Department of Applied Mathematics

University of Colorado
at Boulder

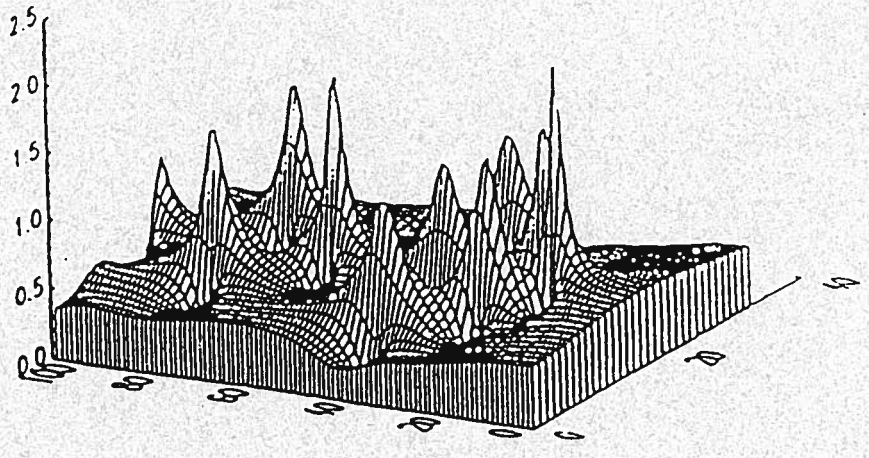
Boulder, Colorado 80309-0526

Annual Report

1996-97

Mark J. Ablowitz, Director

June 30, 1997



PREFACE

From the Chair

The Department of Applied Mathematics (APPM) has a broadly based teaching commitment offering a full range of degrees, BS, MS and PhD, and maintains a strong interdisciplinary component consisting of an extraordinary level of inter-University faculty participation.

Applied Mathematics was awarded departmental status by the Regents of the University in the summer of 1996, and has successfully completed its first year as the Department of Applied Mathematics. This caps seven years of status as an independent unit of Applied Mathematics on the Boulder Campus. We remind the readers of the APPM Annual Reports that there was a Department of Applied Mathematics on the Boulder Campus from 1906-1966. That unit was merged into the Department of Mathematics in 1966. In 1989, an independent unit, the Program in Applied Mathematics, was created.

The Department of Applied Mathematics continues to serve the University, the national and international communities in ways far beyond the measure of its small size of twelve tenure track and three full-time instructors. In 1996-97 the faculty taught 2,998 students, all at a level of calculus and above. This is the largest number of students APPM has ever taught. Enrollment increases have been witnessed at all levels. At the lower division level the faculty are teaching in excess of 100 students/lecture. Graduate enrollment has increased from 40 in 1995-96 to 44 this year. We also note that the number of affiliated faculty has increased to 35. (Affiliated faculty can direct graduate students in an MS or PhD degree.) These are remarkable figures considering the fact that there were no graduate students or affiliated faculty in 1989, when the independent Program in Applied Mathematics began operations.

Research activities by the core faculty are varied and substantial. This includes service on seventeen editorial and advisory boards of journals and periodicals, the publication of 36 articles, the delivery of forty invited lectures and the awarding of $806,300 in external research funding. There were 34 APPM preprints during 1996-97. This brings the total number of articles in the preprint series to 337 since its inception in 1989.

We are pleased to announce that thanks to a substantial anonymous gift, the department is able to recognize one of its outstanding graduates. The 1997 Henrie-James Award went to Eric Phipps. Congratulations Eric!

The undergraduate BS degree has been strengthened by the addition of an Actuarial Sciences option. The undergraduate committee has also developed plans for a Financial Math option which we expect to begin offering in the 1998-99 academic year. In 1996-

any year since the unit was formed. In addition, APPM graduated five MS and PhD students in 1996-97.

APPM is pleased to welcome Keith Julien as an instructor in Applied Mathematics. Keith received his PhD in Applied Mathematics from Churchill College at Cambridge University in 1991. He has spent the past few years working as a post doctoral researcher in JILA (1991-1994) and as a member of the Advanced Study Program at NCAR (1994-1996). Keith's areas of expertise are mathematical and computational fluid dynamics.

We are sad to report that Professor Emeritus John Maybee passed away on Friday, May 2, 1997. Professor Maybee was one of the charter members of the Applied Mathematics Department, and was a leading expert in Matrix Algebra and Discrete Applied Mathematics. He remained active until his death. More than two years into his retirement, Maybee taught a special topics course, "Introduction to Discrete Mathematics", during fall semester 1996 and continued a vigorous research program. John will be missed by all of us.

From the Associate Chair

This year the Department has had many successes. Fourteen students graduated with the BS in Applied Mathematics in May 1997, and another four graduated last summer and fall. Seven students were on the Dean's list with a cumulative grade point average of 3.50 or better. Seven majors graduated with a minor in another field and one other graduated with a double major. Finally, four of our students graduated with distinction (GPA of 3.8 or better) or high distinction (GPA of 3.9 or better). This is one of our best classes yet.

Further, the President of the Applied Mathematics undergraduate chapter of SIAM was successful in getting the resources necessary to purchase three Silicon Graphics O2 workstations. Obtaining these funds was a major accomplishment, and it has provided the Department the opportunity to move in new directions (see below).

Applied Mathematics developed several important initiatives this past year. Our efforts to be more responsive to a changing educational environment has lead us to introduce projects and mathematical software into the lower division class APPM 2360, "Ordinary Differential Equations and Linear Algebra". And while we have not worked out all of the bugs in this effort, the students were positive about this direction of curriculum development.

Based on a positive response from the students and faculty in the Differential Equations course, plans are underway to introduce projects and mathematical software into Calculus III (Multivariable and Vector Calculus). A consequence of these efforts is that faculty from engineering disciplines and the natural sciences will be invited to give lectures in our sophomore applied mathematics courses.

The second ongoing initiative involves working more closely with our colleagues in the biological sciences and especially the Department of Environmental, Population, and Organismic Biology (EPOB). Applied Mathematics believes that this linkage will have longer term benefits for our undergraduate and graduate students. We hope to formalize this interaction by creating an option in Mathematical Biology. This is a very exciting possibility. Let me also mention that several of the faculty are discussing a new mathematically intense option in computer animation and visualization. This and other ideas were generated in the Applied Mathematics Capstone course (APPM 4955) which was run for the first time this year.

1. ROLE AND MISSION

The objectives of the Department in Applied Mathematics at the University of Colorado at Boulder are summarized below:

a) provide undergraduate and graduate students with high quality education and training in applied mathematics and prepare them for careers in industry, laboratories and the academic professions;

b) offer and monitor degree programs leading to a BS, MS and PhD degrees in Applied Mathematics;

c) nourish and maintain a professional environment in which excellence in teaching, learning, scholarship and creativity are of central importance;

d) assure teaching and research expertise in a number of key areas of applied mathematics, including the methodology of applied mathematics, computational mathematics and algorithms, industrial applications, applied probability and statistics.

2. OVERVIEW

A. Undergraduate Education

In 1996-97, the Department in Applied Mathematics had a core of twelve tenure track faculty members as well as three full-time instructors responsible for the teaching and advising of all undergraduate and graduate students taking applied mathematics courses. The Department has a large teaching commitment since most undergraduate engineering majors are required to take four courses in applied mathematics. The Department taught a total of 3,125 undergraduate and graduate students in sixteen undergraduate courses (divided into 120 sections) and nineteen graduate courses. We had 52 undergraduate majors with 18 receiving their baccalaureate degrees. We are proud that 33 made the Engineering Dean's List for academic achievement with grade point averages of 3.5 or better. There are also 22 students pursuing a minor in Applied Mathematics in the College of Arts and Sciences. The 1997 Henrie-James Award went to Eric Phipps. Eric graduated with a 3.98 average!

B. Graduate Education

The graduate student population continues to grow and the graduate program is prospering. In 1996-97, the Department had 44 graduate students represented by seventeen teaching assistantships, nine graduate students on fellowships and traineeships, eleven research assistantships and six providing their own support. The number of

graduate students supported by research grants has increased substantially; this is due in part to the success of our faculty in obtaining research support and to the affiliated faculty program. The Department has 34 affiliated faculty members, each of whom can direct a graduate student towards an MS or PhD in Applied Mathematics. It should be noted that, counter to national trends, we continue to be very successful in recruiting U.S. citizens to study in our graduate program. In 1996-97 80% of the incoming students with support were U.S. citizens from U.S. undergraduate universities. Among all graduate students in 1996-97 eight were foreign graduate students and five more will be starting in the fall. Although we certainly encourage international applications, our success in being able to attract high quality American graduate students continues to be remarkable.

