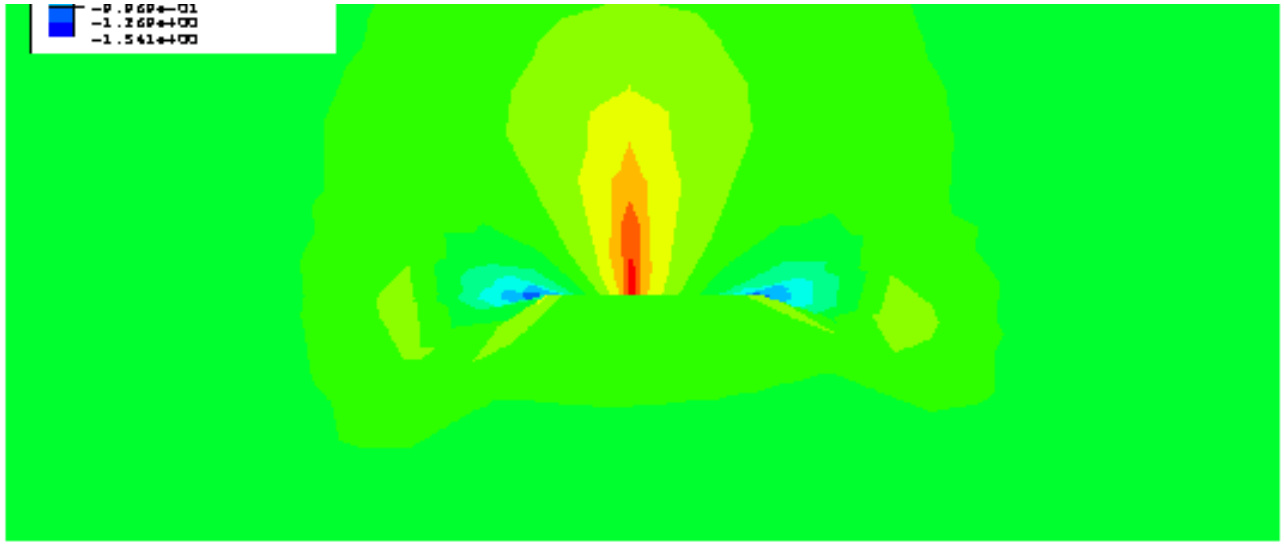


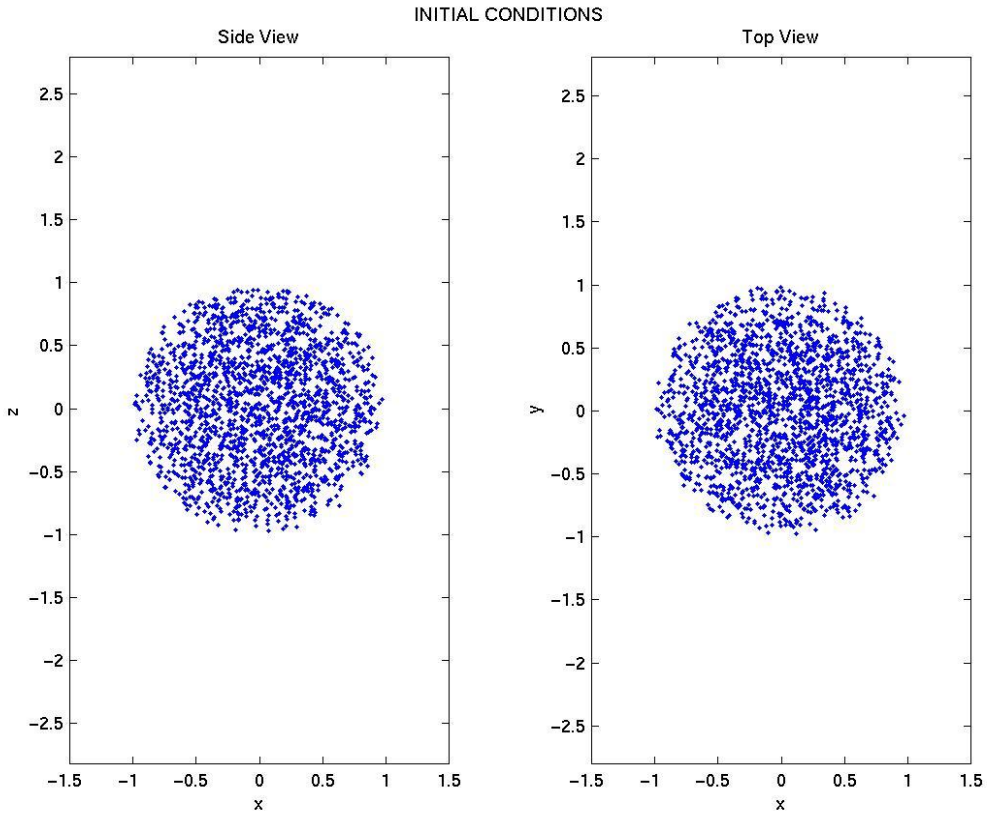
Figure 1: The principal stress σ_1, post-suturing, of a triangular wound of orthotropic, abdominal, human skin such that each suture point of the upper triangular boundary is advanced perpendicularly to the base of the triangle. This suturing pattern **(bottom line)** is the most optimal suturing pattern as indicated by the lowest values of principal stress, aspect ratio and stretch variation, as compared to left and right directions of suturing.

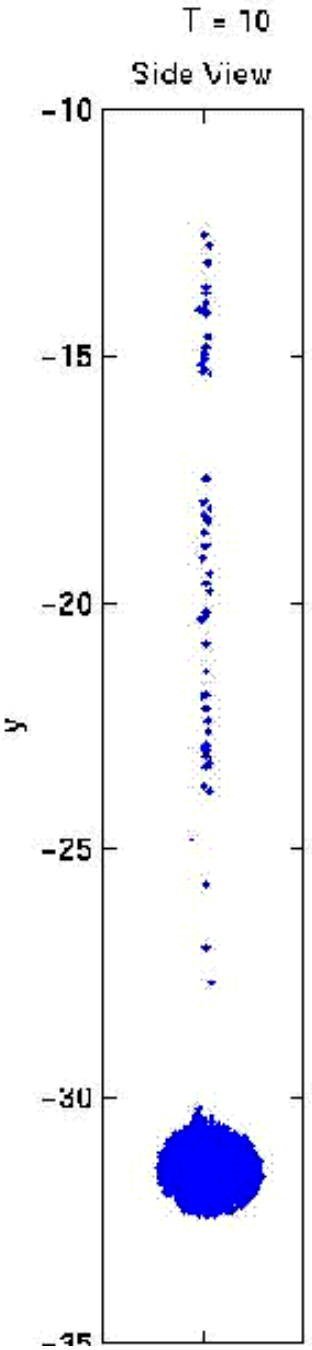
[1]Department of Mathematical Sciences, Center for Applied Mathematics and Statistics, New Jersey Institute of Technology, Newark, New Jersey 07102
[2]UMDNJ - Institute for Disability Prevention and Wellness, School of Osteopathic Medicine at Stratford, Stratford, NJ 08084

