

PROGRAM IN APPLIED MATHEMATICS

UNIVERSITY OF COLORADO
AT BOULDER

BOULDER, COLORADO 80309-0526

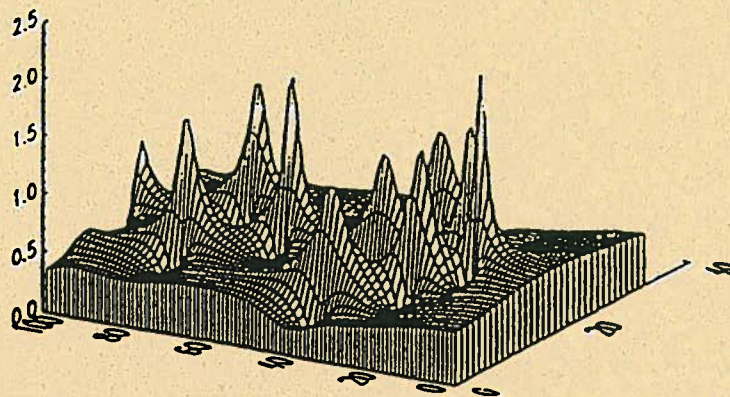
ANNUAL REPORT

1994-95

Mark J. Ablowitz, Director

Robert Easton, Interim Director

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1. The first section discusses the importance of maintaining accurate records for all activities and events. It emphasizes the need for consistency and thoroughness in data collection.

2. The second section outlines the various methods used to gather information, including surveys, interviews, and focus groups. It provides details on how these methods are implemented and the types of data they yield.

3. The third section describes the process of analyzing the collected data. It covers statistical techniques and qualitative analysis methods used to interpret the findings.

4. The fourth section discusses the dissemination of results. It details how the findings are presented to stakeholders, including reports, presentations, and public forums.

5. The fifth section addresses the challenges and limitations of the research process. It identifies common pitfalls and offers strategies to overcome them.

6. The sixth section provides a summary of the overall research process and its outcomes. It highlights the key findings and their implications for future research and practice.

PREFACE

The Program in Applied Mathematics (PAM) has completed six years of service to the University and the State of Colorado as a reconstituted academic unit. The development of the Program has been remarkable. PAM offers a BS, MS and PhD in Applied Mathematics and teaches over 10,000 credit hours per year which corresponds to our teaching approximately 2,700 students per year. It ranks seventeenth among the 34 academic units in the College of Arts and Sciences in credit hours taught. The Program has 12 tenure track faculty members, 3 full time instructors, 40 graduate students and 5 externally supported postdoctoral research associates. In addition to the core faculty, the Program has 30 affiliated faculty members from departments throughout the university who can direct MS and PhD's in Applied Mathematics.

The BS degree in Applied Mathematics is offered to students in the College of Engineering. A minor in Applied Mathematics is offered to students in the College of Arts and Sciences. At the lower division level the Program teaches a sequence of three four-credit courses entitled Calculus for Engineers and a four-credit introduction to differential equations. These courses directly serve the needs of the College of Engineering and thus are taught in a different format than calculus courses in the College of Arts and Sciences. Lower division math courses for engineers have been taught separately from A&S courses since 1906 when a Department of Applied Mathematics was created on the Boulder campus. During the period 1966-1988 Applied Math was merged with the Mathematics Department.

The Program in Applied Mathematics currently has fifty-one undergraduate majors. Nineteen of our majors were on the Dean's list last semester with grade point averages of 3.5 or better. Eleven students graduated this year with BS degrees in Applied Mathematics. In 1992 the Boulder undergraduate applied mathematics team won a first prize for its solution in the 1992 National Modelling Contest.

The PhD degree in Applied Mathematics is one of two coordinated PhD programs in the University of Colorado system. The Boulder Applied Math PhD, which is coordinated with the Denver campus, has been successful. In six years the number of graduate students has increased from 0 to 40 and the Program has granted 8 PhD degrees. The National Science Foundation has selected the Program in Applied Mathematics as one of the very few mathematical sciences units in the U.S. to be awarded a major graduate traineeship grant (\$550,000). Currently there are 20 graduate students who are supported by external grants; this includes 5 supported by NSF, 8 by the DOD AASERT Program, 4 by faculty and affiliated research grants and 3 graduate students are supported by other fellowship programs.

