

Department of
Program in Applied Mathematics

University of Colorado
at Boulder

Boulder, Colorado 80309-0526

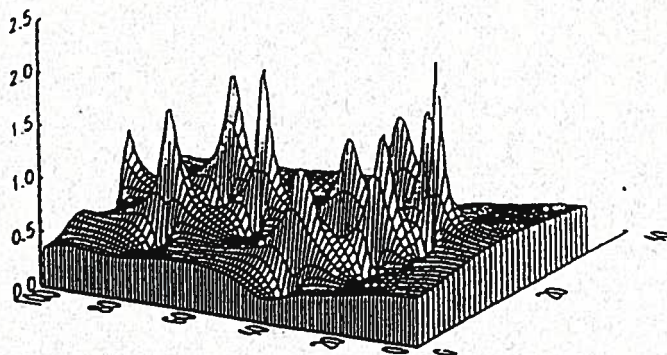
Annual Report

1995-96

Mark J. Ablowitz, Director

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PREFACE

The Program in Applied Mathematics continues to be extremely successful in its educational and research functions. The undergraduate major is marked by unusual excellence: more than 50% of our majors were on the Dean's List this year. Over the past seven years numerous new courses have been introduced, and the BS degree has been reorganized and renovated. Our students are finding a wide variety of positions in industry and laboratories and many are continuing on to graduate school. The MS and PhD degrees have also been reorganized and invigorated, and the graduate program has grown from 0 to 40 students during the past seven years. In terms of graduate students in the mathematical sciences, this represents an increase of about 60%. An extraordinary computational facility has been built, consisting of 31 high performance workstations and 12 Macintosh computers. The system is being used vigorously by our students, faculty and visitors from throughout the world. The affiliated faculty program allows faculty from other units at the university and nearby institutions to be able to direct MS and PhD students in Applied Mathematics. Currently there are 33 affiliated faculty members from other departments throughout the university, nearby laboratories and universities. There are 19 graduate students supported by external grants: five by NSF traineeship funds, five by the DOD ASSERT program, nine by faculty and affiliated research grants and three by other fellowship programs. In fiscal year 1995 the Applied Math faculty brought in a record \$1.6 million in research grants. Faculty serve in 18 positions on editorial and advisory boards of 14 journals, textbook series, or periodicals. During the past seven years the faculty and students have written over 300 research papers.

The Program in Applied Mathematics (PAM) has completed yet another remarkable year. At the March 1995 Regents meeting, the board requested that the departmental status of the Program in Applied Mathematics be resolved. This event set into motion a sequence of reviews and committee deliberations aimed at settling this issue. In the spring of 1995 the physical science departments (Chemistry, Physics, Geological Sciences, and Astrophysical, Planetary, and Atmospheric Sciences) voted overwhelmingly in favor of Applied Mathematics being a department in the College of Arts and Sciences.

In the fall of 1995 a mediation committee was organized by Vice Chancellor Wallace Loh and the Dean of Arts and Sciences, Charles Middleton. The committee was headed by Emeritus Professor of Mathematics and former Dean of Arts and Sciences, William Briggs, Sr. Other members of the committee were Mark Ablowitz (Director of Applied Math), James Curry (Professor of Applied Math), Robert Tubbs (Chair of Math) and Robert Goodrich (Professor of Math). The committee met over a period of two months, agreed upon a set of recommendations, and wrote a report documenting these recommendations. This document is usually referred to as the "Briggs Report". Among other items, the committee recommended that there be a Department of Applied Mathematics and that a coordinating committee between the two units (Applied Mathematics

and Mathematics) be established in order to avoid unnecessary duplication and to enhance collaboration.

The Program in Applied Mathematics underwent program review during the past year. This required meetings and an evaluation by an Internal Review Committee (IRC) in December 1995. The members of the IRC were Professor Thomas DeGrand, Physics; Professor John Cary, Astrophysical, Planetary, and Atmospheric Sciences; and Professor Tissa Illangasekare, Civil Engineering. The committee concluded that overall PAM is extremely strong and has been very successful. They recommended that PAM become a department in Arts and Sciences. Subsequently, in February 1996, the faculty and students met with the External Review Committee (ERC), whose members were Professor D. Benny, MIT; Professor E. Fabes, University of Minnesota; and H. Keller, Cal Tech. The ERC was also extremely favorable in its review and they too recommended that PAM become a separate department. Finally, the full Program Review Panel (PRP) wrote its report in April 1996. The report, which is a public document, is strongly supportive of the efforts by PAM. The PRP stated the following: "Based upon the self study, the Briggs, the IRC, and the ERC reports as well as what would be best for the university community as a whole, the PRP strongly endorses the goal of giving PAM the status of a department."

The Program then presented its case to the Arts and Sciences Council (ASC) on May 9, 1996. At that meeting the ASC overwhelmingly voted down a proposal to transfer PAM to the College of Engineering (voting 33-2-0). The ASC later voted 31 in favor, 3 against, and 2 abstaining to grant departmental status to PAM.

Subsequently, Dean of Arts and Sciences Charles Middleton recommended to Vice Chancellor Wallace Loh that PAM become a department in the College of Arts and Sciences. Vice Chancellor Loh then wrote a recommendation to Chancellor Park summarizing the situation and recommending that PAM become a department in Arts and Sciences. Chancellor Park initiated a formal campus recommendation to President Beuchner that a Department of Applied Mathematics be created on the Boulder campus. Meetings were then organized with Vice President Byyny, Assistant Vice President Dahlin and President Beuchner explaining the situation in detail. The University supported the campus recommendation. Plans were made to present the campus recommendation to the Regents, first to the Academic Planning Committee of the Regents on August 7, 1996, and then to the full Board of Regents on August 8, 1996. In preparation for these meetings a complete dossier had to be put together containing all the recommendations with explanations and supporting information. Throughout the process Interim Dean of Arts and Sciences Dale Mood, Associate Vice Chancellor David Kassoy, Vice Chancellor Wallace Loh, and Chancellor Park were supportive and very helpful. We extend our heartfelt thanks to all of them. We are also deeply appreciative of the support of the incoming Dean of Arts and Sciences, Peter Spear.

At the Planning Committee meeting of August 7, 1996, participants who spoke in favor of the recommendation or as chairs of relevant committees or appropriate administrators were Vice Chancellor Wallace Loh, Mark Ablowitz (Director of PAM), James Curry (Associate Director of PAM), William Briggs Sr. (Facilitator), Jeff Mitton (Chair of the ASC), David Prescott (Distinguished Professor of MCDB), Robert Schnabel (Associate Dean of Engineering) and Interim Dean of Arts and Sciences Dale Mood. The opposition case was presented by Professor Marty Walter (Chair designate of the Mathematics Department).

On August 8, 1996, the Board of Regents took up this matter. After hearing briefly from Vice President Byyny and Chancellor Park, the Board voted in favor of creating a new Department of Applied Mathematics. It will be housed in the College of Arts and Sciences. Regent Robert Sievers, Chairman of the Board, explained after the vote that it was extremely important for the students and the University that we all work cooperatively together. Mark Ablowitz and Marty Walter met shortly after the vote and agreed on the need to work effectively and cooperatively to improve the mathematical sciences at the University of Colorado. This will be beneficial to all of us!

So, as Applied Mathematics enters a new period, we look forward to working with our colleagues in the Mathematics Department to enhance the stature of mathematical sciences and to help the students, faculty and administration at the University of Colorado understand the value, excitement and vitality of mathematical sciences. Given the importance of mathematical sciences both fundamentally and to the world in which we live, we are confident that the University will respond affirmatively and enthusiastically in broad support of the field.

1. ROLE AND MISSION

The objectives of the Program 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 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 1995-96, the Program in Applied Mathematics had a core of 12 tenure track faculty members plus three full-time instructors responsible for the teaching and advising of all undergraduate and graduate students taking applied mathematics courses. The program has a large teaching commitment since most undergraduate engineering majors are required to take four courses in applied mathematics. The Program taught a total of 2730 undergraduate and graduate students in 23 undergraduate courses (divided into 101 sections) and 19 graduate courses. We had 54 undergraduate majors with 15 receiving their baccalaureate degrees. We are very proud that 31 made the Dean's List for academic achievement with grade point averages of 3.5 or better. There are also 18 students pursuing a minor in Applied Mathematics in the College of Arts and Sciences.