This year twenty students were supported partially or fully by fellowships or grants. The National Science Foundation graduate traineeships supported six students: Anna Bunce, Brian Bloechle, Eric Harker, Chris Higginson, Joe Iwanski and Ken Jarman. Michelle Ghrist received partial support from the traineeship grant, complementing her award from the National Physical Science Consortium. The $555,000 NSF traineeship grant provides full support for six predoctoral students over a five-year period. The Department is truly grateful for the efforts of Jim Meiss in having the foresight and investing so much effort to procure this prestigious award. In addition, there were two students who are supported by DOD AASERT Awards: Scott Mock (AFOSR, Prof. Ablowitz) and David Trubatch (ONR, Prof. Ablowitz). Nicholas Coult was in his last year of support on a University of Colorado Chancellor's Fellowship; Christina Perez continues to receive an NSF Minority Graduate Fellowship. An additional nine students were supported by faculty or affiliated faculty grants (AFOSR, DARPA, DOE, and NSF).

C. Enrollment Statistics

Enrollment in the courses offered by the Department continues at extremely high levels. It is particularly noteworthy given the faculty's small size that the Department teaches so many students. The statistics over the past few years are as follows:

Year	Total enrollment in courses	Applied Mathematics graduate students	Applied Mathematics undergraduate majors
1990-91	2562	17	45
1991-92	2781	27	50
1992-93	2797	28	47
1993-94	2809	33	47
1994-95	2670	39	51
1995-96	2647/**2829***	40	54
1996-97	2787/**2998***	44	52

* The totals in bold include the Calculus I & II Work Study groups.

In 1994-95 we observed a small decrease in enrollment in our lower division courses due to smaller enrollment in Engineering. Enrollment in our upper division and graduate courses has continued to increase. Enrollment overall increased in 1995-96 and was up substantially in 1996-97. With projected increases in undergraduate enrollment we foresee significant enrollment increases in applied mathematics courses.

D. Awards

We offer our sincere congratulations to John Williamson who was honored with an award from the International Genetic Epidemiology Society for the "Best Article of the Year" in the journal of the society. This was presented at the IGES meeting in Rio de Janeiro in August 1996. Anne Dougherty received the Minority Engineering Program (MEP) Faculty Appreciation Award, 1995-96. The 1997 Henrie-James Award, which is presented to the department's most outstanding graduate who is continuing on to graduate school, went to Eric Phipps.

E. Graduates

We would like to congratulate our students who graduated this past year with a degree in Applied Mathematics. They are:

PhD degree

December 1996: Robert Cramer, Barry Lee, Alejandro Spina.

Master's degree

August 1996: Scott Mock.

May 1997: James Arnow.

Bachelor's degree

August 1996: Brad Puzie.

December 1996: Jennifer Fox, Rupa Patel, Mark Sitton.

May 1997: Julie Bartsch, Adam Bechtel, Joshua Bell, Marcio Carvalho (graduated with high distinction), Rebecca Dalrymple (graduated with distinction), Scott Gilpin, Ann Hallstrom, Susanne Keck, Amy Keyser (graduated with distinction), John Lawrence, David Lewis (graduated with distinction), Eric Phipps (graduated with high distinction, Henrie-James Award winner), Damon Tohill, David Wieland.

F. Research

The research activities of the core faculty in the Department are varied. They include nonlinear dynamics and waves; chaos theory; solitons and integrable nonlinear evolution equations; nonlinear optics; inverse problems; analysis of nonlinear equations arising in physical phenomena; computational mathematics including wavelet analysis;

multigrid, iterative methods and computational fluid dynamics; matrix algebra; and applied probability and statistics. Our affiliated faculty are rostered in a wide range of departments and nearby institutions, including Aerospace Engineering; Astrophysical, Planetary, and Atmospheric Sciences; Chemistry and Biochemistry; Civil Engineering; Colorado School of Mines; Computer Science; Electrical and Computer Engineering; Geological Sciences; Mathematics; Mechanical Engineering; CIRES (Cooperative Institute for Research in Environmental Sciences); INSTAAR (Institute for Arctic and Alpine Research); and the Graduate School of Business.

This report provides data which show that the faculty in the Department are extremely active in their research and scholarly work (a list of publications, invited lectures and Department Preprints are included at the end of this report). However, another very important aspect of the faculty's role in the national and international scholarly effort in applied mathematics is service as editors and advisory board members of archival journals and textbook series. In fact, during 1996-97 the faculty in the Department served in seventeen such capacities on fourteen journals/periodicals comprised of:

Applied and Computational Harmonic Analysis (Beylkin)
Cambridge University Press Texts in Applied Mathematics (Ablowitz)
Chaos (Ablowitz)
Communications on Applied Nonlinear Analysis (Bebernes, Easton)
Electronic Transactions in Numerical Analysis (Manteuffel)
Inverse Problems (Ablowitz)
Journal of Engineering Mathematics (Ablowitz)
Journal of Numerical Linear Algebra and Applications (Manteuffel)
Physica D (Meiss)
Rocky Mountain Journal of Mathematics (Bebernes)
Springer-Verlag Series in Integrable Systems and Solitons, World Scientific (Ablowitz)
SIAM Journal of Numerical Analysis (Manteuffel, Beylkin, McCormick)
SIAM Journal of Scientific Computing (McCormick)
Studies in Applied Mathematics (Ablowitz).

In addition, Jim Curry is a member of the board of governors of The Geometry Center at the University of Minnesota and Tom Manteuffel is vice president of the Society of Industrial and Applied Mathematics (SIAM).

External research grant/contract support continues to be strong. The Office of Contracts and Grants of the University documents external support for 1995-1996 for the Department in Applied Mathematics to be $806,300. As mentioned above, this includes significant grant support for our graduate students.

G. Conferences

The Eighth Copper Mountain Conference on Multigrid Methods was held April 6-11, 1997, at Copper Mountain, Colorado. The conference was organized by Tom Manteuffel and Steve McCormick from the Department of Applied Mathematics and Front Range Scientific Computations, Inc., in cooperation with the Society of Industrial and Applied Mathematics and supported by DOE, the GMD, IBM, and NSF. Attendance for this meeting was approximately 100.

H. Remarks

A warm and sincere thanks to our fine staff: Stu Naegele (Department Administrator); Lynn Jackson (Student Services Coordinator), who left us this June after one year with the Department; Margy Lanham (Professional Research Assistant); Meg Rowland (Faculty Services Coordinator) who left in December; and Lynn Randolph who replaced Meg in January. Our staff members work very hard and certainly go the "extra mile" for the Department. Without them the Department could not function. The faculty of the Department conveys its sincerest gratitude.

2. FACULTY, RESEARCH ASSOCIATES AND STAFF

A. Core Faculty and Long Term Visitors

Mark J. Ablowitz, Director, Professor; PhD, Massachusetts Institute of Technology. Partial Differential Equations, Solitons, Nonlinear Waves.

Jerrold Bebernes, Professor; PhD, University of Nebraska. Differential Equations, Reaction Diffusion Systems, Combustion Theory, Analysis.

Gregory Beylkin, Professor; PhD, New York University. Computational Methods, Wavelets, Geophysical Inverse Scattering.

Gino Biondini, Research Associate; PhD, Universita de Perugia, Italy, Nonlinear Waves.

Robert Cramer, Research Associate; PhD University of Colorado at Boulder. Numerical Analysis, Wavelets, Potential Theory.

James H. Curry, Professor; PhD, University of California at Berkeley. Dynamical Systems, Numerical Methods, Nonlinear Equations.

David Dean, Research Associate; PhD University of Colorado at Denver. Computational Math, Multigrid Analysis

Anne Dougherty, Instructor; PhD, University of Wisconsin, Madison. Applied Probability, Stochastic Processes.

Tobin Driscoll, NSF Postdoctoral Fellow; PhD, Cornell University. Numerical Analysis: Particularly, domain Decomposition and Computational Electrodynamics.

Holger Dullin, PhD, University of Bremen, Germany, May 1997-May 1998.

Robert Easton, Professor; PhD, University of Wisconsin. Dynamical Systems, Hamiltonian Mechanics.

Bengt Fornberg, Professor; PhD, Uppsala University, Uppsala, Sweden. Numerical Analysis, Computational Fluid Dynamics, Concurrent Computing.