Research and creativity are extremely important to the Program in Applied Mathematics. In the past six years the faculty have written over 240 research papers, and are sought after to present lectures at meetings throughout the world and to be members of editorial and advisory

boards of major journals in applied mathematics. This year 17 journals/periodicals have editors and/or advisors from The Program's faculty. In the most recent annual report of the University of Colorado's Office of Contracts and Grants, external support in the Program in Applied Mathematics totalled nearly \$1.4 million, a figure which is extraordinary for a mathematical sciences unit.

Because of the nature of our research and educational mission, during the past five years, the Program in Applied Mathematics has developed one of the most powerful computing laboratories at the university. This was made possible with two large grants from the NSF division of Scientific Computing Research Equipment in the Mathematical Sciences with matching funds from the University of Colorado. The laboratory has a number of computationally proficient workstations with sophisticated graphic capabilities, including two SGI Indigo2 Extremes, eight Sun Sparc 20s, one Sun Sparc 10, five SGI Indigos, one SGI Personal Iris, and one Sun 4. This is in addition to a variety of computing devices in faculty and staff offices.

The following annual report documents the educational and research activities of the faculty and students in the Program in Applied Mathematics. Extra copies can be obtained by writing to Ms. Margy Lanham, Program in Applied Mathematics, Campus Box 526, University of Colorado, Boulder, CO 80309-0526 (margy@boulder.colorado.edu).

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, 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 1994-95, the Program in Applied Mathematics had a core of eleven 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 2670 undergraduate and graduate students in 20 undergraduate courses (divided into 41 sections) and 16 graduate courses. We have 51 undergraduate majors and we are very proud that 19 are on the Dean's list for academic achievement with grade point averages of 3.5 or better. There are also 11 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. The Program currently has 39 graduate students. In 1994-95 we had 19 teaching assistantships, 8 graduate students on fellowships and traineeships, and currently 12 graduate students are supported by research grants. 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 30 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 1994-95 over 80% of incoming students with support were U.S. citizens from U.S. undergraduate universities. Currently we have 6 foreign graduate students and 2 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 is remarkable.

This year the National Science Foundation graduate traineeships supported Erik Bollt, Brian Bloechle, Eric Harker and Joseph Iwanski. Michelle VanSteenberg 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 in procuring this prestigious award, which was one of only three such awards by NSF in the mathematical sciences. In addition, there are eight students who are supported by DOD AASERT Awards: Robert Cramer, Ron Flickinger and James Keiser (ONR; Prof. Beylkin), Daryl McCallister, Lora Merck 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; Richard Charles and Christina Perez received NSF fellowships.

C. Enrollment Statistics

The 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

In 1994-95 we observed a small decrease in enrollment in our lower division courses due to smaller enrollments in Engineering. However, enrollment in our upper division courses has continued to increase. 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 honor; 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

August 1994: Scott Herod. May 1995: Erik Bollt, James Keiser.

Master's degree

December 1994: Kerrie Paige, Vicky Corlew; Cheryl Persinger. May 1995: Nicholas Coult, Joy Eakins, Jennifer Fess.

Bachelor's degree

December 1994: Hoa Nguyen. May 1995: Suzanne Doyle, Jason Gingerich, Jennifer Kolar, Albert Lee, Jonathan Nolting, Jennifer Oursler, Megan Prenger, Bain Slack, Simon Springett, Shawn Tanner.

F. Research

The research activities of the core faculty in the Program are varied. They include nonlinear dynamics, 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 including Aerospace Engineering; Astrophysical, Planetary, and Atmospheric Sciences; Chemistry and

Biochemistry; Civil Engineering; Computer Science; Electrical and Computer Engineering; Geological Sciences; Mathematics; Mechanical Engineering; 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. In fact, during 1994-95 the faculty in the Program currently serve in seventeen such capacities on fourteen journals/periodicals which include:

Applied and Computational Harmonic Analysis (Beylkin)
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 on Applied Mathematics (Ablowitz) (through 12/94)
SIAM Journal on Numerical Analysis (Beylkin, Manteuffel)
SIAM Journal on Scientific Computing (Manteuffel, McCormick)
Studies in Applied Mathematics (Ablowitz)

In addition, J. Curry is a member of the board of governors of The Geometry Center at the University of Minnesota and T. Manteuffel is a member of the governing council of the Society of Industrial and Applied Mathematics (SIAM) and a member of the program committee of SIAM.