B. Graduate Education

The graduate student population continues to grow and the graduate program is prospering. In 1995-96, the Program had 40 graduate students represented by 19 teaching assistantships, seven graduate students on fellowships and traineeships, and 12 research assistantships. 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 Program has 33 affiliated faculty

members, each of whom can direct a graduate student towards a 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 1995-96 over 80% of the incoming students with support were U.S. citizens from U.S. undergraduate universities. We had eight foreign graduate students and four 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 nineteen students were supported partially or fully by fellowships or grants. The National Science Foundation graduate traineeships supported Brian Bloechle, Eric Harker, Chris Higginson and Joseph Iwanski. 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 Program is truly grateful for the efforts of Jim Meiss in having the foresight and investing so much effort to procure this prestigious award, which was one of only three such awards by NSF in the mathematical sciences. In addition, there were five students who are supported by DOD AASERT Awards: Robert Cramer (ONR; Prof. Beylkin), Lora Billings and Tony Werckman (ONR, Profs. Segur and Curry), Scott Mock (AFOSR, Prof. Ablowitz) and David Trubatch (ONR, Prof. Ablowitz). Nicholas Coult was awarded a University of Colorado Chancellor's Fellowship; Christina Perez received an NSF Fellowship. An additional six students were supported by faculty or affiliated faculty grants (AFOSR, ONR, DOE, and NSF).

C. Enrollment Statistics

Enrollment in the courses offered by the Program continues at extremely high levels. It is particularly noteworthy given the faculty's small size that the Program 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	2734	40	54

In 1994-95 we observed a small decrease in enrollment in our lower division courses due to smaller enrollment in Engineering. However, enrollment in our upper division courses has continued to increase. Enrollment was up in 1995-96, and with projected increases in undergraduate enrollment we foresee significant enrollment increases in applied mathematics courses.

D. Teaching Awards

Faculty in the Program have been honored with distinguished teaching awards. We are extremely pleased to note that Professor Harvey Segur was named Outstanding Faculty Member by the Minority Engineering Program, 1995. Harvey was previously awarded the Boulder Faculty Assembly (BFA) Teaching Award for 1993-94. All of us in the Program know of Professor Segur's high quality lecturing and deep concern for teaching. It is wonderful to have this recognized by the Minority Engineering Program and earlier by the BFA. Congratulations Professor Segur! This is the second faculty member in the Program who has been a recipient of a University teaching honor. In 1991-92 Professor Curry was the recipient of this award. Professor Curry has also been recognized as a President's Teaching Scholar for 1993-95.

E. Graduates

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

PhD degree

May 1996: David Sholl.

Master's degree

December 1995: Richard Charles, Robert Cramer, Bernard Deconinck, Joseph Iwanski, David Sterling, Jaimi Yee.

May 1996: Markus Berndt, Lora Billings, Brian Bloechle, Kari Clark, Matthew Convery, Eric Harker, Alan Herod, Rudy Horne, Hugh MacMillan, Cristina Perez, Angela Pignotti, Billy Riddle Jr., Peter Staab, David Trubatch, Wei Wang.

Bachelor's degree

August 1995: Carmela Baca, Yoshiharu Iguchi.

December 1995: Andrew Burnette, Dean Dalvit, Melissa Ferrara, Letitia Kalafus, Barbra Marranzino, Lynn Seagren, Gregory Smith, Kari Tenfjord.

May 1996: Scott Bates, William Lenz, Christopher McKnight, Lisa Schauer, Anna Szczyrba (graduated with high distinction).

F. Research

The research activities of the core faculty in the Program 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, 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 Program are extremely active in their research and scholarly work (a list of publications, invited lectures and Program 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 1995-96 the faculty in the Program currently serve in eighteen such capacities on fourteen journals/periodicals which include:

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 (Manteuffel, 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 was elected vice-president of the Society of Industrial and Applied Mathematics (SIAM) and is a member of the Master Program committee of SIAM.

We are pleased to note that Jim Meiss and his former student, Erik Bolit, appeared on the BBC World Service news and the BBC television program, *Tomorrow's World*, regarding their work on minimizing the amount of energy required to propel a rocket to the moon. The work was also covered by the *New Scientist*, *Geo* magazine in Korea and Germany and the French Magazine, *Science et Vie Junior*.

We are also pleased to welcome Dr. Tobin Driscoll, winner of an NSF Postdoctoral Fellowship. Toby has elected to take his fellowship here. He will be working in computational math with Bengt Fornberg.

External research grant/contract support continues to increase. The Office of Contracts and Grants of the university documents external support for 1994-1995 for the Program in Applied Mathematics to be nearly \$1.6 million dollars! This includes significant grant support for graduate students as follows: a) the NSF traineeship grant will support six students; b) the DOD AASERT program now supports five students; and c) three students have been awarded their own fellowship support. We are also pleased to note that Professor Meiss was awarded a CRCW faculty fellowship for 1993-94 and Professor Ablowitz was awarded a CRCW fellowship for 1994-95.

G. Conferences

In the summer of 1995, the Program in Applied Mathematics hosted a symposium in honor of the 70th birthday of Martin David Kruskal entitled "Symposium in Applied Mathematics: nonlinear waves and dynamics, asymptotic analysis, and physical applications." It was held in Boulder from August 3-6, 1995. A large and varied group of people gathered for this event. Forty-four speakers represented sixteen countries, numerous local participants attended the talks and friends and family of all ages came from around the world to celebrate Martin's birthday. A banquet on Saturday night was an opportunity for songs, limericks and messages from those of Martin's friends who could not attend. An outdoor evening dinner also provided a chance for visiting.

A broad range of topics was covered during the four day Symposium in fourteen sessions and one poster session. Among the topics covered, certain broad themes received special emphasis -- solutions of nonlinear equations, singularity analysis of nonlinear differential equations, the use of such analysis to identify integrable equations, and its relation to the corresponding analysis for nonlinear difference equations. Those interested in details of lecture topics can consult a special commemorative issue of *Methods and Applications of Analysis* which will appear as the last issue of 1996 or the first of 1997, or, for abstracts of talks, look on the world wide web at

<http://amath.colorado.edu/appm/seminars/kruskal/>

Harvey Segur, Mark Ablowitz, and Peter Clarkson organized the Symposium. A Department of Energy grant provided partial funding.

The Program in Applied Mathematics has a tradition of holding a small annual conference jointly with the Center for Nonlinear Studies (CNLS) at Los Alamos, with the venue alternating between Boulder and Los Alamos. In 1996 the conference was held in Los Alamos on March 29 and 30. The purpose of this meeting is to give our graduate students, instructors and visitors an opportunity to meet other young scientists in related fields and, when feasible, allow them to give lectures in order to gain valuable experience in speaking before scientific audiences. The consensus of opinion is that this meeting is a very worthwhile experience. Thanks go to our local organizer, Connie Schober.

The Third Colorado Conference on Iterative Methods was held April 9-13, 1996, at Breckenridge, Colorado. The conference was organized by Tom Manteuffel and Steve McCormick from the Program in Applied Mathematics and Front Range Scientific Computations, Inc., in cooperation with the Special Interest Group in Numerical Linear Algebra of the Society of Industrial and Applied Mathematics, with DOE and NSF providing grant money. Topics included nonsymmetric linear systems, nonlinear systems, optimal order algorithms and applications on advanced architectures. Attendance for this meeting was approximately 200.

H. New Faculty

Bengt Fornberg joined the Program as a full professor in the Fall semester. Bengt was formerly a tenured faculty member at Cal Tech (1974-1984) and more recently worked at Exxon Research (1984-1995). He is a world renowned expert in spectral methods in numerical analysis and computational fluid dynamics.

Dr. Hector Lomeli joined us in Fall 1995 from the University of Minnesota to be the Program's new long term instructor. Hector's field of expertise is dynamical systems. We also hired Dr. Vy Le, an expert in the analysis of partial differential equations, as a one year instructor. Anne Dougherty continues her appointment as instructor. Anne's research area is applied probability and stochastic processes. Anne also makes significant contributions as coordinator of our SIAM undergraduate chapter and faculty coordinator of General Engineering 1350, our collaborative learning effort.

I. Remarks

Sarbarish Chakravarty began a position as Assistant Professor (lecturer) in the School of Mathematics at the University of New South Wales, Sydney, Australia.

Constance Schober is leaving for a position as Assistant Professor in the Department of Mathematics at Old Dominion University, Norfolk, Virginia.

A warm and sincere thanks to our fine staff: Stu Naegele (Program Administrator); Janet Glasser (Student Services Coordinator), who left us this January after 5 years to become an intern in the CDSS Department and complete her MA degree; Lynn Jackson, who replaced Janet this May; Margy Lanham, formerly the Faculty Services Coordinator, who shifted to Professional Research Assistant in January; Meg Rowland, who joined us in January to fill Margy's old position; and Linh Huynh, our work study student for three years now. Our staff members work very hard and certainly go the "extra mile" for the Program; without them the Program could not function. The faculty of the Program 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.