Rod Halburd, Research Associate; PhD to be awarded, University of New South Wales, Australia. Integrable Systems.

Scott Herod, Instructor, PhD, University of Colorado. Symmetries and Differential Equations.

Keith Julien, Instructor, PhD, Cambridge University. Mathematical and Computational Fluid Dynamics.

Sang Dong Kim, Dept. of Mathematics, PhD, University of Wisconsin at Madison. Kyungpook National University, Korea. Computational Math.

Congming Li, Assistant Professor; PhD, New York University. Nonlinear Differential Equations.

Hector Lomeli, Instructor; PhD, University of Minnesota. Dynamical Systems.

John Maybee, Professor Emeritus, Deceased, April 1997; PhD, University of Minnesota. Applied Combinatorics and Matrix Analysis.

Tom Manteuffel, Professor; PhD, University of Illinois, Urbana. Computational Math; Numerical Linear Algebra, Iterative Mathematics, Numerical Solution of PDE's.

Junta Matsukidaira, Research Associate; PhD, University of Tokyo. Nonlinear Waves, Integrable Systems, Discrete Dynamical Equations.

Steve McCormick, Professor; PhD, University of Southern California. Computational Math, Numerical Partial Differential Equations, Multigrid Methods, Parallel Computation, Computational Fluids, Tomography, Electromagnetics.

James D. Meiss, Professor; PhD, University of California at Berkeley. Dynamical Systems, Hamiltonian Mechanics, Plasma Physics.

Lucas Monzón, Research Associate; PhD, Yale University. Harmonic Analysis, Wavelets.

J. Adam Norris, Part-time Instructor; PhD, University of Colorado, Boulder. Phase Change Kinetics, Perturbation Methods, Numerical Methods.

Harvey Segur, Professor; PhD, University of California at Berkeley. Nonlinear Waves, Fluid Dynamics, Asymptotic Methods.

Makoto Umeki, Research Associate; PhD, University of Tokyo. Fluid Dynamics, Nonlinear Physics.

John Williamson, Professor; PhD, University of Minnesota. Statistical Methods in Genetics, Applied Probability, Mathematical Statistics.

B. Affiliated Faculty, Graduate Department

Norm Bleistein (Mathematics, Colorado School of Mines), Direct & Inverse Scattering, Asymptotic Methods, Wave Phenomena

William Blumen (Astrophysical, Planetary, and Atmospheric Sciences), Geophysical Fluid Dynamics in Atmospheric Science

Elizabeth Bradley (Computer Science), Scientific Computation, Artificial Intelligence, Nonlinear Dynamics

Richard Byrd (Computer Science), Numerical Computation, Optimization Algorithms

John Cary (Astrophysical, Planetary, and Atmospheric Sciences; Physics), Nonlinear Dynamics, Plasma Physics, Accelerator and Space Physics

Senarath deAlwis (Physics), Theoretical Physics, String Theory, Quantum Gravity

Thomas DeGrand (Physics), Numerical Methods for Quantum Field Theory

Fred Glover (Graduate School of Business), Large-scale Systems, Applied Artificial Intelligence, Optimization Models

Martin Goldman (Astrophysical, Planetary, and Atmospheric Sciences; Physics), Plasma Physics, Nonlinear Waves, Turbulence

Vijay Gupta (Geological Sciences), Hydrology, Stochastic Processes, Fluid Dynamics

Ute Christina Herzfeld (INSTAAR, Geomathematics), Geostatistical Analysis of Remote Sensing Data, Applications in Glaciology, Marine Geophysics and Global Change Research

Tissa Illangasekare (Civil Engineering), Mathematical Modeling of Flow and Transport in Porous and Fractured Media, Computational Methods, Numerical Modeling

Elizabeth Jessup (Computer Science), Numerical Computation, Parallel Computation

David Kassoy (Mechanical Engineering), Fluid Dynamics, Combustion Theory, Thermal Science

James Kelly (College of Business), Heuristic Search, Optimization, Artificial Intelligence

Manual Laguna (College of Business), Exact and Heuristic Methods for Combinatorial Optimization Problems, Network Flow Programming, Applied Artificial Intelligence

Michael Lightner (Electrical Engineering), VLSI, Discrete Mathematics, Graph Theory

Shankar Mahalingam (Mechanical Engineering) Turbulent Combustion, Direct Simulations

Oliver McBryan (Computer Science), Parallel Computation, Graphics and Visualization, Computational Fluid Dynamics

Andrew Moore (Astrophysical, Planetary, and Atmospheric Sciences), Ocean Data Assimilation, Coastal Ocean Modeling, Stability Analysis of Oceanic Flows, Climate Modeling

Lev Ostrovsky (CIRES/NOAA Environmental Technology Laboratory), Nonlinear waves, Fluid Dynamics, Oceanography, Acoustics

Harihar Rajaram (Civil Engineering), Fluid Flow, Transpost Phenomena, Reactive Processes in Natural Porous Media

John Rundle (Geological Sciences; Cooperative Institute for Research in Environmental Sciences), Statistical Mechanics Applied to Earth Sciences, Complex Systems, Simulations of Nonlinear Systems, Earthquakes, Transport Processes in the Geological Sciences

Robert Sani (Chemical Engineering), Computational Fluid Dynamics, Free and Moving Boundary Problems, Stability of Systems

Duane Sather (Mathematics), Partial Differential Equations, Fluid Mechanics

Robert Schnabel (Computer Science), Numerical Methods for Optimization, Nonlinear Equations, Parallel Scientific Computation

Richard Seebass (Aerospace Engineering), Aerodynamics, Gas Dynamics, Supersonic and Hypersonic Flows

J. Michael Shull (Astrophysical, Planetary, and Atmospheric Sciences), Theoretical Astrophysics

Rex Skodje (Chemistry and Biochemistry; Joint Institute for Laboratory Astrophysics), Nonlinear Dynamics, Quantum Chaos, Molecular Dynamics

Gary Stormo (Biology), Molecular Structures and Patterns, Computer Sequence Analysis, Splicing Algorithms

Renjeng Su (Electrical Engineering), Nonlinear Dynamics Modeling, Control, Robotics

Juri Toomre (Astrophysical, Planetary, and Atmospheric Sciences; Joint Institute for Laboratory Astrophysics), Astrophysics, Mathematical Modeling, Numerical Simulation

Patrick Weidman (Mechanical Engineering), Hydrodynamic stability, solitary waves and their interaction, counterrotating vortex rings, Stokes flow on dendrite models, similarity flows in natural convection, fluid sloshing in freely suspended containers

Jeffrey B. Weiss (Astrophysical, Planetary, and Atmospheric Sciences; Program in Atmospheric and Oceanic Sciences), Geophysical Fluid Mechanics, Turbulence, and Climate Predictability

Ellen Zweibel (Astrophysical, Planetary, and Atmospheric Sciences), Plasma Physics, Astrophysics

C. Short Term Visitors, 1996-97

Stanley Alama, MacMaster University, Canada, April 1997

Rafael Bru, Universidad Politecnica, Valencia, Spain, June - August, 1997

Sarbarish Chakravarty, University of New South Wales, Sydney, Australia, December 1996 - February, 1997

Wenxiong Chen, Southwest Missouri State University, February 1997

Silvana Delillo, Universita de Perugia, Italy, Oct. 4 - Nov. 9 and May 3 - May 17, 1997

Andrew Lacey, Heriot-Watt University, Edinburgh, Scotland, July 1-10, 1996

Moshe Israeli, Technion, Haifa, Israel, February 1997

Chang-Ock Lee, Dept. of Mathematics, Inha University, Korea, January 26 - February 25, 1997 and July 23-August 2, 1997

Kathryn Lenz, Dept. of Mathematics & Statistics, University of Minnesota at Duluth, February 1 - April 30, 1997

Dick McGehee, School of Mathematics, University of Minnesota, Minneapolis, June 1997

Bruce Peckham, Dept. of Mathematics & Statistics, University of Minnesota at Duluth, February 1 - April 30, 1997

Naoki Saito, Schlumberger-Doll Research, January 1997

Constance Schober, Dept. of Mathematics, Old Dominion University, Norfolk, Virginia, June 1997

Gerhard Starke, University of Karlsruhe, Germany, March 1997

Irina Talanina, Dept. of Optical Science, University of Arizona, May 29-June 2, 1997

Javier Villarroel, University of Salamanca, Spain, August - September 1996

Lev Vozovoi, Technion, IIT, Haifa, Israel, July - September 1996

D. Staff

Stuart Naegele, Department Administrator

Lynn Jackson (to June 1997), Student Services Coordinator

Margy Lanham, Professional Research Assistant

Meg Rowland (to December 1996), Faculty Services Coordinator

Lynn Randolph (from January 1997), Faculty Services Coordinator

3. COLLOQUIA, SEMINARS, SYMPOSIA, 1996-97

A. Applied Mathematics Colloquium Schedule, 1996-97

Our Applied Mathematics Colloquium series continued this year. The colloquia were held Friday afternoons during the academic year at 3:00 p.m., with coffee and tea preceding at 2:30 p.m. in the APPM conference room, ECOT 226.