External research grant/contract support continues to increase. The Office of Contracts and Grants of the university documents external support for 1993-1994 for the Program in Applied Mathematics to be nearly \$1.4 million dollars! This includes significant grant support for graduate students: a) the NSF traineeship grant which will support six students; b) the DOD AASERT program which now supports eight students; and c) three students who 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

This summer the Program in Applied Mathematics is organizing and hosting an international conference entitled "Symposium in Applied Mathematics: Nonlinear Waves and Dynamics, Asymptotic Analysis, and Physical Applications" which will be held August 3-6, 1995. This conference will honor the many significant and varied contributions of Professor Martin D. Kruskal who will turn 70 years old this year. The meeting will be broad in scope and will include the following topics: nonlinear waves and dynamics, asymptotic analysis, and physical applications.

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 1995 the conference was held in Boulder on March 17 and 18. 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 opinion is that this meeting is a very worthwhile experience. Thanks go to our local organizer, Yoshi Kimura.

During the summer of 1994 the Program hosted visitors from the former Soviet Union (FSU). This was the second such summer program and involved theoretical and mathematical problems in physics, astrophysical sciences and related fields. It was sponsored by the Sloan Foundation; the Program in Applied Mathematics; Dept. of Astrophysical, Planetary, and Atmospheric Sciences; Dept. of Physics; Dean of Arts and Sciences; Dean of CU Graduate School; Vice President for Academic Affairs and Research; Vice Chancellor for Academic Affairs; and the National Center for Atmospheric Research. In 1994 there were four long-term visitors and four short-term visitors. Two seminars were given each week throughout the summer.

Rocky Mountain Experience IV, our annual short summer mini-conference, was held August 3 and 4, 1994 and featured 17 speakers. It coincided with the end of the 1994 visiting FSU summer program. This year Rocky Mountain Experience V will be held in conjunction with the Symposium in Applied Mathematics.

The Third Colorado Conference on Iterative Methods was held April 4-10, 1994, 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 is joining the Program as a full professor. 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.

During this academic year we received over 200 applications in response to our advertisement for instructor positions. We have hired Dr. Hector Lomeli from the University of Minnesota to be the Program's new long term instructor. Hector's field of expertise is dynamical systems. We have also hired Dr. Vy Le, an expert in the analysis of partial differential equations, as a one year instructor. We welcome both Hector and Vy. Anne Dougherty continues her appointment as instructor. Anne's research area is applied probability and stochastic processes.

I. Remarks

Yoshi Kimura leaves for a position as full professor in the Graduate School of Polymathematics at Nagoya University in Japan. This is a remarkable advancement from instructor to full professor. Congratulations Yoshi!

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

A warm and sincere appreciation to our fine staff: Stu Naegele (Administrative Assistant), Janet Glasser (Student Coordinator), Margy Lanham (word processing operator), Linh Huynh (work study student) for the outstanding job they have done this year. 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 THANK YOU VERY MUCH!

2. FACULTY AND STAFF

A. Core Faculty and Long Term Visitors

- Mark J. Ablowitz**, Professor; PhD, Massachusetts Institute of Technology. Partial Differential Equations, Solitons, Nonlinear Waves.
- Loyce Adams**, Visiting Professor from Dept. of Applied Math, University of Washington; PhD, University of Virginia. Numerical Linear Algebra, Multigrid Methods, PDE Immersed Interface Problems
- 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.
- Sarbarish Chakravarty**, Lecturer, Research Associate; PhD, University of Pittsburgh. General Relativity, Nonlinear Integrable Systems.
- Mark Coffey**, Instructor; PhD, Mathematics, Courant Institute of Mathematical Sciences, New York University; PhD, Physics, Iowa State University. Nonlinear partial differential equations, theoretical superconductivity.
- James H. Curry**, Professor; PhD, University of California at Berkeley. Dynamical Systems, Numerical Methods, Nonlinear Equations. (Also Interim Director MASP, Minority A&S Program.)
- Anne Dougherty**, Instructor; PhD, University of Wisconsin, Madison. Applied Probability, Stochastic Processes.
- Robert Easton**, Director, 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.
- Ben Herbst**, Visiting Professor; PhD, University of Orange Free State, South Africa. Numerical Analysis, Solitons.
- Scott Herod**, Instructor, PhD, University of Colorado. Symmetries and Differential Equations.
- Yoshi Kimura**, Instructor; PhD, University of Tokyo. Theoretical and Computational Fluid
- Kadir Kirkkopru**, Research Associate; PhD, University of Colorado. Perturbation Methods, Computational Fluid Dynamics. (through December 1994)
- Randy Leveque**, Visiting Professor from Applied Math and Mathematics Departments, University Washington; PhD, Stanford. Numerical Analysis, Computational Fluid Dynamics, Nonlinear Hyperbolic Conservation Laws.
- Congming Li**, Assistant Professor; PhD, New York University. Nonlinear Differential Equations.
- John Maybee**, Professor Emeritus; PhD, University of Minnesota. Applied Combinatorics and Matrix Analysis.