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

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

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

Jean-Michel Fiard, Research Associate; PhD, Université de Savoie, France. Computational Math, Numerical Partial Differential Equations, Multigrid Methods, Computational Fluids, Solid Oxide Fuel Cells, Finite Volumes Methods.

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

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

Vy Le, Instructor; PhD, University of Utah. Analysis of Partial Differential Equations.

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

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

John Maybee, Professor Emeritus; 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.

Constance Schober, Instructor, Research Associate; PhD, University of Arizona.
Integrable Systems, Computational Methods.

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

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

B. Affiliated Faculty--Graduate Program

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

- Lev Ostrovsky** (CIRES/NOAA Environmental Technology Laboratory), Nonlinear waves, Fluid Dynamics, Oceanography, Acoustics
- 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 Modelling, 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, 1995-96

Toshinao Akuzawa, University of Tokyo, Japan, March 8-24, 1995
Amir Averbuch, Tel Aviv University, Israel, May 1996
Robert Burrige, Schlumberger-Doll Research, CT, June - August, 1995
Sarbarish Chakravarty, University of Pittsburgh, PA, Dec. - Feb. 1995
Yu Chen, Yale University, Oct. 5-12, 1995
Peter Clarkson, University of Kent, July - August 1995
Tetsuo Deguchi, Ochanamiza University, Tokyo, Japan, Sept. 10-29, 1995
Boris Dubrovin, SISSA, Trieste, Italy, July 1-31, 1995
Ben Herbst, University of Orange Free State, South Africa, Nov. - Dec. 1995
Kazuhiro Hikami, University of Tokyo, Japan, Oct. - Nov., 1995
Mats Holmstrom, Upsala University, Sweden, June 1995
Takeshi Iizuka, Ehime University, Japan, March 8-24, 1995
Moshe Israeli, Technion, Haifa, Israel, May 1996
Yasumasa Kajinaga, University of Tokyo, Japan, Feb. 27 - March 16, 1995
Elizabeth Mansfield, University of Kent, July - August 1995
Hideyuki Mizuta, University of Tokyo, Japan, Oct. - Nov., 1995
Yashuhiro Ohta, Hiroshima University, Japan, July 1 - Sept. 4, 1995
Christoph Pflaum, Technical University of Munich, Germany, April 1996
Steve Roberts, Australian National University, Oct. 2-31, 1995
Masahiro Shiroishi, University of Tokyo, Japan, Sept. 10-29, 1995
Gerhard Starke, University of Karlsruhe, Germany, July 1 - August 15, 1995
Bruno Torresani, Centre de Physique Theorique, Marseilles, France, Sept. 1995
Takeya Tsurumi, University of Tokyo, Japan, Feb. 27 - March 16, 1995
Lev Vozovoi, Technion, IIT, Haifa, Israel, March - Sept. 1996
Miki Wadati, University of Tokyo, Japan, Feb. 27 - March 16, 1995
Johan Walden, Upsala University, Sweden, June - August 1995

D. Staff

Stu Naegele -- Program Administrator
Janet Glasser (to January 1996)- Student Services Coordinator
Lynn Jackson (from May 1996) -- Student Services Coordinator
Meg Rowland (from January 1996) -- Faculty Services Coordinator
Margy Lanham -- Professional Research Assistant
Linh Huynh -- work study

3. COLLOQUIA, SEMINARS, SYMPOSIA, 1995-96

A. Applied Mathematics Colloquium Schedule, 1995-96

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 2:45 p.m. in the PAM conference room, ECOT 2-01.

David Logan, Mathematics, University of Nebraska, September 8, 1995
"The Stability of Traveling Waves for a Solute Transport Problem"

Harvey Segur, Program in Applied Mathematics, University of Colorado, Boulder, September 15, 1995
"Waves in Shallow Water"

Joe Hammack, September 22, 1995
"Resonant Interactions Among Ripples in Finite Domains"

Robert Easton, Program in Applied Mathematics, University of Colorado, Boulder, September 29, 1995
"Isolating Blocks and Resonance Zones for Maps"

Yu Chen, Yale University, October 6, 1995
"Heisenberg's Uncertainty Principle and Inverse Scattering"

Wei-Ming Ni, School of Mathematics, University of Minnesota, October 13, 1995
"Spike-layers, Geometry of Domains and Singular Perturbations"

Ronald B. Guenther, Department of Mathematics, Oregon State University, October 20, 1995
"Modeling Surface Water Waves Based on the Navier-Stokes' Equations"

Hector Lomeli, Program in Applied Mathematics, University of Colorado at Boulder, October 27, 1995
"Billiards and Twist Maps"

David Sholl, Program in Applied Mathematics, University of Colorado at Boulder, November 3, 1995
"Diffusion of Clusters on Surfaces"

Thomas F. Russell, Department of Mathematics, University of Colorado at Denver, November 10, 1995
"A Control-Volume Mixed Method on Irregular Quadrilateral and Hexalateral Grids"

Congming Li, Program in Applied Mathematics, University of Colorado at Boulder, November 17, 1995.
"Singularities of Solutions to Partial Differential Equations"

Ren Su, Department of Electrical Engineering, University of Colorado at Boulder, December 1, 1995.
"Feature Correspondence in Computer Vision"

Juan L. Velazquez, Departamento de Matematica Aplicada, Universidad Complutense, Madrid, December 8, 1995.
"Global Existence for a System of Parabolic Equations Arising in Combustion"

James D. Meiss, Program in Applied Mathematics, University of Colorado at Boulder, January 26, 1996.

“Average Transport for Chaotic Maps”

Louis Scharf, Electrical and Computer Engineering, University of Colorado at Boulder, February 2, 1996.

“Geometrical Ideas in Signal Processing”

Duane Sather, Department of Mathematics, University of Colorado at Boulder, February 9, 1996.

“Langmuir Circulations in Ocean Surface Layers”

Robert Kohn, Courant Institute, NYU, February 16, 1996.

“Shape Memory Polycrystals II: Assessing the consequences of energy minimization”

Rick Miranda, Dept. of Mathematics, Colorado State University, February 23, 1996.

“Exploitation of Symmetry in Numerical Analysis and Pattern Analysis”

Russel E. Caflisch, University of California, Los Angeles, March 1, 1996.

“Theory and Application of Quasi-Monte Carlo Methods”

Pavel Bochev, Dept. of Mathematics, University of Texas at Arlington, March 8, 1996.

“Finite Element Methods of Least-Squares Type”

Thomas G. Kurtz, Dept. of Mathematics and Statistics, University of Wisconsin at Madison, March 15, 1996.

“Particle Representations for Solutions of Stochastic Partial Differential Equations”

Edgar Knobloch, Dept. of Physics, University of California, Berkeley and JILA, University of Colorado at Boulder, April 12, 1996.

“Turing Instability in Three Dimensions”

H. Hermes, Dept. of Mathematics, University of Colorado at Boulder, April 19, 1996.

“Nonlinear Stabilizing Feedback Controls”

John M. Finn, Los Alamos National Laboratory, April 26, 1996.

“Nonlinear Dynamics of Three Dimensional Divergence Free Flows and Applications”

B. Seminars in Applied Mathematics, 1995-96

The Program 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-030 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:

Gilberto Flores, UNAM, Mexico City and the University of Wyoming, September 7, 1995

“Traveling Fronts in a Mechanochemical Model”

Tetsuo Deguchi, Department of Physics, Ochanomizu University, Japan, September 14, 1995

“On a Universality of Random Knotting”

Robert D. Pierce, Department of Mathematics, Pennsylvania State University, September 21, 1995

“On the Validity of Mean-Field Amplitude Equations for Counterpropagating Wavetrains”

Masahiro Shiroishi, Department of Physics, University of Tokyo

“Exact Integrability of the 1D Hubbard Model and the Tetrahedral Zamolodchikov Algebra”

L.A. Ostrovsky, University of Colorado/CIRES, and NOAA/ERL/ETL, Boulder, October 5, 1995

“Perturbation Theory and Soliton Dynamics”

John Casti, Santa Fe Institute, October 12, 1995

“Would-Be-Worlds, the Science and the Surprise of Artificial Worlds”

Robert M. Kerr, Geophysical Turbulence Program, NCAR, October 19, 1995

“Outstanding Questions on the Nature of Small-Scale Turbulence and Intermittency”

Robert M. Kerr, Geophysical Turbulence Program, NCAR, October 26, 1995

“The Role of Singularities in Euler and Turbulence”

Scott Herod, Program in Applied Mathematics, University of Colorado at Boulder, November 2, 1995