Paul Fife, Department of Mathematics, University of Utah at Salt Lake City, September 6, 1996
"The Modeling and Analysis of Nonlocal Interactions in Material Science"

Tarek P. Mathew, University of Wyoming, September 13, 1996
"Uniform Convergence of the Schwarz Alternating Method for Solving Some Singularly Perturbed Elliptic Equations with Applications to Parabolic Equations"

Gary Meisters, University of Nebraska, September 20, 1996
"Keller's Jacobian Conjecture Finishes the Markus-Yamabe Conjecture"

R.G. Roble, High Altitude Observatory, NCAR, September 27, 1996
"Modeling the Global Circulation, Temperature and Compositional Structure of the Upper Atmosphere and Ionosphere Using the NCAR TIME-GCM"

Marek Fila, Department of Mathematics, Iowa State University, October 4, 1996
"Boundedness of Global Solutions of Parabolic Equations"

Sergey Bolotin, Moscow State University and University of Wisconsin at Madison, October 18, 1996
"Variational Criteria for Chaotic Behavior of Hamiltonian Systems"

Junping Wang, Department of Mathematics, University of Wyoming and Texas A&M University, October 25, 1996
"On the Mathematics of Option Pricing Problems"

Michael I. Weinstein, Department of Mathematics, University of Michigan, November 1, 1996
"Nonlinear Resonances and Radiation Damping in Conservative Systems"

Mariana Haragus-Courcelle, Mathematisches Institut A, Universität Stuttgart, Germany, November 8, 1996
"Two-Dimensional Solutions of Nonlinear Elliptic Equations"

Thomas A. Manteuffel, Department of Applied Mathematics, University of Colorado at Boulder, November 15, 1996
"First-Order Systems Least Squares (FOSLS): A methodology for solving systems of PDEs"

Rodolfo Ragionieri, University of Florence and University of Colorado Visiting Scholar, November 22, 1996
"Singularities of Solutions to Partial Differential Equations"

Nick Trefethen, Cornell University, December 6, 1996
"Computational Mathematics in the 21st Century: Finite vs. Infinite Computations"

Stan Wagon, Macalester College, January 24, 1997
"Some New Ideas in the Visualization of Differential Equations"

Naoki Saito, Schlumberger-Doll Research, January 31, 1997
"Adapted Feature Extraction and Their Applications"

Randall J. LeVeque, University of Washington, February 7, 1997
"Nonlinear Conservation Laws and Shock-Capturing Numerical Methods"

Dmitry Treschev, Moscow State University, February 14, 1997
"Dynamics in Stochastic Layers of Area-Preserving Maps"

Bruce B. Peckham, Department of Mathematics and Statistics, University of Minnesota at Duluth, February 21, 1997
"Shape Memory Polycrystals II: Assessing the consequences of energy minimization"

Daniel Chan, CFD Technology Center, Boeing North American, February 28, 1997
"A Least-Squares Spectral Element Method for Predicting Fluid Dynamic Phenomena and Acoustic Wave Propagation"

Max Gunzburger, Department of Mathematics, Iowa State University, March 7, 1997
"Analysis and Approximation of Flow Control Problems"

John Guckenheimer, Center for Applied Mathematics, Cornell University, March 14, 1997
"Natural Rhythms: Multiple Time Scales in Neurons"

Gerhard Starke, University of Karlsruhe, Germany, March 21, 1997
"Multilevel Methods for Convection-Diffusion-Problems"

Kathryn Lenz, Department of Mathematics and Statistics, University of Minnesota at Duluth, April 4, 1997
"Introduction to Structured Singular Values and an Algebraic Approach to Finding Them"

Stanley Alama, MacMaster University, Canada, April 11, 1997
"Transition Layer Solitons for a Reaction-Diffusion System with Multiple-Well Potential"

Victor H. Barocas, Dept. of Chemical Engineering, University of Colorado at Boulder, April 25, 1997
"Transient Simulation of Compressible Viscoelastic Fluid Gels"

B. Seminars in Applied Mathematics, 1996-97

The Department maintained the Applied Mathematics Seminar, a weekly seminar series on Thursday afternoons at 4:00 p.m. Each Thursday we used the Physics seminar room G-031 and had coffee and tea on the 11th floor of Duane Physics. We are grateful to the Physics Department for allowing us to use their facilities. A list of visiting speakers and the titles of their talks follows:

Javier Villarroel, University of Salamanca, Spain, September 12, 1996
"The Discrete Spectrum of the Schrödinger Operator and KP Solutions"

Tobin Driscoll, Department of Applied Mathematics, University of Colorado at Boulder, September 26, 1996
"Schwarz-Christoffel Conformal Mapping in MATLAB"

Tobin Driscoll, Department of Applied Mathematics, University of Colorado at Boulder, October 3, 1996
"Numerical Conformal Mapping Using Cross-Ratios and Delaunay Triangulation"

Junta Matsukidaira, Department of Applied Mathematics and Informatics, Ryukoku University, Japan, October 17, 1996
"From Soliton Equations to Integrable Cellular Automata through a Limiting Procedure"

Radha Balakrishnan, The Institute of Mathematical Sciences, Madras, India, October 24, 1996
"Nonlinearity and Geometry: Some Applications in Physics"

Silvana De Lillo, Departimento di Fisica, Universita de Perugia, Italy, November 7, 1996
"On Integrable Stochastic Volterra Lattice"

Bernard Deconinck, Department of Applied Mathematics, University of Colorado at Boulder, November 14, 1996
"A Constructive Test for Integrability of Lattice Systems"

John Rundle, Departments of Geological Sciences and Physics, CIRES & Colorado Center for Chaos and Complexity, University of Colorado at Boulder, November 21, 1996
"Metastability and Nucleation in Models for Earthquakes and Other Nonequilibrium Driven Threshold Systems"

Nick Trefethen, Cornell University, December, 1996
"Potential Theory, Polynomial Approximation, and Matrix Iterations"

Thomas A. DeGrand, Physics Department, University of Colorado at Boulder, January 23, 1997
"Fixed Point Actions for Lattice Quantum Field Theories"

Carl E. Patton, Department of Physics, Colorado State University, January 30, 1997
"Microwave Solitons in Magnetic Films - Soliton Numbers, Soliton Decay, Soliton Energies, Soliton Velocities, and Soliton Trains"

Andrew Hamilton, JILA, University of Colorado at Boulder, February 6, 1997
"What is the best way to measure cosmological power spectra?"

Igor Mel'nikov, General Physics Institute, the Russian Academy of Sciences, and Department of General Physics, Moscow Institute of Physics and Technology, February 13, 1997
"Non-Envelope Approach to an Optical Bullet Flight"

Jointly sponsored with Colorado Center for Chaos and Complexity:
Cécile Penland, Cooperative Institute for Research in Environmental Science, University of Colorado at Boulder, February 20, 1997
"Stochasticity, chaos, and an application to El Niño"

Steve Blair, Optoelectronic Computing Systems Center, Dept. of Electrical and Computer Engineering, University of Colorado at Boulder, February 27, 1997
"Spatial and Spatio-Temporal Solitons for Optical Logic and Switching"

Steve Tobias, JILA, University of Colorado at Boulder, March 6, 1997
"Convective and Absolute Instabilities of Fluid Flows in Finite Geometry--From Sunspots to Spirals"

Jointly sponsored with Colorado Center for Chaos and Complexity:
Jay Palmer, NOAA Environmental Technology Laboratory, March 13, 1997
"Remodeling Atmospheric Turbulence with Neural Networks"

Alex Zozulya, JILA, University of Colorado at Boulder, March 20, 1997
"Optical Vortices in Anisotropic Nonlinear Media"

Andrew Moore, CIRES/PAOS/APAS, University of Colorado at Boulder, April 3, 1997
"Stochastic Forcing of Tropical Interannual Variability: A Paradigm for El Niño/Southern Oscillation?"