Jonathan H. C. Luke: Sedimentation of a Suspension Globule

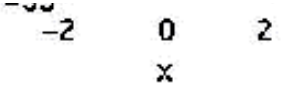
Imagine a large container holding a viscous fluid. Suppose a small amount of fluid is removed and mixed with small particles to form a suspension. If a small globule of this suspension is returned to the fluid in the large container, the globule will settle through the clear fluid in the container under the action of gravity. As a first approximation we expect the globule to settle as a droplet of fluid having a viscosity given by the Einstein theory of suspension viscosity and a density equal to the average density of the suspension. This expectation is valid for short times, but on longer time scales dramatic departures from the "effective fluid" theory are seen. The simulation presented here illustrates such departures.

In this simulation two thousand particles are initially placed at random locations in a spherical globule of unit radius. The figure below shows projections of the particle positions onto the *x*-*z* and *x*-*y* planes.





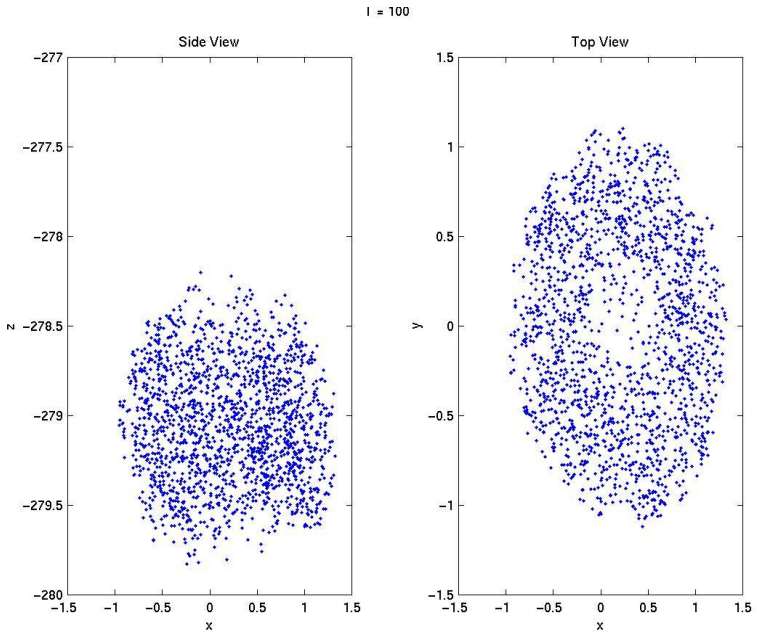
After the globule has settled for a short time (*T=10)*, we find (see the figure to the far right of this page) that it retains its spherical shape, but the globule has a tail of particles in its wake. Note: the vertical axis of this figure should be labeled *z*. In this figure slightly more than fifty of the two thousand particles in the globule are found in its tail.



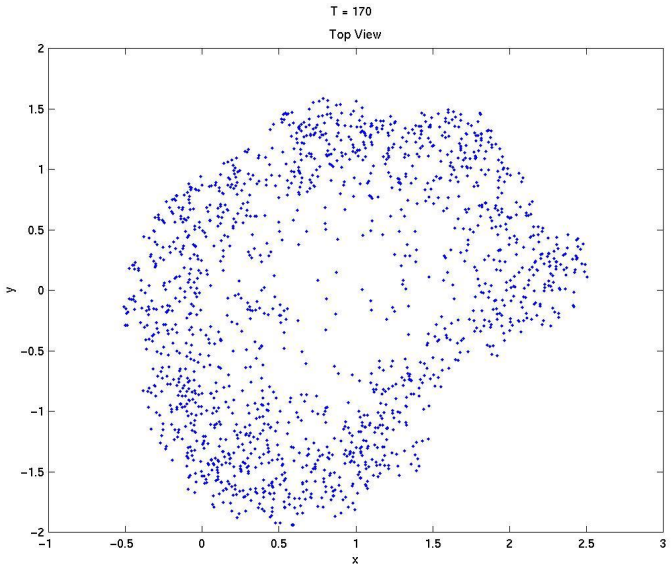
This general situation persists for a considerable period of time. A similar side view at a much latter time (*T=100)* would show similar features except a much longer tail of particles. At *T=100* about two hundred seventy particles have been swept out of the main globule.

Luke (continued)

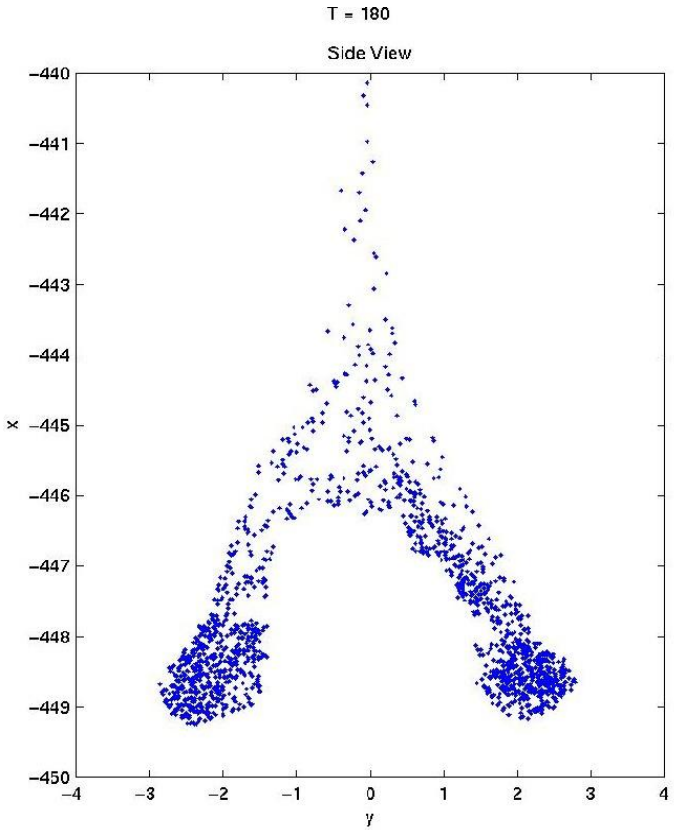
This loss of particles takes a toll on the spherical shape of the globule. The figure below, showing top and side views of the globule (not include particles that have been expelled), reveals that the globule is slightly wider and shorter than the original. The top view reveals a depletion of particles near the central axis of the



globule leaving the it with a shape suggesting a torus. This metamorphosis from a sphere to a torus seems to be part of a mechanism that induces an instability leading to a rather dramatic breakup of the globule.