“Large Rings, Ideals, and Counting Solutions of Differential Equations”

Robert Kerr, Geophysical Turbulence Program, NCAR, November 9, 1995

“Reconnection in the Atmosphere and Sun”

Gustavo Cruz-Pacheco, Department of Mathematics, University of New Mexico, November 16, 1995

“The Nonlinear Schrödinger Limit of the Complex Ginzburg-Landau Equation”

Hector Lomeli, Program in Applied Mathematics, University of Colorado at Boulder, November 30, 1995

“A Melnikov Method for Twist Maps”

A.A. Zozulya, Joint Institute for Laboratory Astrophysics, University of Colorado at Boulder, December 7, 1995

“Breakup of Two-Dimensional Bright Spatial Solitons Due to Transverse Modulation Instability”

Peter Staab, Program in Applied Mathematics, University of Colorado at Boulder, January 25, 1996

“The Effectiveness of Help Groups in First Year Calculus”

Sarbarish Chakravarty, School of Mathematics, University of New South Wales, Australia, February 1, 1996

“Soliton Interactions in Optical Fibers”

Constance Schober, Program in Applied Mathematics, University of Colorado at Boulder, February 8, 1996

“Computational Chaos in the Nonlinear Schrödinger Equation Without Homoclinic Crossings”

Robert Kohn, Courant Institute, NYU, February 15, 1996

“Shape Memory Polycrystals I: Modelling recoverable strain via energy minimization, relaxation, and homogenization”

L.S. Ostrovsky, University of Colorado, CIRES/NOAA Environmental Technology Laboratory, February 22, 1996

“Interactions Between Internal Waves, Flow and Turbulence: Theory and Experiments”

Russel E. Caflisch, University of California, Los Angeles, February 29, 1996

“Singularities in Incompressible Flows”

John O. Dow, Civil, Environmental and Architectural Engineering, University of Colorado at Boulder

“A Unified Approach to Error Analysis in Computational Mechanics”

- Miki Wadati, Dept. of Physics, University of Tokyo, March 14, 1996
 "Yangian Symmetry of the d-Function Fermi Gas"
- Takeshi Iizuka, Dept. of Physics, Ehime University, Japan, March 21, 1996
 "Gap Solitons in Periodic Media"
- Steve Fromm, Dept. of Mathematics, University of Wyoming, April 18, 1996
 "Some Variational Problems from Probability"
- Anne C. Morlet, Cleveland State University, April 25, 1996
 "What Can Regularization Do for You?"
- M.D. Spector, Tel Aviv University, May 2, 1996
 "Witham Averaging and Nonlinear Wave Dynamics for the Benjamin-Ono Equation"

**C. University of Colorado, Denver - University of Colorado, Boulder
 Joint Seminars in Computational Mathematics, 1995-96**

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:

- Eli Turkel, University of Tel Aviv, Israel, August 11, 1995 (in Denver)
 "Preconditioning for Low Mach Number Flow"
- Eli Turkel, University of Tel Aviv, Israel, August 14, 1995 (in Denver)
 "High Order Methods for Acoustics and Electro-Magnetics"
- Eli Turkel, University of Tel Aviv, Israel, August 15, 1995 (in Denver)
 "Central Difference Schemes for CFD"
- Richard Morrow, CSIRO Division of Applied Physics, Sydney, Australia, August 22, 1995 (in Boulder)
 "The Flux-Corrected Transport Method"
- Thomas F. Russell, Department of Mathematics, University of Colorado, Denver, September 5, 1995 (in Denver)
 "A Conservative Finite-Volume Eulerian-Lagrangian Localized Adjoint Method for the Two-Dimensional Advection-Dispersion Equation"
- Bengt Fornberg, Program in Applied Mathematics, University of Colorado, Boulder, September 19, 1995 (in Boulder)
 "Fast Generation of Weights in Finite Difference Formulas"
- Tom Manteuffel, Program in Applied Mathematics, University of Colorado, Boulder, October 3, 1995 (in Denver)
 "Multiple Recursion Conjugate Gradient Methods"
- Yu Chen, Yale University, October 10, 1995 (in Boulder)
 "Recursive Linearization for Inverse Scattering"
- Stephen Roberts, School of Mathematical Sciences, Australian National University, October 17, 1995 (in Boulder)
 "A Finite Element Method for the Solution of Mean-Curvature and Related Geometric Flows"

Randall J. LeVeque, University of Washington, November 14, 1995 (in Boulder)
"Multi-Dimensional Wave-Propagation Algorithms, Adaptive Mesh Refinement, and Software for Hyperbolic PDEs"

Leopoldo P. Franca, Department of Mathematics, University of Colorado at Denver, November 28, 1995 (in Denver)
"Residual Free Bubbles"

Corrado Ronchi, Italy, December 5, 1995 (in Boulder)
"Development, Analysis, and Parallelization of the Cubed Sphere Method for Numerical Solution of Partial Differential Equations"

Musa Yavuz, Turkey, December 12, 1995 (in Boulder)
"Simplified Discrete Ordinates Method for Neutron Transport Problems"

Joe Pasciak, Brookhaven National Laboratories, January 23, 1996 (in Denver)
"Two-Level Preconditioners for 2m'th Order Elliptic Finite Element Problems"

Bengt Fornberg, Program in Applied Mathematics, University of Colorado at Boulder, February 6, 1996 (in Boulder)
"Computing Steady Incompressible Flows Past Blunt Bodies--An Historical Overview"

Klaus Ressel, Department of Mathematics, University of Colorado at Denver, April 16, 1996 (in Denver)
"Hybrid Lanczos-Type Product Methods"

Clive F. Baillie, Center for Applied Parallel Processing, Computer Science Department, University of Colorado at Boulder, April 30, 1996 (in Boulder)
"Grand Challenge and Weather Codes on Massively Parallel Processors"

D. Special Seminars, 1995-96

We had several special seminars during the year:

Kristin Jarman, Ohmeda Medical Systems, Louisville, CO, November 16, 1995 (sponsored by SIAM undergraduate chapter)
"Applications of Mathematics to Biomedical Engineering"

Bengt Fornberg, Program in Applied Mathematics, University of Colorado at Boulder, December 5, 1995 (sponsored by SIAM undergraduate chapter)
"Freak Waves -- a Possibility of Reducing Shipping Damage Through Forecasts"

Pat Quillen, Hughes Aircraft, February 6, 1996 (sponsored by SIAM undergraduate chapter)
"Satellite Orbit Simulation and Error Analysis"

Roger Brockett, Harvard University, March 8, 1996
"Computing with Differential Equations"

Gabe Foster, GW Hannaway & Associates, March 14, 1996 (sponsored by SIAM undergraduate chapter)
"Digital Hollywood"

Toshinao Akuzawa, March 15, 1996
"Integrable System and Motion of Matrix Elements"

Yasumasa Kajinaga, March 15, 1996
"The Folding Problem of Polymerized Membranes"

Takeya Tsurumi, March 15, 1996
"Motion of Curves Specified by Accelerations"

Takeshi Iizuka, March 15, 1996
"Gap Solitons in Optical Fiber"

E.A. Kuznetsov and S.S. Minaev, Landau Institute, Moscow and Institute of Chemical Kinetics and Combustion, Novosibirsk, Russia, May 8, 1996 (presented jointly with the Center for Combustion Research, University of Colorado at Boulder)
"Formation and Propagation of Cracks on the Flame Surface"

Timothy J. Pedley, DAMTP, Cambridge, May 21, 1996 (presented jointly with the Department of Chemical Engineering and the Laboratory for Computational Dynamics, JILA, University of Colorado at Boulder)
"Models of Low and Self-Excited Oscillations in Collapsible Tubes"

Gilbert Strang, Department of Mathematics, MIT, May 16, 1996 (presented jointly with the Center for Aerospace Structures, University of Colorado at Boulder)
"Creating and Comparing Wavelets"

Bradley M. Palmer, Department of Kinesiology, University of Colorado at Boulder, May 17, 1996
"A Model of Heart Muscle Cell Contraction Dynamics"

Tim Callahan, Physics Department, University of California at Berkeley, June 13, 1996
"Tools for Finding Normal Forms for Systems with Symmetry"

E. Los Alamos/Colorado Days, 1996

Los Alamos/Colorado Days, the annual joint conference of the Program in Applied Mathematics and the Center for Nonlinear Studies (CNLS) at Los Alamos, was held in Los Alamos on March 29-30, 1996. Speakers and poster presenters were: Teri Barth, Gino Biondini, Sergey Burtsev, David Cai, Roberto Camassa, Wooyoung Choi, Bernard Deconick, Charlie Doering, Tim Elston, Bengt Fornberg, Michael Gehmeyr, Salman Habib, Scott Herod, Peter Staab, Don Stark, and Gerhard Starke.