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

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.

Gerhard Starke, Research Associate; PhD, University of Karlsruhe, Germany. Iterative Methods, Numerical Solutions of PDEs.

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 and Physics), 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 and 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 and Physics), Plasma Physics, Nonlinear Waves, Turbulence

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

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

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

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, 1994-95

Amir Averbuch, Tel-Aviv University (July 1994)

Achi Brandt, Weizmann Institute (March-April 1995)

Robert Burrige, Schlumberger-Doll Research, Ridgefield, CT (June-August 1995)

Zhiqiang Cai, University of Southern California (July 1994)
Wenxiong Chen, Southwest Missouri State University (August 1994).
Peter Clarkson, University of Exeter, UK (August 1994)
Victor Galaktionov, Keldysh Inst. of Applied Mathematics, Moscow, Russia (Summer 1994)
Joe Hammack, Pennsylvania State University (September 1994)
Xiancheng Hu, Tsinghua University (March-May 1995)
Takeshi Iizuka, Dept. of Physics, Ehime University, Japan (September 1994)
Moshe Israeli, Technion, Haifa, Israel (February 1995)
Isaak M. Khalatnikov, Landau Institute for Theoretical Physics, Moscow and Tel Aviv Univ.
Sacler Inst. of Advanced Studies, Israel (July-August 1994)
Martin D. Kruskal, Princeton and Rutgers Universities (July 1994)
Jacques Laskar, Ecole Normale Supérieure, Paris (May 1995)
Vladimir Makhankov, Joint Institute for Nuclear Research, Dubna, Russia; and Center for
Nonlinear Studies, Los Alamos National Laboratory (August 1994)
Elizabeth Mansfield, University of Exeter, UK (August 1994)
Robert MacKay, University of Warwick, UK (May 1995)
Shintaro Mori, Dept. of Physics, University of Tokyo (February 1995)
S. Murakami, Dept. of Physics, University of Tokyo (February 2-March 9, 1995)
Kazuaki Nakayama, Dept. of Physics, University of Tokyo (February 1995)
Takenobu Nakao, Dept. of Physics, University of Tokyo (September 1994)
Christoph Pflaum, Institut für Informatik, TU Munich, Germany (March-June 1995)
Vladimir Prigodin, A.F. Ioffe Physico-Technical Institute, Russian Academy of Sciences, St.
Petersburg, Russia (July-August 1994)
Ulrich Ruede, University of Munich (August 1994)
Michael Spector, Dept. of Fluid Mechanics, Tel Aviv University (July-August 1994)
Linda Stals, Australian National University (February 1995)
Jaroslav Stark, University College of London, UK (May 1995)
Boris Stern, Institute for Nuclear Research, Russian Academy of Sciences, Moscow (Summer
1994)
Hideaki Ujino, Dept. of Physics, University of Tokyo (February 1995)
Javier Villarroel, University of Salamanca, Spain (September 1994)
Miki Wadati, Dept. of Physics, University of Tokyo (Feb 2-March 9, 1995)
Tetsu Yajima, Dept. of Applied Physics, University of Tokyo, Japan, (September 1994)
Gene D'Yakonov, Moscow State University (February-March 1995)

D. Staff

Stu Naegele - Administrative Assistant

Janet Glasser - Student Coordinator

Margy Lanham - Word Processing Operator

3. COLLOQUIA, SEMINARS, SYMPOSIA, 1994-95

A. Applied Mathematics Colloquium Schedule, 1994-95

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.