At about *T=170* there are so few particles near the central axis of the globule that there is a rather sudden jet of clear fluid that passes along its central axis from the bottom of the globule to the top. With this surge of clear fluid, the radius of the globule grows rapidly which completes the transformation to a toroidal topology. This structure, however, is short lived. It is apparently unstable.



The result at *T=180*, shown to the right, is that the globule splits into two. Note: the vertical axis of this figure should be labeled *z*.

This simulation illustrates some of the remarkable features that arise from sedimentation dynamics. Ongoing work seeks to identify and analyze such features and to understand their effects on the structure of sedimenting suspensions.

Zoi-Heleni Michalopoulou

Gibbs sampling was shown to be a powerful tool for simultaneous source localization and deconvolution. Modeling statistically the unknown amplitude and phase of the source spectrum, we obtained more robust source localization results with the new processor than with conventional matched field processing. Figure 1 shows ambiguity surfaces obtained with (a) the Bartlett processor and (b) the Gibbs sampling localization-deconvolution processor for the same data. The Gibbs sampling processor correctly identifies the source position (2 km in range and 34 m in depth). The Bartlett processor results in values of 1.46 km and 54 m for range and depth, far from the true source location. Multiple sidelobes can be observed in the Bartlett surface, whereas very little uncertainty is present in the surface generated with the new processor.

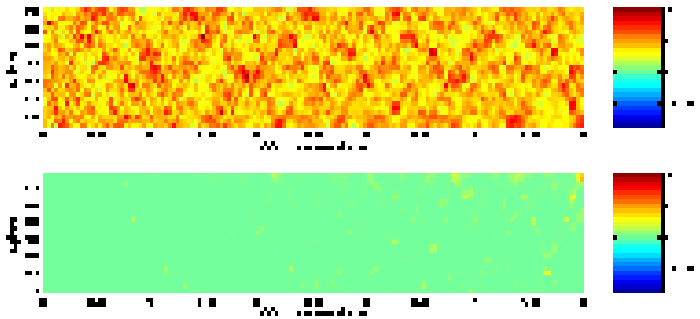


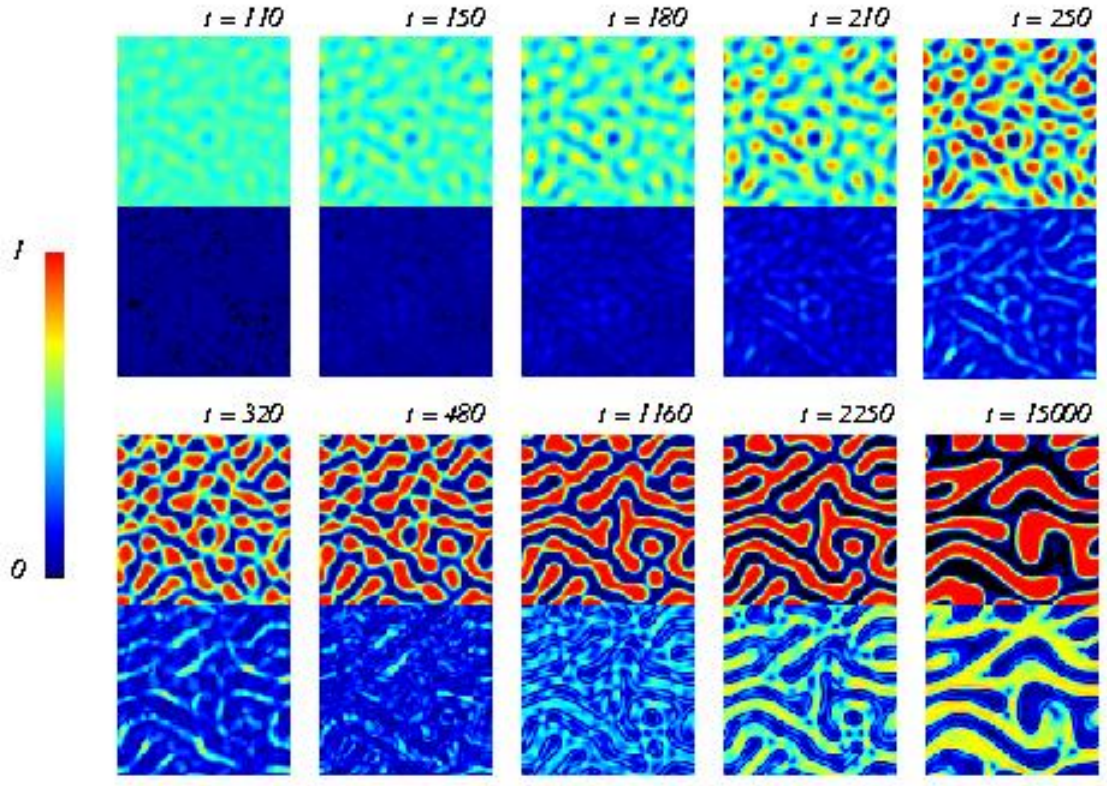
Figure 1: Ambiguity surfaces obtained with the (a) Bartlett processor and (b) the Gibbs sampling localization-deconvolution processor for the same data.