F. Symposium in Applied Mathematics: Kruskalfest

A symposium entitled "Symposium in Applied Mathematics: nonlinear waves and dynamics, asymptotic analysis, and physical applications" was held in Boulder from August 3-6, 1995, in honor of the 70th birthday of Martin David Kruskal. There were 44 talks and one poster session. For details of lecture topics, consult the special commemorative issue of *Methods and Applications of Analysis* which will appear as the last issue of 1996 or as the first of 1997, or, for abstracts of talks and posters, look on the world wide web at

<http://amath.colorado.edu/appm/seminars/kruskal/>

4. COMMITTEES

A. Undergraduate Committee -- Jim Curry, Chair

The members of the Undergraduate Committee were John Williamson, Bob Easton, Tom Manteuffel, Jim Meiss, and Jim Curry (chair). Anne Dougherty was Faculty Liaison to SIAM, an undergraduate Applied Math organization.

The Program in Applied Mathematics had 54 undergraduate majors this year. Thirty-one (31) of our majors were on the Dean's list with grade point averages of 3.5 or better. Eric Phipps won the 1995 Frank Prouty Memorial Scholarship, and H.A. Arnold and Eric Phipps, along with Mark Coffey, published an article in *Physical Review B*. Fifteen (15) students graduated this year with bachelor of science degrees in applied mathematics.

Undergraduate students in APPM 1350 (Calculus I) now have the option of simultaneously taking GEEN 1350 (the calculus work group), where students work in a collaborative learning environment. This is a one-credit hour course taken on a pass/fail basis. The course is taught by graduate teaching assistants with the help of several undergraduate assistants. The undergraduate assistants are enthusiastic about having the teaching experience, and they provide valuable role models for the students in the course.

The new Minor in Applied Mathematics, available to students in the College of Arts and Sciences or in Engineering, is growing. There are now 18 students who are pursuing a minor in Applied Mathematics.

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 and technical presentations, mentor lunches, math contests, and a "Professors' Night Out." Four student members attended the National SIAM Conference in March. Officers for 1995-96 were Bill Lenz, President; Lisa Schauer, Vice President; Kate Lainson, Treasurer; and Scott Bates, Secretary. Representatives elected to serve for 1996-97 are Joe Pearse, President; Jorgen Solberg, Vice-President; and Jenny Fox, Secretary/Treasurer.

Some of our best students are also becoming members of Tau Beta Pi, the engineering honor society: Greg Bachmeyer, Scott Bates, and Amy Keyser (secretary for next year).

B. Graduate Committee -- Steve McCormick, Chair

The Graduate Committee consists of Bengt Fornberg, Congming Li, Harvey Segur, 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 Program had 40 graduate students during 1995-96, of whom 7 began the fall of 1995. One student received a PhD and 21 received their MS degrees. For the fall semester of 1996, there were 59 applicants, of whom 9 were awarded teaching assistantships. In addition, one incoming student was awarded an NSF Graduate Traineeship.

The number of (funded) teaching assistantships has remained at about 17-19 during the past five years. Now 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 Program has risen to 15% for 1995-96.

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

In summary, the graduate program of PAM 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 marketable applied mathematicians.

5. FACULTY SERVICE TO THE UNIVERSITY, PROGRAM AND SOCIETIES, CALENDAR YEAR 1995

Mark Ablowitz: Program Director; member of Council of Chairs in the College of Arts and Sciences; CRCW Fellowship 1994-95

Jerrold Bebernes: member of Advisory Committee to University Mathematics Program; Chair of Colloquium Committee

Gregory Beylkin: member of Program Graduate Committee and Program Library Committee

James Curry: Chair of the Program Undergraduate Committee (from 7/1/95); member of Program Mathematical Sciences Mediation Committee, Arts and Sciences Futures Committee, Committee to Restructure the Office of the Dean of the College of Arts and Sciences, and Campus Policy Board on Information Technology; sabbatical Spring 1995

Robert Easton: Program Interim Director; Program Associate Director; Chair, Program Review Self Study Committee; Chair, Dept. Diversity Committee; member of Program Instructor Search Committee; member of Council of Chairs, Complexity Committee, and College of Engineering Educational Policy and Planning Committee; participant of College of Engineering Open House

Bengt Fornberg: Visiting Professor of Mathematics, University of Strathclyde; member of Program Graduate Committee

Congming Li: member of Program Undergraduate Committee, Program Graduate Committee and College of Engineering and Applied Science Education Committee

Tom Manteuffel: Chair of Program Numerical Analysis Preliminary Exam Committee; Vice-president at Large of the Society of Industrial and Applied Mathematics; Editor-in-Chief of the Society of Industrial and Applied Mathematics Journal of Numerical Analysis; member of Program Undergraduate Committee, and Program Computing Committee; Program representative to Arts and Science Council; member Joint PhD Coordinating Committee

Steve McCormick: Chair of Program Graduate Committee (from 7/1/95); member of Program Faculty Search Committee, Program Computer Committee, Program Executive Committee, and Program Numerical Analysis Preliminary Committee

James Meiss: member of Program Undergraduate Committee, and Boulder SMART Committee; chair, Program Computer Committee; University representative for the Goldwater Scholarship; organized the 3rd SIAM Dynamical Systems Meeting

Harvey Segur: Chair of Program Graduate Committee (to 6/30/95); member of Boulder Faculty Assembly

John Williamson: Chair of Program Undergraduate Committee (to 6/30/95); member of College of Engineering Scholarship Committee

6. TEACHING ACTIVITIES

A. Courses Taught by Program Faculty, Academic Year 1995-96

(i) Undergraduate Courses

- APPM 1350 *Dougherty, Lomeli, Schober, Segur*, Calculus 1 for Engineers.
- APPM 1360 *Bebernes, Dougherty, Meiss, Norris*, Calculus 2 for Engineers.
- APPM 2350 *Herod, Le, Manteuffel, McCormick*, Calculus 3 for Engineers.
- APPM 2360 *Bebernes, Curry, Le, Li, Meiss*, Linear Algebra and Differential Equations.
- APPM 3010 *Meiss*, An Introduction to Nonlinear Systems: Chaos.
- APPM 3050 *Herod*, Introduction to Symbolic and Numerical Computation.
- APPM 3310 *Fornberg, Le*, 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 4520 (MATH 4520) *Williamson*, Introduction to Mathematical Statistics.
- APPM 4560 *Williamson*, Introduction to Probability Models.
- APPM 4570 *Dougherty*, Statistical Methods.
- APPM 4580 *Little/Williamson*, Statistical Applications Software Methods.
- APPM 4650 *Easton*, Intermediate Numerical Analysis 1.
- APPM 4660 *Easton*, Intermediate Numerical Analysis 2.

(ii) Graduate Courses

- APPM 5350 *Fornberg*, Methods in Applied Mathematics: Boundary Value Problems.
- APPM 5360 *Ablowitz*, Methods in Applied Mathematics: Complex Variables.
- APPM 5440 *Li*, Applied Analysis 1.
- APPM 5450 *Li*, Applied Analysis 2.
- APPM 5470 (MATH 5470) *Segur*, Methods in Applied Mathematics 3: Partial Differential Equations.
- APPM 5480 *Segur*, Methods in Applied Mathematics 4: Perturbation Methods.
- APPM 5520 (MATH 5520) *Williamson*, Introduction to Mathematical Statistics.
- APPM 5560 *Williamson*, Introduction to Probability Problems.
- APPM 5570 *Dougherty*, Statistical Methods.
- APPM 5580 *Little/Williamson*, Statistical Applications Software Methods.
- APPM 5600 (MATH 5600) *Manteuffel*, Numerical Analysis 1.
- APPM 5610 (MATH 5610) *Fornberg*, Numerical Analysis 2.

- APPM 6520 (MATH 6520) *Williamson*, Mathematical Statistics.
- APPM 6550 (MATH 6550) *Holley*, Introduction to Stochastic Processes.
- APPM 7300 *Ablowitz*, Mathematical Methods in Nonlinear Waves and Integrable Equations.
- APPM 7400 *Bebernes*, Topics in Applied Mathematics--Techniques for Partial Differential Equations.
- APPM 7400 *Meiss*, Topics in Applied Mathematics--Dynamical Systems.
- APPM 7400 *Beylkin*, Topics in Applied Mathematics--Wavelets and Fast Algorithms in Numerical Analysis and Signal Processing.
- APPM 7400 *Curry*, Teaching and Learning Seminar in the Mathematical Sciences.
- APPM 8000 *McCormick*, Seminar in Applied Mathematics.
- APPM 8100 *Meiss*, Seminar--Nonlinear Waves and Dynamical systems
- APPM 8200 *McCormick*, Seminar--Computational Mathematics.