Keith Julien, Dept. of Applied Mathematics, University of Colorado at Boulder, April 10, 1997
"Rapidly rotating thermal convection"

Jointly sponsored with Colorado Center for Chaos and Complexity: April 17, 1997 -
Henry Hermes, Dept. of Mathematics, University of Colorado at Boulder
"Control of Cardiac Arrhythmias"
Anne Nolin, CIRES, University of Colorado at Boulder
"Detecting Oscillations in the Recent Climate Record of Greenland"
Gary Stormo, Dept. of MCD Biology, University of Colorado at Boulder
"Genetic Regulatory Networks"
Randall Tagg, Dept. of Physics, University of Colorado at Denver
"Complexity for all ages: research problems in complex systems involving graduate, undergraduate and even high school students."

Jointly sponsored with Colorado Center for Chaos and Complexity:
Robin Gutell, Dept. of Chemistry, University of Colorado at Boulder, May 1, 1997
"Folding RNA Molecules"

C. University of Colorado, Denver/University of Colorado, Boulder Joint Seminars in Computational Mathematics, 1996-97

The Joint CU Denver-CU Boulder Computational Math Seminar continued the expanded form of last year, with the regular lecture on Tuesdays at 12:00 preceded by three hours of open discussion, with the location alternating between Denver and Boulder. There were typically 20 or more faculty, students, and visitors from the two campuses attending the open discussions and regular lectures. A list of speakers and the titles of their talks follows:

Sang Dong Kim, Dept. of Mathematics, Kyungpook National University, September 10, 1996 (in Boulder)
"Finite difference preconditioning cubic spline collocation method of elliptic equations"

Chichia Chiu, Michigan State University, September 24, 1996 (in Denver)
"Models and Computer Simulations of Bacterial Growth and Chemotaxis"

Lynn Bennethum, Department of Mathematics, University of Colorado at Denver, October 15, 1996 (in Denver)
"Exploiting the Entropy Inequality to Obtain Constitutive Relations -- The Navier-Stokes Equation"

Harihar Rajaram, Dept. of Civil & Environmental Engineering, University of Colorado at Boulder, November 5, 1996 (in Boulder)
"Some Issues in Transport Through Heterogeneous Porous Medi"

J.E. Dendy, Jr., Los Alamos National Laboratory, Los Alamos, NM and Hamdi Tchelepi, Chevron Oil Field Research Co., La Habra, CA, December 3, 1996 (in Boulder)
"Multigrid Applied to Implicit Well Problems"

Rebecca Tyson, February 4, 1997 (in Boulder)
"Fractional Step Methods Applied to a Chemotaxis Model"

Andrew Knyazev, February 18, 1997 (in Boulder)
"Linear elasticity for mathematicians"

Xiao-Chan Cai, Computer Science Dept., University of Colorado at Boulder, February 25, 1997 (in Boulder)
"Parallel Schwarz Methods and Their Applications in Nonlinear and Unsteady Compressible Flow Simulations"

Stephen Thomas, NCAR, Mesocale and Microscale Meteorology Division, Boulder, March 4, 1997 (in Boulder)
"Krylov methods and preconditioners for the time integration of the nonhydrostatic anelastic equations of atmospheric flow in general curvilinear coordinates"

Jeffrey S. Scroggs, Dept. of Mathematics, North Carolina State University, March 11, 1997 (in Boulder)
"A semi-implicit semi-Lagrangian global circulation model."

Kathryn Lenz, Department of Mathematics and Statistics, University of Minnesota at Duluth, April 1, 1997 (in Boulder)
"Growth Simulation of Juvenile Poplar Using ECOPHYS"

D. Special Seminars, 1996-97

We had several special seminars during the year.

The weekly Dynamical Systems seminar is a research working group led by James Meiss and Robert Easton. In the fall the group studied a number of research papers in topics such as ecological modeling, Arnold diffusion, noninvertible maps, and the modeling of the remarkable "levitron"--a top that levitates in a static magnetic field. In the spring we hosted several visitors including Sir Michael Berry (who gave a wonderful lecture on the levitron), Bruce Peckham and Holger Dullin. In addition, seminars from local students and faculty were given by Mark Werner, Lora Billings, David Sterling, Robert Easton, Hector Lomeli, and Joe Iwanski.

The following seminars were sponsored by the SIAM undergraduate chapter:

Jeremy Zucker, Dept. of Applied Mathematics, University of Colorado at Boulder, Oct. 17, 1996, "Advances in Morphogenesis: From Turing to Gray-Scott "

Jenny Fox, Dept. of Applied Mathematics, University of Colorado at Boulder, Nov. 7, 1996, "Mathematics Applied to Atmospheric Science: Modeling of Cloud Dynamics and Mircophysical Proccesses Governing Precipitation"

Rupa Patel, Dept. of Applied Mathematics, University of Colorado at Boulder, Nov. 21, 1996, "Singular Value Decomposition and the KP Equation"

Eric Phipps, Dept. of Applied Mathematics, University of Colorado at Boulder, March 12, 1997, "Two Examples of Noninvertible Maps that derive from Newton's Method"

Adam Bechtel, Danielle Bundy, Chris Hall, Eric Phipps and Jeremy Zucker, Dept. of Applied Mathematics, University of Colorado at Boulder, April 29, 1997, Two Presentations by the Mathematical Modeling Contest Participants

Casey Boyd, Dept. of Computer Science, University of Colorado at Boulder, October 30, 1996, "Virtual Reality"

Dr. Susan Solomon, Aeronomy Laboratory, NOAA, Boulder, Colorado, April 3, 1997 "Ozone Depletion at the Ends of the Earth and Points in Between"

Dr. Hector Lomeli, Dept. of Applied Mathematics, University of Colorado at Boulder, April 17, 1997, "The Mathematics of Pool"

4. UNDERGRADUATE AND GRADUATE COMMITTEES

A. Undergraduate Committee. John Williamson, Chair

The members of the Undergraduate Committee were Jim Curry (ex officio), Tom Manteuffel, Jim Meiss, and John Williamson (chair). Anne Dougherty was Faculty Advisor to the Applied Math undergraduate chapter of SIAM.

The Department in Applied Mathematics had 52 undergraduate majors this year. During the academic year 33 of our majors were on the Dean's list with a grade point average of 3.5 or better during either the fall or spring semester. Eric Phipps won the 1997 Henrie-James Award as the outstanding applied mathematics major who is going on to graduate school. Eighteen students graduated this year with bachelor of science degrees in Applied Mathematics. Nine of these students graduated with a cumulative grade point average of 3.5 or better. Six majors graduated with at least a minor in another field and three others graduated with double majors. Finally, four of our students graduated with distinction (GPA of 3.8 or better) or high distinction (GPA of 3.9 or better).

The minor in Applied Mathematics, available to students in the College of Arts and Sciences or in Engineering, continues to grow. There are now 23 students who are pursuing a minor in Applied Mathematics or who have graduated with the minor during the past year.

The undergraduate student chapter of SIAM (the Society for Industrial and Applied Mathematics) continues to be very active. There are over twenty members in the chapter. Events this past year included meetings, technical presentations by invited speakers and mentor lunches. In addition, the Undergraduate Applied Math Seminar was also started. This seminar series provides a forum for undergraduate applied math majors to present their own research or projects to their peers. We were pleased that during 1996-97, there were five presentations on a wide range of topics. SIAM also hosted a presentation on ozone depletion by Susan Solomon, an internationally known researcher in this area. Officers for 1996-97 were Joe Pearse, President; Cris Dozier, Vice President; Danielle Bundy, Treasurer; and Jenny Fox, Secretary. For the 1997-98 academic year, Joe Pearse will continue as President, Cris Dozier as Vice President and Mike Rempe will be Secretary/Treasurer.

This past February, five students, under the direction of Anne Dougherty and Bengt Fornberg, (with support from the undergraduate SIAM chapter), participated in the four-day Mathematical Modeling contest sponsored by COMAP. The contest drew 409 entries in all, 271 from the US, 107 from the People's Republic of China, and 31 from other countries. The work of both our teams:

- Danielle Bundy and Christopher J. Hall
- Adam Bechtel, Eric Phipps, and Jeremy Zucker

was judged *Meritorious* (in the top 15% of competing teams).

B. Graduate Committee. Steve McCormick, Chair

The Graduate Committee consists of Bengt Fornberg, Congming Li, Jim Meiss, and Steve McCormick (chair).