C. B. Muratov

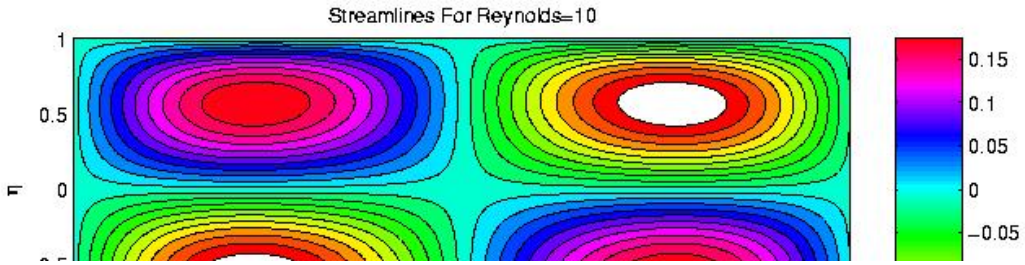
A lot of the current display technology is based on liquid crystal devices. One of the technological goals in their manufacturing is to make devices which would allow for fast switching of the display elements. The idea is that instead of using homogenous films of the liquid crystal, one can prepare a mixture of

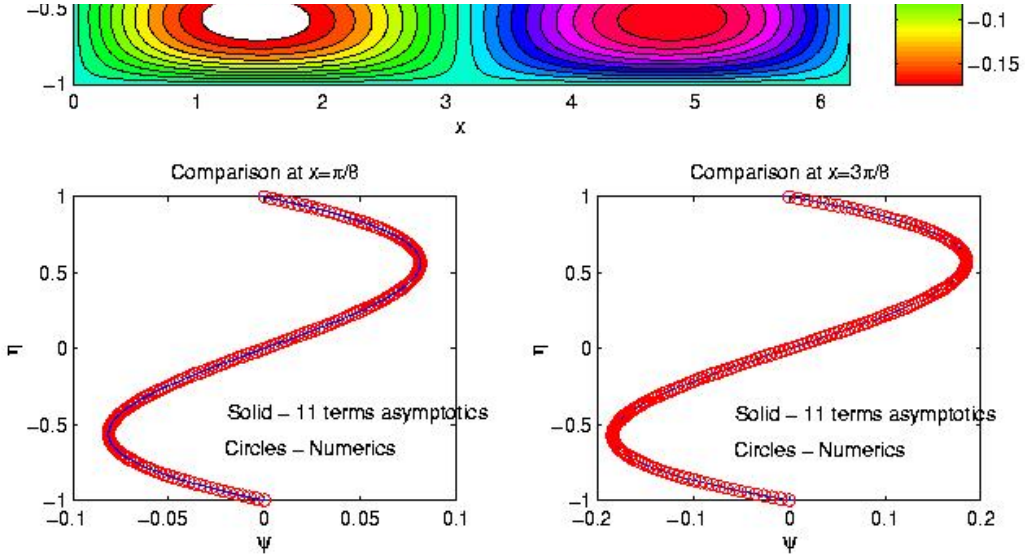
small (microscopic) liquid crystal droplets that are easier to manipulate. Also, by arranging the liquid crystal into stripes or other kinds of patterns, one can produce tuneable diffraction gratings.

In order to manufacture these kinds of devices, one needs an understanding of the kinetics of the droplet formation in the polymer-liquid crystal mixtures. A numerical simulation of a model introduced by Muratov and E is shown in the figure below. When the temperature of the mixture is suddenly lowered, the polymer and the liquid crystal tend to segregate. The upper parts of the picture shows the polymer-rich regions in red and the liquid crystal regions in blue. You can see the initial formation of the droplets from the thermodynamic instability followed by their growth and coarsening at later times. The lower portions of the pictures show the distributions of the degree of the orientational ordering (yellow: high ordering).

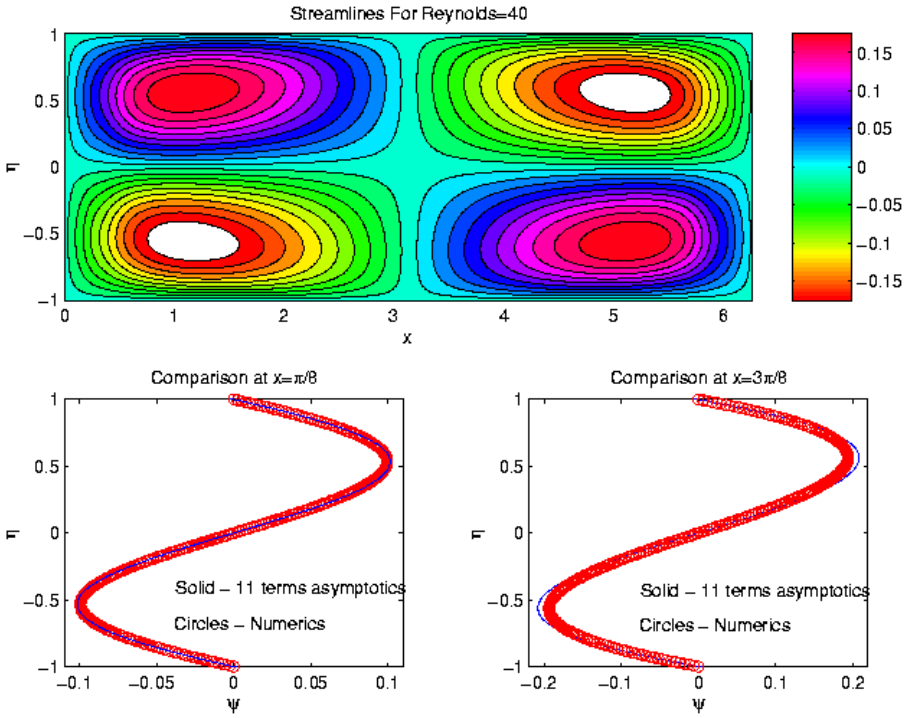


Demetrius Papageorgiou





The Figures represent the streamlines of the steady-streaming flow between two cylinders. The flow is set up as follows: Consider two infinitely long cylinders with different diameters and with the smaller cylinder inside the larger. Initially the cylinders have a common axis and a viscous fluid fills the annulus between them. The inner cylinder is now set into an oscillatory motion along its diameter (the outer cylinder can be set into motion in a similar way also). The back and forth motion causes a complicated time dependent flow field and is a fundamental example of many flows of practical interest. In the limit of high frequency oscillations, viscous Stokes boundary layers are set up at the solid surfaces and a steady streaming flow is set up in the main part of the annulus with slip boundary conditions coming from matching requirements with the boundary layers. The Figures show numerical computations (using pseudospectral methods) for two representative Reynolds numbers (these are the steady streaming Reynolds numbers) of 10 and 40 respectively. Steady states are achieved for the cases shown. The equations solved are valid in the narrow gap limit where the azimuthal dependence is small relative to the radial one. The flow over half the gap is shown with the geometry straightened out to represent the cylinder walls as straight lines.