B. Summer Courses, 1996

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

7. RESEARCH ACTIVITIES FOR CALENDAR YEAR 1995

A. Research Publications for Calendar Year 1995

Mark Ablowitz:

- "Multisoliton Interactions and Wavelength-Division-Multiplexing", S. Chakravarty, M.J. Ablowitz, J.R. Sauer, R.B. Jenkins, *Opt. Lett.*, **20** (1995) 136-138.
- "Integrability, Computation and Applications", M.J. Ablowitz, S. Chakravarty, B.M. Herbst, *Acta Applicande Mathematicae*, **39** (1995) 5-37.
- "Data-Dependent Timing Jitter In WDMS Soliton Systems", R.B. Jenkins, J.R. Sauer, S. Chakravarty and M.J. Ablowitz, *Opt. Lett.* **20** (1995) 1964-1966.
- "Numerical Simulation of Quasi-Periodic Solutions of the Sine-Gordon Equation", M.J. Ablowitz, C.M. Schober and B. Herbst, *Physica D* **87** (1995) 35-47.

Gregory Beylkin:

- "On the Fast Fourier Transform of Functions with Singularities" *Applied and Computational Harmonic Analysis*, **2** (1995) 363-381.
- "A Multiresolution Strategy for Numerical Homogenization", G. Beylkin and M.E. Brewster, *Applied and Computational Harmonic Analysis*, **2** (1995) 327-349.
- "On Factored FIR Approximation of IIR Filters", *Applied and Computational Harmonic Analysis*, **2** (1995) 293-298.
- "SAR Imaging and Multiresolution Analysis", G. Beylkin, J.D. Gorman, S. Li-Fliss, and M.A. Ricoy, *Proceedings of SPIE*, 1995.

James H. Curry:

- "Low-order models, initialization, and the slow manifold", J.H. Curry, S.E. Haupt and M.N. Limber, *Tellus*, **47A** (1995) 145-161.

Bengt Fornberg:

- "A compact fourth order finite difference scheme for the steady incompressible Navier-stokes equations", B. Fornberg, M. Li, and T. Tang, *International Journal for Numerical Methods in Fluids*, **20** (1995) 1137-1151.
- "A pseudospectral approach for polar and spherical geometries", *SIAM J. Sci. Comput.*, **20** (1995) 1071-1081.

Congming Li:

- "What Kinds of Singular Surfaces Can Admit Constant Curvature", *Duke Math. J.*, **78** (1995) 437-451.
- "A Note on the Kazdan-Warner Type Conditions", *J. Diff. Geom.*, **41** (1995) 259-268.
- "A Necessary and Sufficient Condition for the Nirenberg Problem", *Comm. Pure Appl. Math.*, **48** (1995) 657-667.

Tom Manteuffel:

- “Accurate Discretization for Singular Perturbations: The One-Dimensional Case”, T. Manteuffel, X.C. Hu, S.F. McCormick, and T.F. Russel, *SIAM J. Numer. Anal.*, Vol. 32, No. 1 (1995) 83-109.
- “A Fast Multigrid Algorithm for Isotropic Transport Problems I: Pure Scattering”, T. Manteuffel, S.F. McCormick, J.E. Morel, S. Oliveira, and G. Yang, *SIAM J. Sci. and Stat. Comp.*, Vol. 16, No. 3, May 1995, 601-635.
- “Adaptive K -step Iterative Methods for Nonsymmetric Systems of Linear Equations”, T. Manteuffel, G. Starke, and R.S. Varga, *Elec. Trans. Numer. Anal.*, Vol.3 (1995) 50-65.
- “First-Order System Least Squares for Velocity-Vorticity-Pressure Form of the Stokes Equations, with Application to Linear Elasticity”, T. Manteuffel, Z. Cai, and S.F. McCormick, *Elec. Trans. Numer. Anal.*, Vol.3 (1995) 150-159.

Steve McCormick:

- “A Fast Multigrid Algorithm for Isotropic Transport Problems, Part I: Pure Scattering”, S.F. McCormick, T. Manteuffel, J. Morel, S. Oliviera, and G. Yang, *SIAM J. Sci. Comp.*, 16 (1995) 601-635.
- “Accurate Discretization for Singular Perturbations: the One-Dimensional Case”, S.F. McCormick, X.C. Hu, T. Manteuffel, T. Russell, *SIAM J. Numer. Anal.*, Vol. 32, No. 1 (1995) 83-109.
- “First-order System Least Squares for Second-order Elliptic Problems with Discontinuous Coefficients”, S.F. McCormick, T. Manteuffel, and G. Starke, *Procs. 7th Copper Mountain Conf. on Multigrid Methods*, NASA Pubs., Hampton, VA, 1995.
- “A Global Shallow Water Numerical Model Based on the Semi-Lagrangian Advection of Potential Vorticity”, S.F. McCormick, J.R. Bates, A. Brandt, Y. Li, and J. Ruge, *Quart. J. Royal Meteorol. Soc.*, 121 (1995) 1981-2005.

James Meiss:

- “Controlling Transport through Recurrences”, E. Boltt and J.D. Meiss, *Physica D*, 81 (1995) 280-294.
- “Evolution of Magnetic Islands in a Helic”, T. Hayashi, T. Sato, H.J. Gardner, and J.D. Meiss, *Physics of Plasmas*, 2 (1995) 752-775.
- “Targeting Chaotic Orbits to the Moon through Recurrence”, E. Boltt and J.D. Meiss, *Physics Lett. A*, 204 (1995) 373-383.

Constance Schober:

- “Numerical Simulation of Quasi-Periodic Solutions of the Sine-Gordon Equation”, M.J. Ablowitz, C.M. Schober, and B. Herbst, *Physica D*, 87, 1995.

Harvey Segur:

- “Two-dimensional Periodic Waves in Shallow Water, Part 2: Asymmetric Waves”, J.L. Hammack, D. McCallister, H. Segur, and N.W. Sheffner, *J. Fluid Mech.*, 285 (1995) 95-122.

John A. Williamson

- “The Guess LOD Approach: Sufficient Conditions for Robustness”, *Genetic Epidemiology*, 12 (1995).

B. Invited Lectures and Meetings Attended for Calendar Year 1995

Mark Ablowitz:

University of Colorado, Program in Applied Mathematics, "1895-1995: Integrability and Applications", Feb. 10, 1995.

Colorado State University, Dept. of Mathematics, "1895-1995: Integrability and Applications", March 30, 1995.

Ph.D. Course, KdV'95, University of Amsterdam, the Netherlands, "Numerical Computation of Integrable Systems I and II", April 21, 1995.

International Symposium, KdV'95, Amsterdam, the Netherlands, "1895-1995: Integrability and Applications", April 25, 1995.

Mathematics Department, University of Leeds, United Kingdom, "1895-1995: Integrability and Applications", April 27, 1995.

Mathematics Department, University of Loughborough, United Kingdom, "1895-1995: Integrability and Applications", May 5, 1995.

Workshop on Nonlinear Phenomena, Solitons and Symmetries, Kent University, Canterbury, UK, "Integrability, Painleve, Equations and Novel Systems", May 9, 1995.

Workshop on Nonlinear Optics, Mathematics Department, University of Arizona, "Nonlinear Schrödinger Equations and Wavelength Division Multiplexing", October 2, 1995.

Department of Mathematics, Kent University, Canterbury, England, "Computational and Effective Chaos in Integrable Systems", November 17, 1995.

Jerrold Bebernes:

Oberwolfach PDE Conference, Oberwolfach, Germany, "Understanding Blowup", February 14-21, 1995.

Autonoma Universita, Madrid, Spain, "Blowup and Beyond", February 23-28, 1995.

Center for Dynamical Systems, Georgia Tech, Atlanta, GA, "Initiation of Reaction Waves", May 22, 1995.

European Research Conference on Local Singularities to Solutions to Nonlinear and Singular PDE's, San Feliu, Spain, "Global Existence for Nonlinear Parabolic Problems", September 19-24, 1995.

Math Colloquium, Colorado School of Mines, "Shear Band Formation", November 10, 1995.

Gregory Beylkin:

Batelle PNL, Richland, WA, "Unequally Spaced Fast Fourier Transform and its Applications", January 1995

Princeton University, "Unequally Spaced Fast Fourier Transform and its Applications", May 1995

Princeton University, "Multiresolution Strategy for Homogenization", May 1995

ARPA Program Review, Arlington, VA, "Fast Numerical Algorithms and SAR Applications", May 1995

AMS-SIAM Summer Seminar, Park City, Utah, "Multiresolution Strategy for Homogenization", August 6-9, 1995.