The main business of the committee is to advise the current graduate students, process graduate applications, decide upon admission to the graduate program and administer the preliminary exams. Preliminary exams are given twice each year, in four areas: Applied Analysis, Computational Analysis, Partial Differential Equations and Probability/Statistics.

The Department had 44 graduate students during 1996-97, of whom fourteen began in the fall of 1996. In the past year, three students have received PhDs and two students have received MS degrees. For the fall semester of 1996, there were 59 applicants, of whom nine were awarded teaching assistantships (average GPA 3.60).

The number of (funded) teaching assistantships has remained at about 17-19 during the past five years. Currently a majority of our graduate students are supported on research contracts. The percentage of American students has fluctuated between 80%-90%, while the percentage of women students fluctuated between 21%-41%. Minority student representation in the Department is at 14% for 1996-97.

One measure of the health of the graduate program can be found by observing that APPM graduate students were authors or co-authors on six preprints of the Department in Applied Mathematics within the last year.

In summary, the graduate program of Applied Math is now coming of age. While we have many improvements to make, we believe that it has developed remarkably well and that it is continuing to enhance its ability to produce highly qualified and employable applied mathematicians.

5. FACULTY SERVICE TO THE UNIVERSITY, DEPARTMENT AND SOCIETIES, CALENDAR YEAR 1996

Mark Ablowitz: Department Chair; member of Council of Chairs in the College of Arts and Sciences, and American Mathematical Society Short Course Committee

Jerrold Bebernes: Chair of Department Colloquium Committee; member of Advisory Committee to University Mathematics Department, and Department Budget Committee

Gregory Beylkin: Member of Department Graduate Committee, and NSF-DMS/DARPA Review Panel

James Curry: Department Associate Chair; Co-Director of Society of Industrial and Applied Mathematics Diversity Day at Stanford University; CO-PI Connect Colorado statewide Systemic Initiative; member of Advisory Board for the NSF Geometry Center, Campus Committee for Information Technology, Presidential Teaching Scholar Selection Committee, and BFA Teaching Excellence Selection Committee

Anne Dougherty: Faculty Advisor of CU-Boulder Society for Industrial and Applied Mathematics; member Department Probability and Statistics Preliminary Committee

Robert Easton: Chair of Department Review Self-Study Committee, and Department Diversity Committee; member of College Educational Policy and Planning Committee, and University Committee on Complexity formed to create new Center for Chaos and Complexity (member of new center); participant of College of Engineering High School Honors Institute; sabbatical 1996-97

Bengt Fornberg: Visiting Professor of Mathematics, University of Strathclyde, Scotland (1991-1997); member of Department Graduate Committee, University Council on Research and Creative Work

Congming Li: Member of Department Graduate Committee

Hector Lomeli: Member of Boulder Campus Early Alert Program Committee

Tom Manteuffel: Vice-President-at-Large of the Society of Industrial and Applied Mathematics; Member of Department Undergraduate Committee, Department Computer Committee, UC-Denver/UC-Boulder Joint PhD Coordinating Committee, Arts & Science Council Grievance Committee, and Arts & Science Council Natural Science Cluster Budget Committee

Steve McCormick: Chair of Department Graduate Committee (to 6/30/97); member of Department Computer Committee, and Department Numerical Analysis Preliminary Committee

James Meiss: Member of Department Undergraduate Committee, Department Graduate Committee, Department Computer Committee, Center for Integrated Plasma Studies, Colorado Center for Chaos and Complexity, and University Scholarship Committee; Campus Representative for the Goldwater Scholarship

Harvey Segur: Member of Department Graduate Committee, Boulder Faculty Assembly, University Faculty Council; sabbatical 1996-97.

John Williamson: Chair of Department Undergraduate Committee (to 6/30/97); Coordinator for Campus Statistics Coordinating Committee; member of College of Engineering Undergraduate Academic Affairs Committee, College of Engineering Scholarship Committee, and College of Engineering Planning and Policy Committee

6. TEACHING ACTIVITIES

A. Courses Taught by Department Faculty, Academic Year 1996-97

Undergraduate Courses

APPM 1350 *Ablowitz, Deconinck, Dougherty, Lomeli, Norris,* Calculus 1 for Engineers.

APPM 1360 *Dougherty, Halburd, Herod, Li, Lomeli,* Calculus 2 for Engineers.

APPM 2350 *Herod, Li, Manteuffel, McCormick,* Calculus 3 for Engineers.

APPM 2360 *Bebernes, Curry, Halburd, Julien, Li, Meiss,* Linear Algebra and Differential Equations.

APPM 3010 *Lomeli,* An Introduction to Nonlinear Systems: Chaos.

APPM 3310 *Curry, Herod,* Matrix Methods and Applications.

APPM 3570 *Williamson,* Applied Probability.

APPM 4350 *Fornberg,* Methods in Applied Mathematics: Boundary Value Problems.

APPM 4360 *Ablowitz,* Methods in Applied Mathematics: Complex Variables.

APPM 4380 *Fornberg,* Modeling in Applied Mathematics.

APPM 4520 (MATH 4520) *Goodrich,* Introduction to Mathematical Statistics.

APPM 4560 *Williamson,* Introduction to Probability Models.

APPM 4570 *Dougherty,* Statistical Methods.

APPM 4580 *Little,* Statistical Applications Software Methods.

APPM 4650 *Beylkin, Holley,* Intermediate Numerical Analysis 1.

APPM 4660 *Driscoll,* Intermediate Numerical Analysis 2.

APPM 4955 *Curry,* Seminar--Capstone Course

Graduate Courses

APPM 5350 *Fornberg,* Methods in Applied Mathematics: Boundary Value Problems.

APPM 5360 *Ablowitz,* Methods in Applied Mathematics: Complex Variables.

APPM 5440 *Bebernes,* Applied Analysis 1.

APPM 5450 *Bebernes,* Applied Analysis 2.

APPM 5470 (MATH 5470) *Meiss, Gustafson,* Methods in Applied Mathematics 3: Partial Differential Equations.

APPM 5480 *Fornberg,* Methods in Applied Mathematics 4: Perturbation Methods.

APPM 5520 (MATH 5520) *Goodrich,* Introduction to Mathematical Statistics.

APPM 5560 *Williamson,* Introduction to Probability Problems.

APPM 5570 *Dougherty,* Statistical Methods.

APPM 5580 *Little,* Statistical Applications Software Methods.
APPM 5600 (MATH 5600) *Manteuffel,* Numerical Analysis 1.
APPM 5610 (MATH 5610) *Beylkin,* Numerical Analysis 2.
APPM 6540 (MATH 6540) *Holley,* Time Series Analysis.
APPM 6550 (MATH 6550) *Williamson,* Introduction to Stochastic Processes.
APPM 7100 *Meiss,* Dynamical Systems.
APPM 7400 *Curry,* Open Topics in Applied Mathematics
APPM 7400 *Maybee* Open Topics in Applied Mathematics
APPM 7400 *Meiss,* Open Topics in Applied Mathematics
APPM 8000 *Bebernes, Fornberg,* Seminar in Applied Mathematics.
APPM 8100 *Ablowitz,* Seminar--Nonlinear Waves and Dynamical Systems.
APPM 8200 *Manteuffel,* Seminar--Computational Mathematics.

B. Summer Courses, 1997

APPM 1350 *Ghrist,* Calculus 1 for Engineers.
APPM 1360 *Halburd* , Calculus 2 for Engineers.
APPM 2350 *Herod,* Calculus 3 for Engineers.
APPM 2360 *Merck, Staab,* Introduction to Linear Algebra and Differential Equations.
APPM 4650 *Norris,* Intermediate Numerical Analysis 1.

7. RESEARCH ACTIVITIES FOR CALENDAR YEAR 1996

A. Research Publications for Calendar Year 1996

Mark Ablowitz:

"Integrability, Monodromy Evolving Deformations and Self-Dual Bianchi IX Systems", S. Chakravarty and M.J. Ablowitz, *Phys. Rev. Lett.*, **76** (1996) 857-860.

"Computational Chaos in the Nonlinear Schrödinger Equation Without Homoclinic Crossings", M.J. Ablowitz, B.M. Herbst, and C.M. Schober, *Physica A*, **228** (1996) 212-235.

"On the Numerical Solution of the Sine-Gordon Equation I. Integrable Discretizations and Homoclinic Manifolds", M.J. Ablowitz, B.M. Herbst, and C.M. Schober, *J. Comp. Phys.*, **126** (1996) 299-314.

"The Burgers Equation under Deterministic and Stochastic Forcing", M.J. Ablowitz and S. De Lillo, *Physica D*, **92** (1996) 245-259.