Streamlines For Reynolds=40
x
η
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
Comparison at x=π/8
Solid – 11 terms asymptotics
Circles – Numerics
ψ
Comparison at x=3π/8
Solid – 11 terms asymptotics
Circles – Numerics
ψ

Michael Siegel: Effect of small surface tension on finger competition in a Hele-Shaw cell

(J. Casademunt, E. Paune, M. Siegel)

This figure depicts some unexpected results obtained in a study of finger competition in a Hele-Shaw cell. A Hele-Shaw cell consists of two closely spaced glass plates, with a viscous fluid occupying the gap between the plates. When air is injected into the viscous fluid (say, through a hole in one of the plates) an interesting fingering pattern develops on the interface.

G. I. Taylor realized in 1956 that the equations governing flow in a Hele-Shaw cell are analogous to those governing flow in porous media, and therefore the cell could serve as a simple apparatus to study flow instabilities arising during oil recovery.

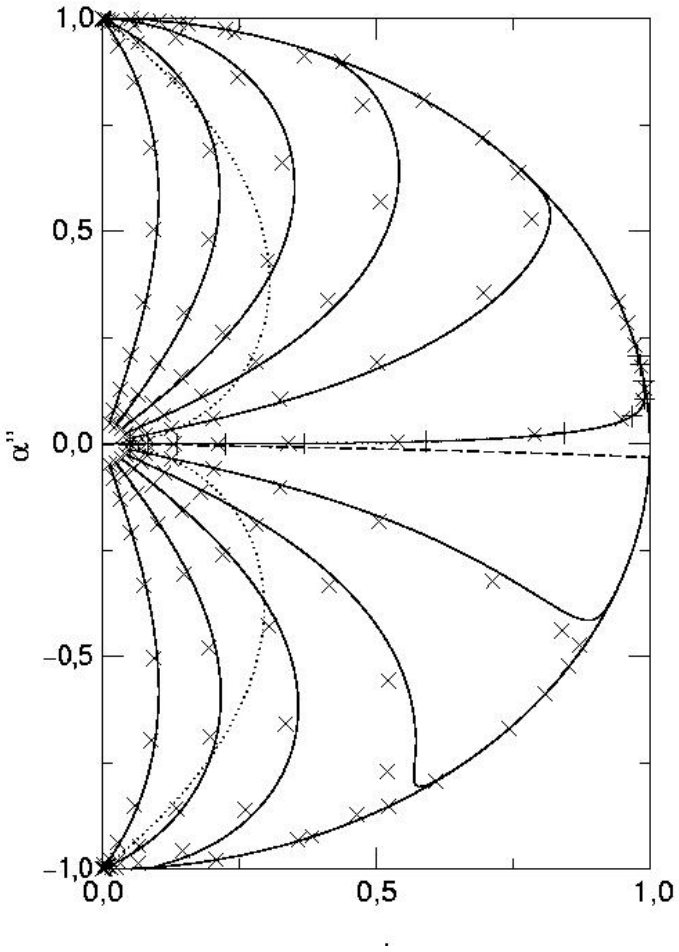
The figure represents the effects of small surface tension during the "competition" of two fingers of air propagating into the viscous liquid. A special class of solutions is employed, so that the dynamics under zero surface tension can be simply described by two time varying parameters, α » and α » » (plotted on the figure axes).

The solid lines show the trajectories according to the zero surface tension dynamics. The trajectories start near the point (0, 0), and flow into either the point (0.0, 1.0) or (0.0, -1.0), indicating the emergence of a single dominant finger (call it finger A or B, respectively). The different solid curves correspond to differing initial angles and relative initial sizes for the two fingers. The dashed center line represents two aligned, equal sized figures.

For the curves lying above the dashed center line, the trajectories flow toward the point (0.0, 1.0), indicating that for this data finger A wins the competition. Since these trajectories do not cross the dashed center line the winning finger is also the initially larger finger. The two trajectories starting just below the dashed line also flow into the point (1.0, 0.0), so that A again wins the competition. However, in this case A is the initially smaller finger, since the trajectories cross the dashed line. The three leftmost trajectories below the dashed line flow into the point

(0.0, -1.0), indicating that finger B wins the competition. In this case, finger B is also the initially larger finger.

The *x*'s mark the trajectories obtained when a small amount of surface tension is incorporated into the calculations. Above the dashed line, the trajectories for positive surface tension remain faithful to those for zero surface tension. However, below the dashed line, the positive surface tension trajectories all flow into the point (0.0, -1.0). Thus, unlike the zero surface tension dynamics, a smaller initial finger never wins the competition. These results suggest that incorporating an arbitrarily small amount of surface tension in the model can have a dramatic effect on the outcome of finger competition in a Hele-Shaw cell.