ARPA Program Review, Arlington, VA, "Fast Numerical Algorithms and SAR Applications", September 1995

James H. Curry:

Claytor Lecture at the American Mathematical Society, Berkeley, CA, "Bairstow Methods of Factoring Polynomials Iteratively", January 1995.

Bob Easton:

Third SIAM Conference on Dynamical Systems, Snowbird, Utah, "Applications of the Conley Index", May 20-24, 1995.

Colorado State University, Fort Collins, "Isolating Blocks and Epsilon Chains", Sept. 21, 1995.

Program in Applied Mathematics, University of Colorado, Boulder, "Isolating Blocks and Resonance Zones for Maps", September 29, 1995.

Midwest Dynamical Systems Conference 25th Anniversary, Cincinnati, Ohio, "Resonance and Transport in Discrete Dynamical Systems", October 6-8, 1995.

University of Colorado Complexity Seminar, "Discrete Dynamical Systems, an Introduction", October 23, 1995.

Scott Herod:

Colorado Days, Center for Nonlinear Studies, Los Alamos, NM, "On the Effects of Introducing Delays in Differential Equation Models", March 30, 1996.

Program in Applied Mathematics, University of Colorado, Boulder, "Counting Solutions of Differential Equations", November 2, 1995.

Congming Li:

Mathematisches Forschungsinstitut Oberwolfach Conference, Germany, "Qualitative Aspects of Partial Differential Equations", February 16, 1995.

Department of Mathematics, Hong Kong University of Science and Technology, May 23, 1995.

Institute of System Sciences, Academia Sinica, P.R. China, May 29, 1995.

Institute of Applied Mathematics, Academia Sinica, P.R. China, May 30, 1995.

Department of Mathematics Graduate School of the Academia Sinica & USTC, June 1, 1995.

Department of Mathematics XuZhou Normal University, XuZhou, JiangSu, P.R. China, June 14, 1995.

SuZhou University Conference on Mathematical Modeling and Analysis of Superconductivity, JiangSu Province, P.R. China, June 21, 1995.

Institute of Mathematical Science, ZheJiang University, HangZhou ZheJiang, P.R. China, June 23, 1995.

Department of Mathematics, University of Wyoming, October 25, 1995.

AMS Meeting 905, Los Angeles, CA, November 12, 1995.

Courant Institute of Mathematical Science, New York University, November 29, 1995.

Tom Manteuffel:

- Colloquium, Wichita State University, "First-Order Systems Least-Squares: A New Methodology for Solving Partial Differential Equations", March 10, 1995.
- Workshop on Conjugate Gradient Methods, University of Washington, Seattle, WA, "Multiple Recursion Conjugate Gradient Methods", July 9-14, 1995.
- Minisymposium on Least-Squares Finite Element Methods, SIAM Annual Meeting, Charlotte, NC, "First-Order Systems Least-Squares: A New Methodology for Solving Partial Differential Equations", October 22-27, 1995.

Steve McCormick:

- AFIT Distinguished Lecture Series, Wright Patterson AFB, Dayton, Ohio, "Multilevel First-order System Least Squares in CFD", January 26, 1995.
- Seventh Copper Mountain Conference on Multigrid Methods, Copper Mtn., CO, "First-order System Least Squares: General Principles", March 6, 1995.
- ICASE Lecture Series, Hampton, VA, "First-order System Least-squares Methods in Fluid Dynamics", May 7, 1995.
- AFOSS Contractor Meeting, Phillips Lab, Albuquerque, NM, "Multilevel Methods in Large-scale Computation", June 28, 1995.

James Meiss:

- Mathematics Dept., University of Bourgogne, Dijon, France, "Control of Chaos -- Efficient Satellites", March 30, 1995.
- Physics Dept., University of Minnesota, "Controlling Chaos", April 12, 1995.
- Physics Dept., University of Minnesota, "Self Consistent Chaos", April 13, 1995.
- NATO Advanced Study Institute on 3 Degrees of Freedom, Sagoro, Spain, "On the Breakup of Invariant Tori with Three Frequencies", June 19-30, 1995.

Lucas Monzón:

- University of Colorado, Boulder, "Wavelets and Quadrature Mirror Filters", January 26, 1995.

Constance Schober:

- Dynamics Days, Houston, TX, "On the Numerics of Integrable Discretizations", January 1995.
- Dept. of Mathematics, University of Wyoming, Laramie, "A Melnikov Analysis of Numerically Induced Chaos in the Nonlinear Schrödinger Equation", May 1995.
- Third SIAM Conference on Applications of Dynamical Systems, Snowbird, UT, "Symplectic Integrators for the sine-Gordon Equation", May 1995.
- NATO Advanced Study Institute on Hamiltonian Systems with three or more degrees of freedom, S'Agaro, Spain, "Melnikov Analysis of a Hamiltonian Perturbation of the Nonlinear Schrödinger Equation", June 1995.
- Control and Chaos Workshop, East-West Center, Honolulu, Hawaii, "Chaos in Symplectic Discretizations of the Pendulum and sine-Gordon Equations", July 1995.
- Research Institute in Applied Mathematics and Systems (IIMAS), National University of Mexico (UNAM), "Homoclinic Orbits in a Conservative Perturbation of the Nonlinear Schrödinger Equation", August 1995.

Harvey Segur:

Nonlinear Ocean Waves, Luminy, France, "Periodic Waves in Shallow Water", May 19, 1995.

Northwestern University, Evanston, IL, "Periodic Waves in Shallow Water", September 8, 1995.

University of Colorado, Boulder, "Periodic Waves in Shallow Water", September 15, 1995.

C. Research Grants for Calendar Year 1995

Mark Ablowitz:	<u>amount for 1995</u>
NSF, Mathematics Division: 1994-96	\$25,000
AFOSR, Mathematics: 1994-96	\$90,000
ONR, Mathematics: 1994-97	\$36,900
Air Force AASERT: 1993-97	\$29,000
ONR AASERT: 1994-97	\$48,000
 Gregory Beylkin:	
ONR, Mathematics Division: 1993-96	\$35,150
ONR: 1992-1996	\$58,600
ARPA: 1993-96	\$153,200
 James Curry	
AASERT, ONR, Physics/Oceanography Div.: 1993-96	\$29,500
DOE Grant: 1993-96	\$50,000
NSF Statewide Systemic Initiative: 1993-97	\$17,500
 Congming Li	
NSF, 1994-96	\$20,100
 Tom Manteuffel	
DOE, Applied Mathematics: 1993-96	\$106,448
NSF, Mathematics Division: 1994-97	\$50,000
NSF, Special Projects: 1994-97	\$12,000
 Steve McCormick	
AFOSR: 1994-96	\$80,000
NSF, Mathematics Division: 1994-97	\$50,000
NSF, Special Projects: 1994-97	\$12,000
 James Meiss	
NSF, Mathematics Division: 1993-95	\$20,000
NSF, Graduate Traineeship: 1993-98	\$111,000
 Harvey Segur	
NSF, Mathematics Division: 1993-96	\$17,350
ONR, Physics/Oceanography Division: 1995-97	\$56,000

D. Miscellaneous for Calendar Year 1995

Mark Ablowitz:

CRCW Fellow, 1994-1995

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

Advisory boards: *Chaos, Inverse Problems*, Springer Verlag Series in Integrable Systems and Solitons

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

Co-organizer: International Conference, University of Colorado at Boulder, CO, Aug. 3-6, 1995

Jerrold Bebernes:

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

Evaluator: PDE proposals (Classical Analysis Program), NSF Institute of Mathematics with Applications

Gregory Beylkin:

Editorial boards: *SIAM Journal on Numerical Analysis*; *Applied and Computational Harmonic Analysis*; Reviewer: NSF proposals; several journals

James Curry:

Co-PI: Colorado State Systemic Initiative

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

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*

Congming Li:

Reviewer: NSF; *Rocky Mountain Journal of Mathematics*; *Communications in Pure and Applied Mathematics*; *Journal of American Mathematical Society*, *Communications in Partial Differential Equations*, and *Indiana University Mathematics Journal*

Tom Manteuffel:

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

Reviewer: *SIAM Journal on Scientific and Statistical Computing*; *SIAM Journal on Matrix Analysis*; *SIAM Journal on Numerical Analysis*; *Journal of Computational Physics*; *Mathematics of Computation*; *Linear Algebra and its Applications*; *Journal of Numerical Linear Algebra*; *Numerische Mathematica*

Co-Chair, 7th Colorado Conference on Multigrid Methods, Copper Mountain, CO, April 3-7, 1995

Co-Chair, 7th Colorado Conference on Iterative Methods, Copper Mountain, CO, April 9-13, 1996

Vice President at Large of the Society of Industrial and Applied Mathematics

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

Steve McCormick:

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

Reviewer: grant proposals; *IMACS*

Co-Chair, 7th Colorado Conference on Multigrid Methods, Copper Mountain, CO, April 3-7, 1995

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

James Meiss:

Editor: *Physica D*

Reviewer: NSF proposals; *Physica D*; *Physical Review*; *Physics Letters*; *Physical Review Letters*; book for *Physics Today*

Program Chair of SIAM

Harvey Segur:

Reviewer: NSF; International Science Foundation; *Journal of Fluid Mechanics*; *J Nonlinearity*; *Physica D*; *Physical Review E*; *Physical Review Letters*; *Physics Letters A*; *SIAM Journal of Applied Mathematics*.; *European Journal of Mechanics*; *Physics of Fluids*; NWO

Outstanding Faculty Member Award, 1995

8. PREPRINTS OF THE PROGRAM: 1995-96

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

No.