"On a 2+1 Volterra System", J. Villarroel, S. Chakravarty, and M.J. Ablowitz, *Nonlinearity*, **9** (1996) 113-1128.

"Four-wave Mixing in Wavelength-division Multiplexed Soliton Systems--Damping and Amplification", M.J. Ablowitz, G. Biondini, S. Chakravarty, R.B. Jenkins, and J.R. Sauer, *Optics Letters*, **21** (1996) 1646-1648.

"Chaos in Numerics", B.M. Herbst, G.J. Le Roux, and M.J. Ablowitz, *Numerical Analysis*, eds. D.F. Griffiths and G.A. Watson, World Scientific, Singapore (1996) 133-154.

"On the Numerics of Integrable Discretizations", M.J. Ablowitz, B.M. Herbst, and C.M. Schober, *Centre des Recherches Mathematiques, CRM Proceedings*, **9** (1996) 1-11.

Jerrold Bebernes

"Nonlocal problems modeling shear bonding", J. Bebernes and P. Talaga, *Communications on Applied Nonlinear Analysis*, **3** (1996) 79-102.

"On classification of blow-up patterns for a quasilinear heat equation", J. Bebernes and V. Galaktionov, *Differential and Integral Equations*, **9** (1996) 655-670.

"On symmetric and nonsymmetric blow-up for a weekly quasilinear heat equation", J. Bebernes, A. Bressan, and V. Galaktionov, *Nonlinear Differential Equations and Applications*, **3** (1996) 269-286.

"Traveling fronts in cylinders and their stability", J. Bebernes, C. Li, and Y. Li, *Rocky Mountain Journal of Mathematics*, **27** (1997) 1-27.

Gregory Beylkin:

"Wavelets, Multiresolution Analysis, and Fast Numerical Algorithms", G. Beylkin, book chapter in *Wavelets Theory and Applications*, Oxford University Press, 1996.

"Adaptive pseudowavelet algorithms for solving non-linear partial differential equations", G. Beylkin and J. Keiser, Proceedings of SPIE, vol. 2825, 584-599.

James H. Curry:

"On noninvertible mappings of the plane: Eruptions", L. Billings and J. H. Curry, *Chaos*, **6**, (1996) 108-120.

"Bifurcations in a Class of Noninvertible Mappings of the Plane", L. Billings and J. H. Curry, Proceedings of the CESA'96 IMACS Multiconference: Computational Engineering in Systems Applications (Lille, France), **2** (1996) 625-629.

Anne Dougherty:

"Quantitative experimental analysis of transparency and stability in haptic interfaces", A. Dougherty, D. Lawrence, L. Pao, and M. Salada, *Proceedings of the Fifth Annual Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems*, (1996).

Bob Easton

"Migration and the tragedy of the commons", *Colorado Daily* , Oct. 18, 1996.

Bengt Fornberg:

"A Practical Guide to Pseudospectral Methods", Cambridge University Press.

"A new numerical algorithm for the analytic continuation of Green's functions", B. Fornberg, V.D. Natoli, and M.H. Cohen, *Journal of Comput. Physics*, **126** (1996) 99-108.

"The prospect for parallel computing in the oil industry, in Applied Parallel Computing" *Springer Verlag Lecture Notes in Computer Science*, **1184** (1996) 262-271.

Congming Li:

"Local asymptotic symmetry of singular solutions to nonlinear elliptic equations", *Invent. Mathematics.*, **123** (1996) 221-231.

Hector Lomeli:

"Saddle connections and heteroclinic orbits for standard maps", *Nonlinearity*, **9** (1996) 649-668.

"Perturbations of elliptic billiards", *Physica D*, **99** (1996) 59-80.

Tom Manteuffel:

"A Fast Multigrid Algorithm for Isotropic Transport Problems II: with Absorption", T. Manteuffel, S.F. McCormick, J.E. Morel, and G. Yang, to appear in *SIAM J. Sci. and Stat. Comp.* (1996).

"On Hybrid Iterative Methods for Nonsymmetric Systems of Linear Equations", T. Manteuffel, G. Starke, to appear in *Numerische Math.*, (1996).

"Minimal Residual Method Stronger Than Polynomial Preconditioning", T. Manteuffel, V. Faber, W. Joubert, and E. Knill, *SIAM J. Mat. Anal.*, **17**, No. 4 (1996).

Steve McCormick:

"A Fast Multigrid Algorithm for Isotropic Transport Problems II: with Absorption", T. Manteuffel, S.F. McCormick, J.E. Morel, and G. Yang, to appear in *SIAM J. Sci. and Stat. Comp.* (1996).

"First-order system least squares for the vorticity form of the Stokes equations, with application to linear elasticity", *E.T.N.A.*, **3** (1996).

"Multilevel image reconstruction with natural pixels", *SIAM J. Sci. Comp.*, **17** (1996).

James Meiss:

"Average Exit, Times for Volume Preserving Maps", *Chaos*, **12** (1996).

"On the Breakup of Invariant Tori with Three Frequencies", *Proceedings of the NATO Advanced Study Institute on 3 Degrees of Freedom*, Kluwer Academic, 1996.

Harvey Segur:

"A generalized stability criterion for resonant triad interactions", H. Segur, C. Chow, and D. Henderson, *Journal of Fluid Mechanics*, **319** (1996) 67-76.

B. Invited Lectures, Calendar Year 1996

Mark Ablowitz:

Department of Mathematics, Pondicherry University, Pondicherry, India, 6 lectures at the "Winter School in Nonlinear Systems", Topic: "Nonlinear Waves and the Inverse Scattering Transform", January 8-12, 1996.

Conference on Nonlinear Dynamics, School of Mathematics, University of New South Wales, Australia, "Computational Chaos in Integrable Systems", March 27-28, 1996.

Department of Mathematics, University of Sydney, Australia, "100 years of Integrability", April 3, 1996.

Institute for Theoretical Physics, summer school session on "Painlevé One Century Later", Cargese, Corsica, "Painlevé Equations, Darboux-Halphen Systems and the Inverse Transform Method", 4 1/2 hours, June 3-12, 1996.

Workshop on Symmetries and Integrability, Kent University, Canterbury, England, "Solutions to the Time Dependent Schrödinger and the Kadomtsev-Petviashvili Equations", July 1-5, 1996.

Workshop in Nonlinear Optics, Mathematics Department, University of Arizona, Tucson, Arizona, "Wavelength Division Multiplexed Solitons and Four Wave Mixing", October 10-12, 1996.

International Symposium on Advances in soliton theory and its applications--The 30th anniversary of the Toda lattice, Yokohama National University, Yokohama, Japan, "On a New Class of Lump Type Solutions to the Kadomtsev-Petviashvili and Nonstationary Schrödinger Equations", December 1-4, 1996.

Gregory Beylkin:

Universite de Montreal, "An Adaptive pseudo-wavelet approach for solving partial differential equations", Workshop on "Wavelets and Differential equations", March 1996.

Los Alamos National Lab, "A Multiresolution Strategy for Reduction of PDE's and Eigenvalue Problems", April 1996.

Battelle Pacific Northwest Lab, "A Multiresolution Strategy for Reduction of elliptic PDE's and Eigenvalue Problems", June 1996.

DARPA Workshop, "Fast Numerical Algorithms and SAR Applications", June 1996.

University of Colorado, Department of Applied Mathematics, Colloquium, "Multiresolution Strategy for Numerical Homogenization", Sept. 1996.

Princeton University, "Multiresolution Strategy for Homogenization", November 1996.

GMR DARPA Workshop, "Multiresolution Numerical Homogenization for Multiscale Problems", Dec.1-4, 1996

James H. Curry:

Colorado State University, "On the Dynamics of Families of Noninvertible Transformations of the Plane: Eruptions", March 7, 1996

Anne Dougherty:

Series of eight undergraduate lectures presented at the Park City Math Institute Women's Program, held at the Institute for Advanced Study, "An Introduction to Queueing Theory", Summer 1996.

Bob Easton:

Dept. of Applied Mathematics, University of Colorado, Applied Math Dynamical Systems, Fall 1996

Bengt Fornberg:

University of Colorado, Joint Computational Mathematics seminar, "Computing steady incompressible flows past blunt bodies - A historical overview", February 16, 1996.

University of Colorado, Dept. of Applied Mathematics, "Multi-dimensional data visualization/modeling", February 20,1996.

Los Alamos National Lab., "A finite difference procedure for a class of free boundary problems", May 29, 1996.