λ=1/2 ε=0.01

Burt Tilley

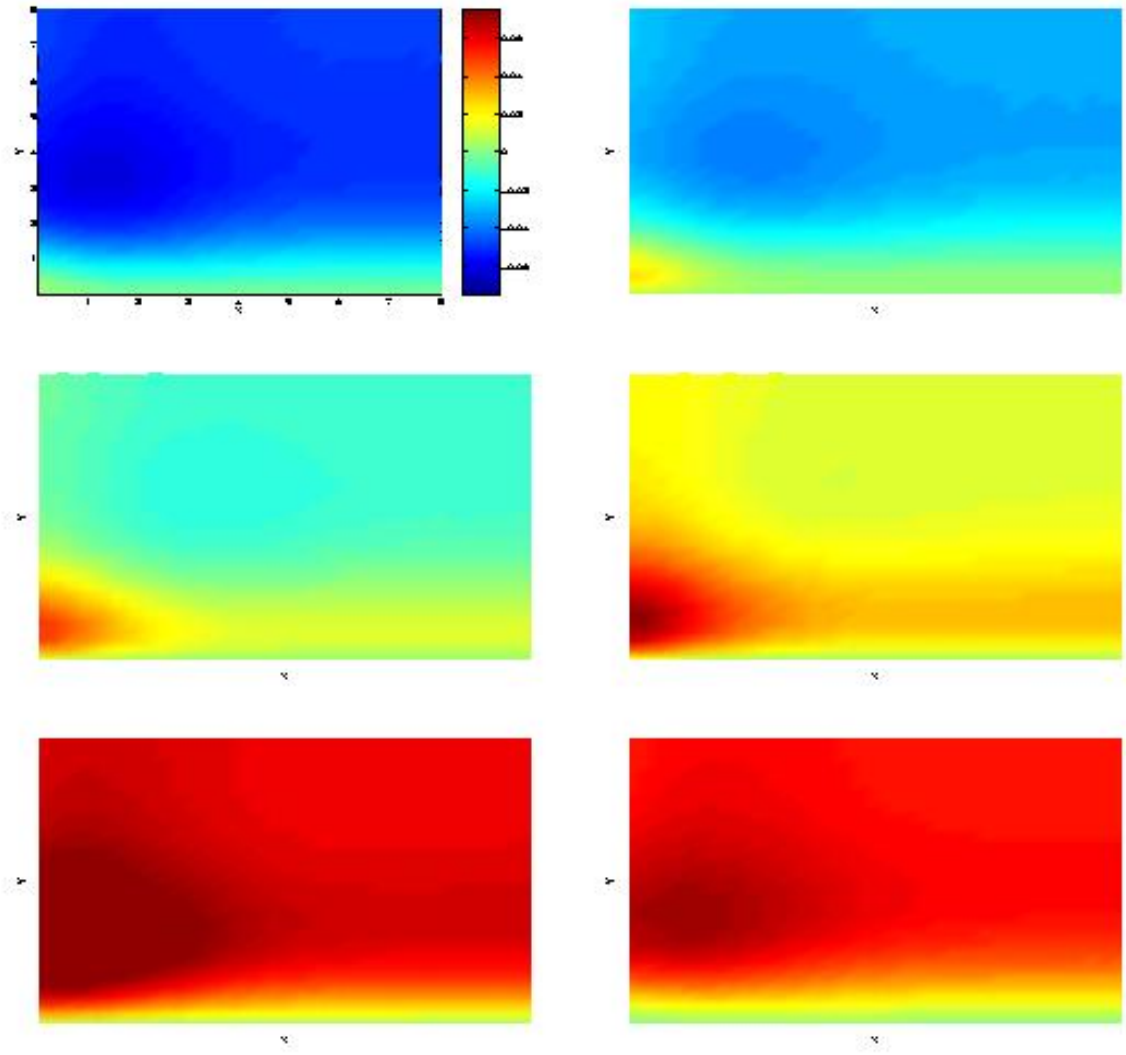


Figure 1: $St = 1, \beta = 1, \varepsilon = 0.1, Pr = 1$, at times $t = 0$ (upper left), $t = \pi/16$ (upper right), $t = \pi/4$ (middle left), $t = 3\pi/16$ (middle right), $t = 3\pi/8$ (lower left), and $t = 15\pi/32$ (lower right).

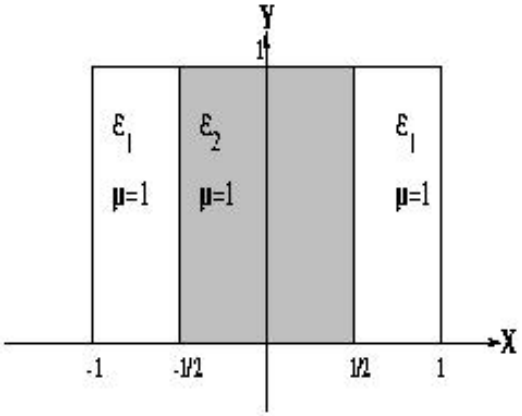
Unsteady Stokes flow near an oscillating, heated contact line

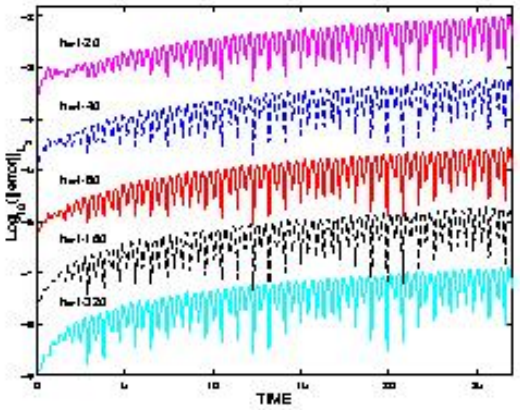
We consider the fluid flow local to a vertical contact line on a heated, oscillating plate. The amplitude of the oscillation and the temperature deviation of the plate from the ambient temperature are assumed to be much smaller than the viscous velocity scale. This flow is then governed by the unsteady Stokes equations coupled to the heat equation in a frame of reference moving with the contact line. For a stationary heated plate, there are three distinct regions of flow that is induced by Marangoni stresses. Two counter-rotating vortical regions are found near the contact line within ten thermal boundary-layer lengths. For an oscillatory, isothermal plate, vortices are generated at the plate during plate reversal and are propagated along the interface. The order-Peclet number correction to the thermal field (one case is shown below) is also found, with a localized heated/cooled region local to the contact line region which is propagated in to the bulk as the plate reverses. We find that if the Biot number is small, then heat transfer from the plate into the bulk is improved. This work was done in collaboration with S. H. Davis and S. G. Bankoff at Northwestern University.

Amir Yefet & Peter G. Petropoulos

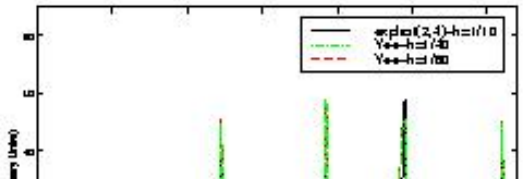
We derived appropriate fourth-order accurate extrapolation and one-sided difference operators in order to complete a model fourth-order scheme near metal boundaries and dielectric interfaces. A stability analysis of the overall scheme showed it is long-time stable. Numerical results verified both the stability analysis, and the scheme's fourth-order convergence rate over complex domains. We have determined that, for a fixed error level, our scheme is computationally cheaper in comparison to the Yee scheme by more than an order of magnitude.

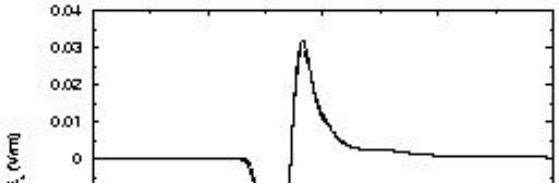
Let a domain which contains air ($\epsilon_1 = 1$) and a lossless dielectric with a relative permittivity of $\epsilon_2 = 4$ be as shown in the Figure below (right). On the left we show the error as a function of time obtained with our new scheme; an inspection of the graph indicates a fourth-order convergence rate.