253. Optimal DNA Sequence Parsing, J.L. Fess, November 1994.
254. The Nonlinear Schrödinger Equation: Asymmetric Perturbations, Traveling Waves and Chaotic Structures, M.J. Ablowitz, B.M. Herbst and C.M. Schober, August 1995.
255. The Burgers Equation Under Deterministic and Stochastic Forcing, M.J. Ablowitz and S. De Lillo, July 1995.
256. On a 2+1 Volterra System, J. Villarroel, S. Chakravarty and M.J. Ablowitz, September 1995.
257. Mel'nikov Analysis of a Hamiltonian Perturbation of the Nonlinear Schrödinger Equation, A. Calini and C.M. Schober, September 1995.
258. A Universality of Random Knotting, T. Deguchi and K. Tsurusaki, September 1995.
259. Computational Chaos in the Nonlinear Schrödinger Equation Without Homoclinic Crossings, M.J. Ablowitz, B.M. Herbst and C.M. Schober, October 1995.
260. On the Break-up of Invariant Tori with Three Frequencies, J.D. Meiss, November 1995.
261. Perturbations of Elliptic Billiards, H.E. Lomeli, November 1995.
262. On the Adaptive Numerical Solution of Nonlinear Partial Differential Equations in Wavelet Bases, G. Beylkin and J.M. Keiser, November 1995.
263. Initial Time Layers and Kadomtsev-Petviashvili Type Equations, M.J. Ablowitz and X-P. Wang, December 1995.
264. On the Numerical Solution of the Sine-Gordon Equation. II. Performance of Numerical Schemes, M.J. Ablowitz, B.M. Herbst and C.M. Schober, December 1995.
265. Late Stage Coarsening of Adlayers by Dynamic Cluster Coalescence, D.S. Sholl and R.T. Skodje, December 1995.
266. Adsorption Kinetics of Direct and Precursor Mediated Dissociative Chemisorption by Atom Abstraction, D.S. Sholl, January 1996.
267. A Sum of Cantor Sets. An Elementary Observation, James D. Arnow, January 1996.
268. Heteroclinic Orbits and Transport in a Perturbed Integrable Standard Map, H.E. Lomeli and J.D. Meiss, February 1996.

269. Multiscale Inversion of Elliptic Operators, A. Averbuch, G. Beylkin, R. Coifman and M. Israeli, March 1996.
270. A Multiresolution Strategy for Reduction of Elliptic PDE's and Eigenvalue Problems, G. Beylkin and N. Coult, March 1996.
271. Painlevé Type Equations, contribution to the Encyclopaedia of Mathematics, Kluwer Academic Publishers, M.J. Ablowitz, March 1996.
272. Some Global Bifurcation Results for Elastic Plates, V.K. Le, April 1996.
273. Contact of a Von Karman Plate and an Elastic Body, V.K. Le, April 1996.
274. Some Global Bifurcation Results for Variational Inequalities, V.K. Le, April 1996.
275. A Multidimensional Analogue of the Denjoy-Perron-Henstock-Kurzweil Integral, D.D. Ang, K. Schmitt and V.K. Le, October 1995.
276. Four-Wave Mixing in Wavelength Multiplexed Soliton Systems, M.J. Ablowitz, S. Chakravarty, R.B. Jenkins and J.R. Sauer, April 1996.
277. Solutions to the Time Dependent Schrödinger and the Kadomtsev-Petviashvili Equations, M.J. Ablowitz and J. Villarroel, May 1996.
278. LU Factorization of Nonstandard Forms and Direct Multiresolution Solvers, D.L. Gines, G. Beylkin and J. Dunn, May 1996.
279. Bifurcations in a Class of Noninvertible Mappings of the Plane, L. Billings and J.H. Curry, May 1996.
280. A Fast Adaptive Algorithm for Elliptic Boundary Value Problems, A. Averbuch, G. Beylkin, R. Coifman and M. Israeli, May 1996.
281. Calculation of Weights in Finite Difference Formulas, B. Fornberg, May 1996.
282. Calculation of Weights for Hermite-Type Finite Difference Schemes, B. Fornberg, May 1996.
283. Four-Wave Mixing in Wavelength-Division Multiplexed Soliton Systems -- Ideal Case, M.J. Ablowitz, G. Biondini, S. Chakravarty, R.B. Jenkins and J.R. Sauer, May 1996.
284. Four-Wave Mixing in Wavelength-Division Multiplexed Soliton Systems -- Damping and Amplification, M.J. Ablowitz, G. Biondini, S. Chakrvarty, R.B. Jenkins and J.R. Sauer, May 1996.
285. A Global Shallow Water Numerical Model Based on the Semi-Lagrangian Advection of Potential Vorticity, J.R. Bates, Y. Li, A. Brandt, S.F. McCormick and J. Ruge, May 1995.
286. Multilevel Image Reconstructon with Natural Pixels, V.E. Henson, M.A. Limber, S.F. McCormick and B.T. Robinson, January 1995.
287. Parallel Multigrid Methods, J.E. Jones and S.F. McCormick, December 1995.
288. First-Porder System Least Squares (FOSLS) for Convection-Diffusion Problems: Numerical Results, J.M. Fiard, T.A. Manteuffel and S.F. McCormick, June 1995.
289. First-Order System Least Squares for Velocity-Vorticity-Pressure Form of the Stokes Equations, with Application to Linear Elasticity, Z. Cai, T.A. Manteuffel and S.F. McCormick, November 1995.

290. First-Order System Least-Squares for Second-Order Elliptic Problems with Discontinuous Coefficients, T.A. Manteuffel, S.F. McCormick and G. Starke, April 1995.
291. Analysis of Velocity-Flux Least Squares Principles for Navier-Stokes Equations, P. Bochev, Z. Cai, T.A. Manteuffel and S.F. McCormick, December 1995.
292. First-Order System Least Squares for the Pure Traction Problem in Planar Linear Elasticity, Z. Cai, T.A. Manteuffel, S.F. McCormick and S. Parter, October 1995.
293. Multilevel First-Order System Least Squares (FOSLS) for Helmholtz Equations, B. Lee, T. Manteuffel, S. McCormick and J. Ruge, June 1995.
294. First-Order System Least Squares for the Stokes Equations, with Application to Linear Elasticity, Z. Cai, T.A. Manteuffel and S.F. McCormick, May 1995.
295. A Nonlinear Multigrid Solver for a Semi-Lagrangian Potential Vorticity Based Shallow Water Model on the Sphere, J.W. Ruge, Y. Li, S. McCormick, A. Brandt and J.R. Bates, July 1995.
296. Averaging for Density Dependent Markov Chain, A. Dougherty, June 1996.
297. Limit Results for the Uniform Random Spanning Tree of a Complete Bipartite Graph, A. Dougherty, June 1996.
298. A Heavy Traffic Limit Theorem for a Controlled Multi-Access Channel, A. Dougherty, June 1996.
299. A Generalized Stability Criterion for Resonant Triad Interactions, H. Segur, C. Chow and D. Henderson, August 1995.
300. A Discrete Curve Shortening Equation, H. Segur, K. Nakayama and M. Wadati, November 1995.
301. Three-phase Solutions of the Kadomstev-Petviashvili Equations, H. Segur, B.A. Dubrovin and R. Flickinger, June 1996.
302. A Constructive Test for Integrability of Semi-Discrete Systems, B. Deconinck, June 1996.
303. On Noninvertible Mappings of the Plane: Eruptions, L. Billings and J.H. Curry, July 1995.