R. Jameson, Accelerator Operations & Technology Division, Los Alamos National Laboratory, September 9, 1994

“Chaos in Linear Particle Accelerators”

B. Fornberg, Exxon Research and Engineering, Annandale, NJ, September 16, 1994

“Computing Steady Incompressible Flows Past Blunt Bodies--An Historical Overview”

J. Smith, Director, Center for Computer Research in Music, Stanford, September 23, 1994

“Music Synthesis via Virtual Acoustics”

A. Bobenko, Technische Universität, Berlin, September 30, 1994

“From Discrete Surfaces to the Discrete Quantum Pendulum (the Discrete Sine-Gordon Equation in Geometry and Physics)”

J. Bebernes, Program in Applied Mathematics, University of Colorado, October 7, 1994

“Beyond Blowup”

R. Wicklin, Geometry Center, University of Minnesota, October 14, 1994

“A New Method for Investigating Resonant Dynamics”

B. Herbst, Program in Applied Mathematics, University of Colorado and Dept. of Applied Mathematics, University of The Orange Free State, South Africa, October 21, 1994

“On the Numerics of Integrable Discretizations”

G. Beylkin, Program in Applied Mathematics, University of Colorado, October 28, 1994

“On Fast Fourier Transform of Functions with Singularities”

D. Levermore, University of Arizona and CNLS, Los Alamos, November 4, 1994

“The Complex Ginzburg-Landau Equation as a Perturbation of the Nonlinear Schrödinger Equation”

S. Mahalingum, Department of Mechanical Engineering, University of Colorado, November 11, 1994

“Direct Numerical Simulation of Turbulent Nonpremixed Flames”

R. Tagg, Department of Physics, University of Colorado at Denver, November 18, 1994

“Controlling Chaos in a Parametrically Forced Pendulum”

T. Burns, Computing and Applied Mathematics Laboratory, National Institute of Standards and Technology, Gaithersburg, MD, December 2, 1994

“Connections Between Localized Behavior in Plasticity and in Combustion”

J.-M. Fiard, Program in Applied Mathematics, University of Colorado and Université de Savoie, France, January 20, 1995

“Mathematical Modelling and Numerical Simulation of Solid Oxide Fuel Cells”

E. Kostelich, Department of Mathematics, Arizona State University, January 27, 1995

“Targeting and Control of Chaos”

E. Van Vleck, Department of Mathematical and Computer Sciences, Colorado School of Mines, February 3, 1995

“Numerical Shadowing Near Hyperbolic Trajectories”

M. Ablowitz, Program in Applied Mathematics, University of Colorado, February 10, 1995

“1895-1995: Integrability and Applications”

U. Herzfeld, Institute of Arctic and Alpine Research, University of Colorado, February 17, 1995

“An Application of Geostatistics to Marine and Satellite Geophysical Data from Antarctica”

V. Arnold, Steklov Mathematical Institute, Russian Academy of Sciences, February 24, 1995
(Part of 33rd Annual De Long Lecture Series)

“Asymptotics of topological complexity in smooth and in holomorphic dynamical systems”

T. Shinbrot, Northwestern University, March 3, 1995

“Will Control of Chaos Ever Lead to Control of Turbulence?”

C. Golé, SUNY at Stony Brook, March 10, 1995

“Rotation Vectors and Lagrangian Systems”

C. Doering, Center for Nonlinear Studies, Los Alamos National Laboratory, March 17, 1995

“Energy Stability and Turbulent Energy Dissipation”

J. Strain, Dept. of Mathematics, University of California, Berkeley, March 24, 1995

“2-D Vortex Methods and Numerical Integration”

M. Tabor, Program in Applied Mathematics, University of Arizona, April 7, 1995

“The Dynamics of Twist and Writhe”

G. Fairweather, Dept. of Mathematical and Computer Sciences, Colorado School of Mines, Golden, April 14, 1995

“Spline Collocation Algorithms for Separable Elliptic Boundary Value Problems”

K. Kafadar, Mathematics, University of Colorado, Denver, April 21, 1995

“A Data-Analytic Approach for Estimating Lead Time and Screening Benefit Based on Survival Curves in Randomized Trials”

G. Forest, Department of Mathematics, Ohio State University and University of Utah, April 28, 1995

“Modeling the Manufacture of Fibers”

B. Seminars in Applied Mathematics, 1994-95

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:

J. Villarroel, University of Salamanca, Spain, September 8, 1994

“On the Two Dimensional Volterra System”

B. Fornberg, Exxon Research and Engineering, Annandale, NJ, September 15, 1994

“A Pseudospectral Approach for Polar and Spherical Geometries”