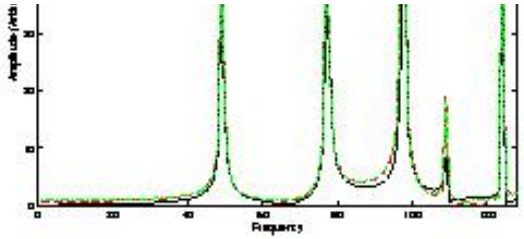


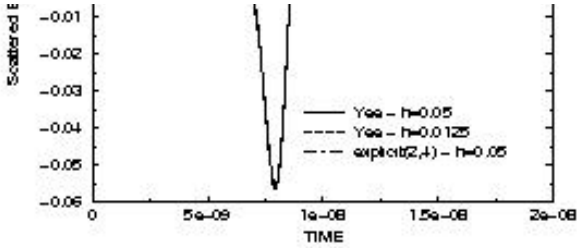


When faced with the problem of computing two-dimensional cavity resonant frequencies, the Figure below (left, for the first five resonances) indicates that using the explicit(2,4) scheme results in a 16−fold savings in memory while requiring only 2/3 more timesteps than the Yee scheme. The Figure on the right confirms a similar computational advantage for a model problem of cylindrical wave scattering by an infinitesimally-thin metal strip (the dashed lines overlap).









C. COLLABORATIVE RESEARCH

John Bechtold:

Flame Dynamics in Near-stoichiometric Mixtures, M. Matalon (Northwestern University)

Hans Chaudhry:

Adaption of Passive Rat Left Ventricle in Diastolic Dysfunction, T. Findley (UMDNJ), A. B. Ritter (UMDNJ) and N. Guzelsu (UMDNJ)

Non-Invasive Light Reflection Technique for Measuring Soft Tissue Stretch, T. Findley (UMDNJ), A. B. Ritter (UMDNJ) and N. Guzelsu (UMDNJ)

Mucus and Puss Secretion by Cof-flator, Steven Kirshblem (Kessler Institute for Rehabilitation)

Anna Georgieva:

Effects of Nonlinearity in Discrete and Continuous Periodic Media, (with Thomas Kriecherbauer, University of Munich) and Stephanos Venakides (Duke University)

Modeling the Impact of Highly Reactive and Soluble Gases on Human Health, (with Paul Schlosser, Chemical Industry Institute of Toxicology)

Time Dependent Breathing Patterns for Rodents and Humans, (withJulia Kimbell, Chemical Industry Institute of Toxicology)

Lou Kondic:

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

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

Hele-Shaw Flow of Non-Newtonian Fluids, M. Shelley (Courant Institute, NYU), P. Palffy-Muhoray (Kent State University), and P. Fast (LLNL)

Cyrill Muratov:

Global variational structure of reaction-diffusion systems of gradient type, G. Medvedev (Princeton University)

Farzan Nadim:

Interaction between fast and slow neuronal oscillations, M.P. Nusbaum (Univ Penn Med Sch), Y. Manor (Ben-Gurion Univ Israel)

Synaptic Dynamics in Oscillatory Networks, Y. Manor (Ben-Gurion Univ Israel)

Peter Petropoulos:

Numerical Dispersion in Numerical Solutions of Electromagnetic Integral Equations, G. Pelekanos (Southern Illinois University)

Bonnie Ray:

Developing and Testing Probabilistic Forecast Models of Drought in the US, Ed Cook (Lamont-Doherty Earth Observatory, Columbia University), Manu Lall (Utah State University), Balaji Rajagopalan (Lamont-Doherty Earth Observatory, Columbia University)

Burt Tilley:

Unsteady Stokes Flow near an oscillatory, heated contact line, S.H. Davis (Department of Engineering Sciences and Applied Mathematics, Northwestern University) and S.G. Bankoff (Department of Chemical Engineering, Northwestern University)

D. CAMS ACADEMIC YEAR RESEARCH PROGRAM FOR GRADUATE STUDENTS

Ph.D.'s Awarded:

Susan Schenk

January 2000 – Advisor: Dr. Lacker

Thesis: **"A Mathematical Model of Wheelchair Racing"**

Juan Gomez

May 2000 – Advisor: Dr. Booty

Thesis: **"A Study of Droplet Burning in the Nearly Adiabatic Limit"**

Peiwen Hou

May 2000 – Advisor: Dr. Luke

Thesis: **"Numerical Analysis of Particle Dynamics in a Falling-ball Viscometer"**

Fu Li

May 2000 – Advisor: Dr. Aubry

Thesis: **"Active Feedback Control of a Wake Flow Via Forced Oscillations Based on a Reduced Model"**

Chengwen Wang

May 2000 – Advisor: Dr. Blackmore

Thesis: **"Multiple Periodic Solutions for Non-autonomous Asymptotically Linear Hamiltonian Systems"**

Report of the Ph.D. Qualifying Exam Committee by Denis Blackmore

During this year we offered Ph.D. Qualifying exams in August, January and May. In August, exams in Analysis, Applied Mathematics, and Linear Algebra/ Numerical Analysis were given. The same three exams were given in January, and in May.

In August, four students took the Analysis exam (two earned an A), one student took and earned an A on the Applied Mathematics exam and four students took and earned A's on the Linear Algebra/Numerical Analysis exam.

In January, one student took and earned an A on the Analysis exam, two students took the Applied Mathematics exam (with none receiving an A) and one student took the Linear Algebra/Numerical Analysis exam (but did not earn an A).

In May, two students took the Analysis exam (one earned an A), two students took the Linear Algebra/Numerical Analysis exam (one earned an A) and two students took and earned an A on the Applied Mathematics exam.