University of Strathclyde, Scotland, "Major computational tasks in the oil industry, June 25, 1996.

Uppsala University, Sweden, "Major computational tasks in the oil industry, August 15, 1996.

Congming Li:

International Conference on Dynamics and Differential Equations, Springfield, Missouri, SMSU, May 1996.

Utah State University, Dept. of Mathematics, January 1996.

Rutgers University, Dept. of Mathematics, March 1996.

University of California at Los Angeles, Dept. of Mathematics, August 1996.

Hector Lomeli:

Southwest Dynamical Systems Conference, Tucson, Arizona, April 1996.

Seminar Instituto Superior Tecnico, Lisbon, Portugal, June 1996.

Tom Manteuffel:

Colloquium, University of Wyoming, May 3, 1996.

CERFACS Workshop on Iterative Methods, Toulous, France, June 10-13, 1996.

Karlsruhe University, Karlsruhe, Germany, June 24, 27 and 28, 1996.

Minisymposium on Transport problems, SIAM Annual Meeting, Kansas City, Mo., July 22, 1996.

Steve McCormick:

Fourth Copper Mountain Conference on Iterative Methods, Copper Mountain, Colorado, "FOSLS for elasticity", April 9, 1996.

Fifth Workshop on Numerical Methods for F. Flow in Sph. Geom., Breckenridge, Colorado, "Multilevel general circulation model", June 12, 1996.

Short Course on Advances in CFD, Louisiana Tech. University, Ruston, Louisiana, "First-order system least squares: general principals", June 24-28, 1996.

Euroconference on Supercomputing, Madrid, Spain, lecture of multigrid and FOSLS, Sept. 23-28, 1996.

James Meiss:

Courant Institute, NYU, New York, "Exit Time Distributions", January 1996.

Am. Physical Society, Division of Plasma Physics, Denver, Colorado, "Quadratic Volume Preserving Maps", November 1996.

Inst. for Theoretical Physics, University of California at Santa Barbara, "Single Particle Hamiltonian Dynamics", December 1996.

Harvey Segur:

Workshop on "Dynamical Systems Methods in Fluid Mechanics", Oberwolfach, Germany, "Periodic waves in shallow water", July 1-5, 1996.

C. Research Grants for Calendar Year 1996

	Amount for 1996
Mark Ablowitz:	
NSF, Mathematics Division: 1994-96	$25,000
AFOSR, Mathematics: 1994-96	$91,500
ONR, Mathematics: 1994-97	$30,500
Air Force AASERT: 1993-97	$39,100
ONR AASERT: 1994-97	$47,000
Jerrold Bebernes:	
NATO: 1993-96	$4,000
Gregory Beylkin:	
ONR, Mathematics Division: 1993-96	$25,200
ONR AASERT: 1992-1996	$24,400
DARPA: 1993-96	$78,100
NASA: 1996-97	$78,200
James Curry:	
AASERT, ONR, Physics/Oceanography Div.: 1993-96	$29,500
DOE Grant: 1993-96	$18,100
NSF Statewide Systemic Initiative: 1993-97	$17,500
Congming Li:	
NSF: 1994-96	$22,900
Tom Manteuffel:	
DOE, Applied Mathematics: 1996-98	$74,400
NSF, Mathematics Division: 1994-97	$50,000
NSF, Special Projects: 1994-97	$12,000
Steve McCormick:	
AFOSR: 1994-96	$39,000
NSF, Mathematics Division: 1994-97	$50,000
NSF, Special Projects: 1994-97	$12,000
DOE: 1996-99	$74,400
James Meiss:	
NSF, Mathematics Division: 1993-95	$28,100
NSF, Graduate Traineeship: 1993-98	$111,000
Harvey Segur:	
NSF, Mathematics Division: 1993-96	$20,000
ONR, Physics/Oceanography Division: 1995-97	$69,800
John Williamson:	
NIMH: 1995-99	$48,200

D. Miscellaneous Activities for Calendar Year 1996

Mark Ablowitz:

Editorial boards: *Journal of Engineering Mathematics; Studies in Applied Mathematics,* Cambridge University Press Texts in Applied Mathematics

Advisory boards: *Chaos, Inverse Problems*

Reviewer: NSF Grants; Air Force Grants; Australian and Canadian Research Grants; *Physics Letters A; Physical Review Letters; Studies in Applied Mathematics; SIAM Journal on Applied Mathematics; Journal of Engineering Math; Chaos, Inverse Problems*, Cambridge University Press

Patent submitted: "Variable Length Nonlinear Feedback Shift Registers with Dynamically Allocated Taps"

Jerrold Bebernes:

Editor: *Rocky Mountain Journal of Mathematics; Communications on Applied Nonlinear Analysis;*

Gregory Beylkin:

Editorial boards: *SIAM Journal on Numerical Analysis; Applied and Computational Harmonic Analysis*

James Curry:

Co-PI: Colorado State Systemic Initiative

Member: Board of Governors of The Geometry Center at the University of Minnesota

Anne Dougherty:

Minority Engineering Program (MEP) Faculty Appreciation Award, 1995-1996

Robert Easton:

Editorial Board: *Communications on Applied Nonlinear Analysis,*

Reviewer: NSF; research journals

Bengt Fornberg:

Visiting Professor, University of Strathclyde (1991-1997)

Reviewer: SIAM book proposals and articles; research journals; proposal evaluation for NSF and FRD (equivalent to NSF in Republic of South Africa)

Congming Li:

Reviewer: NSF proposals; *Rocky Mountain Journal of Mathematics; Communications in Pure and Applied Mathematics; Communications in Partial Differential Equations; Indiana University Mathematics Journal ; SIAM Journal of Mathematical Analysis*

Organizer: PDE session in International Conference on Dynamics and Differential Equations, Springfield, Missouri, SMSU, May-June 1996

Hector Lomeli:

Reviewer: *Physica D*

Tom Manteuffel:

Editor-in-Chief of the *Society of Industrial and Applied Mathematics Journal of Numerical Analysis*

Editorial boards: *Electronic Transactions in Numerical Analysis; Journal of Numerical Linear Algebra and Applications*

Co-Chair: Seventh Colorado Conference on Iterative Methods, Copper Mountain, Colorado, April 9-13, 1996

Vice-President-at-Large: Society of Industrial and Applied Mathematics

Steve McCormick:

Editor: *SIAM Journal on Scientific Computing, SIAM Journal on Numerical Analysis*

Reviewer: grant proposals; research journals; *IMACS*

Co-Chair: Seventh Colorado Conference on Iterative Methods, Copper Mountain, Colorado, April 9-13, 1996

Organizer: Joint CU-Denver/CU-Boulder Seminar on Computational Mathematics

James Meiss:

Editor: *Physica D*

Reviewer: *Physics Letters; Physical Review Letters; Physical Review E; Journal of Fluid Mechanics; Journal of Physics A; Chaos; Journal of Plasma Physics;* Nature; NSF proposals; textbook for Brooks Cole Publishing

Harvey Segur:

Reviewer: NSF; *European Journal of Mechanics; Journal of Fluid Mechanics; Methods and Applications of Analysis; Nonlinearity; Physical Review E; Physical Review Letters; Physics Letters A; Rocky Mountain Journal of Mathematics; Studies in Applied Mathematics*

8. PREPRINTS OF THE DEPARTMENT: 1996-97

Following is a list of preprints developed by Department faculty and visitors during this academic year. If you would like a copy of any preprint, please request a copy in writing from Lynn Randolph, Department of Applied Mathematics, Campus Box 526, University of Colorado, Boulder, CO 80309-0526.

No.

304. On the Well-Posedness of the Eckhaus Equation, M.J. Ablowitz, G. Biondini and S. De Lillo, March 1997.

305. On the New Class of Lump Type Solutions to the Kadomtsev-Petviashvili and Nonstationary Schrödinger Equations, M.J. Ablowitz, November 1996.

306. Discretizations, Integrable Systems and Computation, M.J. Ablowitz, B.M. Herbst and C.M. Schober, November 1996.

307. The Burgers Equation with Moving Boundary, S. De Lillo and G. Biondini, December 1996.

308. New Solutions of the Nonstationary Schrödinger and Kadomtsev-Petviashvili Equations, M.J. Ablowitz and J. Villarroel, December 1996.

309. Nonlinear Waves, Solitons and IST, M.J. Ablowitz, January 1997.

310. Lyapunov Exponents, Singularities and a Riddling Bifurcation, L. Billings, J.H. Curry and E. Phipps, March 1997.

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