Presentations:

Xiaoqun Ma

Matched Arrival Processing for Efficient Inversion in Underwater Acoustics

Oceans ’99 MTS/IEEE Conference, September 1999, Seattle, Washington

(Conference proceedings, Vol. 3, page 1577-1580)

Co-author: Zoi-Heleni Michalopoulou

Adrienne James

Cell Behaviour as a Dynamic Attractor in the Intracellular Signaling System

Institute of Biomedicine (Biophysics and Biomembrane Group), University of Helsinki, Finland, May 3, 2000

E. CAMS SUMMER RESEARCH PROGRAM FOR GRADUATE STUDENTS

1999:

Following the success of previous CAMS Summer Research programs, a Summer program was also offered for Mathematical Sciences Ph.D. students in 1999. The program started on May 17 and was of three months duration. The faculty in charge of the summer program were Professors Bechtold, Luke, and Papageorgiou. Besides the individual research projects that many of the students are working on, there were two seminars given each week. Of the two weekly seminars one was given by a faculty member on fundamental areas of applied mathematics (the areas covered were fluid dynamics, electromagnetics, wave propagation, optimization problems and mathematical biology). The second weekly seminar was given by a graduate student on the specific research

they are conducting. Each graduate student made a presentation which was followed by informal discussions.

These seminars, besides their intrinsic instructive nature, served as a focal point for lively discussions between faculty and students on current and future research resulting from the various projects. In addition, each student completed a brief scientific report of the work accomplished during the program.

Listed below are details of the weekly seminars.

Faculty Workshops:

Michael Siegel, "Introduction to Fluid Dynamics"

John Bechtold, "Introduction to Combustion"

Burt Tilley, "Problems in Hydrodynamic Stability"

John Tavantzis, "Mathematical Tools in Transportation Problems"

Jonathan Luke and Gregory A. Kriegsmann, "Electromagnetic Waves"

David Stickler and Daljit S. Ahluwalia, "Introduction to Wave Propagation"

Hans R. Chaudhry, "Introduction to Bio-Mechanics"

Farzan Nadim, "Introduction to Mathematical Neuroscience"

Dharam Chopra, "Contributions to Orthogonal Arrays"

Student Seminars:

Xiaoqun Ma, "A Linearization Approach to Source Localization in An Uncertain

Environment"

Stuart Walker, "Single and Multi Mode Cavities"

Fu Li, "Control of Vortex Shedding Behind A Circular Cylinder"

Juan Gomez, "Burke Schumann Diffusion Flames"

Raymond Addabbo, "Stability of Laminar Flames"

Urmi Ghosh-Dastidar, "Correlation Loss Factors in Underwater Signal Processing"

Eliana Antoniou, "Near Stoichiometric Flames"

Knograt Savettaseranee, "Stability of Liquid Jets"

Said Kas-Danouche, "Interfacial Hydrodynamics of Annular Films"

Jerry Chen, "Analysis of Discrete Dynamical System Models for Interacting Species—Competition Model"

Lyudmyla Barannyk, "Symmetry Reducation and Invariant Solutions of Equations of Mathematical Physics"

Adrienne James, "Synoptic Changes"

Stephen Kunec, "The Method of Averaging: Perturbation Techniques for Dynamical Systems"

2000:

As with previous years, a Summer Research Program was offered for the Mathematical Sciences Ph.D. students. The program started on May 17 and lasted for 12 weeks.

The faculty in charge of this summer program were Professors Papageorgiou, Blackmore and Muratov.

In addition to individual research projects, students participated in a summer seminar series. Two seminars were given each week. One of the weekly seminars was given by a faculty member on

fundamental areas of applied mathematics, such as mathematical biology, fluid dynamics, electromagnetics, underwater acoustics, wave propagation, and combustion. The second seminar was given by a graduate student on their specific area of research. Each seminar was followed by an informal discussion. The seminar series helped spark interesting dialogues between students and faculty, as well as supplement each student's growing knowledge of applied mathematics.

In addition to presenting, students were asked to compose a brief, scientific report about the work they accomplished during the summer.

Below is a list of the seminars given during the CAMS Summer Research Program 2000:

Faculty Seminars:

Peter Petropoulos, "Computational Methods for Electromagnetic Wave Propagation

Problems -- Parts 1 and 2"

Denis Blackmore, "The Dynamics of Vortex Ring Interactions"

Victoria Booth, "Hippocampal Place Cells and Neural Code"

Farzan Nadim, "Central Pattern Generation in the Nervous System"

Lou Kondic, "Flow of Thin Films -- Parts 1 and 2"

Dawn A. Lott-Crumpler and Hans Raj Chaudhry, "Biomechanics of Human Skin:

Determining Optimal Pattern of Suturing Wounds -- Finite Element and Analytical

Methods -- Parts 1 and 2"

Gregory A. Kriegsmann, "Problems in Wave Propagation -- Parts 1 and 2"

Michael Siegel, "Moving Boundary Problems in Fluid Mechanics"

Srinivasan Balaji, "Statistical Aspects of Learning Theory: Applications to Control and Neural Networks"

Student Seminars:

Ray Addabbo, "Hydrodynamic and Diffusive Instabilities in Near Stoichiometric Flames"

Xiaoqun Ma, "Estimation of Sound Speed Profile Using a Linear Inversion Model"

Eliana Antoniou, "Dynamics of Near Stoichiometric Flames"

Stuart Walker, "Microwave Heating of a Ceramic Slab"

Knograt Savettaseranee, "Fluid Flow in a Tangential Electric Field"

Adrienne James, "Cell Behavior as a Dynamic Attractor in the Intracellular Signaling System"

Hoa K. Tran, "Transport of Electromagnetic Energy"

Said Kas-Danouche, "Interfacial Hydrodynamics of Annular Films"

Steve Kunec, "The Dynamics of Two Self-inhibiting, Inhibitory Coupled Neurons"

Lyudmyla Barannyk, "Strongly Non-Linear Interfacial Waves with Surface Tension"

Xiaoyun Sun, "Vortex Shedding Control of Two Dimensional Unsteady Flow"

Valery Lukyanov, "On Solving the Helmholtz Equation with Higher Order Boundary Conditions"

Summer course in Scientific Computing for the first-year graduate students

Participants: H. Coskun, C. Epstein, V. Lukyanov, R. Search, T. Segin, M. Sun.

The purpose of this short course is to familiarize the first-year graduate students with the numerical methods of solving partial differential equations and some relevant programming practices. It emphasizes both practical and applied aspects of a model problem. The students solve for the distribution of heat inside an electric circuit module with heat-generating parts as a function of time as the circuit is turned on. The application question is whether the proposed circuit design will overheat or not. To answer this question, the students solve the Poisson

equation describing the distribution of temperature inside the module using finite differences with the successive overrelaxation method or conjugate gradient method, and fast fourier transform. Then they compare the efficiency and convergence of these ietrative methods as applied to

this particular problem. The students also learn how to visualize their results on modern workstations, and how to typeset their reports using LaTeX.

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