- T. Yajima, Dept. of Applied Physics, University of Tokyo, Japan, September 22, 1994
 "Multiple Variable Integrable Equations and the Derivative Nonlinear Schrödinger Equation"
- T. Iizuka, Dept. of Physics, Ehime University, Japan, September 29, 1994
 "Soliton Phenomena in Periodic Systems"
- S. Herod, Program in Applied Mathematics, University of Colorado, October 6, 1994
 "Exact Families of Solutions of the Barotropic Vorticity Equation Derived from Symmetry Reductions"
- R. Wicklin, Geometry Center, University of Minnesota, October 13, 1994
 "Using Technology as a Teaching Tool"
- P. Miller, Department of Mathematics, University of Arizona, October 20, 1994
 "Exact Multiphase Wavetrain Solutions to the Complex Ablowitz-Ladik Equations"
- M. Alber, Department of Mathematics, University of Notre Dame, October 27, 1994
 "On Umbilic Geodesics and Soliton and Billiard Solutions of Nonlinear PDE's"
- C.D. Levermore, University of Arizona and CNLS, Los Alamos National Laboratories, November 3, 1994
 "The Incompressible Navier-Stokes Limit for the Boltzmann Equation"
- J. Weiss, Program in Atmospheric and Oceanic Science, Dept. of Astrophysical, Planetary, and Atmospheric Science, University of Colorado, November 10, 1994
 "Dynamical Systems for Modeling Structured Turbulence"
- L. Ostrovsky, CIRES, University of Colorado; Environmental Technology Lab, NOAA; and Institute of Applied Physics, Russian Academy of Science, N. Novgorod, Russia, November 17, 1994
 "Nonlinear Waves in Rotating Fluids"
- D. Richards, University of the Orange Free State, South Africa, December 1, 1994
 "Automatic Signature Verification"
- L. Monzón, Program in Applied Mathematics, University of Colorado, January 26, 1995
 "Wavelets and Quadrature Mirror Filters"
- M. Coffey, Program in Applied Mathematics, University of Colorado, February 2, 1994
 "Modelling of Vortices in Stratified and Nonlocal Type-II Superconductors"
- K. Naugolnykh, NOAA, Boulder, February 9, 1995
 "On the Propagation and Nonlinear Interaction of the Broad Band Capillary Wave Packet"
- B. Chen, Department of Mathematics, University of Wyoming, February 16, 1995
 "Numerical Solution of Convection in Enclosures with Obstacles"
- A. Tovbis, West Virginia University, February 23, 1995
 "Discretizations of Hamiltonian Systems and Chaos-Integrability Transition"
- N. Akhmediev, Optical Sciences Center, Institute of Advanced Studies, The Australian National University, Canberra, March 2, 1995
 "Coupled Nonlinear Schrödinger Equations: Dynamic Solutions"
- M. Grant, Department of Biology (EPOB), University of Colorado, March 9, 1995
 "Teaching and Learning at the University: Some Personal Experiences"
- C. Lewis, Department of Computer Science, Institute of Cognitive Science, University of Colorado, March 16, 1995
 "Anatomy of a Course: Teaching the Process of Writing Computer Programs"

M. Rabinovich, Institute for Applied Physics, Russian Academy of Science, and Institute for Nonlinear Science, University of California, San Diego, March 23, 1995

“Origin of spirals and Defect Spiral Wave Interaction in the Faraday Experiment”

M. Tabor, Program in Applied Mathematics, University of Arizona, April 6, 1995

“The Structure and Dynamics of Foams”

P. Grinevich, Landau Institute for Theoretical Physics, Moscow, April 13, 1995

“Period Preserving Nonisospectral Flows and the Moduli Space of Periodic Solutions of soliton Equations”

A. Dougherty, Program in Applied Mathematics, University of Colorado, April 20, 1995.

“Two Limit Theorems for Density Dependent Markov Processes, Part I: A Simple Epidemic Model”

A. Dougherty, Program in Applied Mathematics, University of Colorado, April 27, 1995.

“Two Limit Theorems for Density Dependent Markov Processes, Part II: Averaging for Density Dependent Markov Chains with an Application to Graph Theory”

C. Rocky Mountain Experience IV, 1994

Rocky Mountain Experience IV, a mini-workshop, was held August 3-4, 1994 and featured talks by P. Clarkson, M. Coffey, V. Galaktionov, B. Herbst, U. Herzfeld, F. Israilev, D. Kassoy, I. Khalatnikov, Y. Kimura, V. Makhankov, L. Mansfield, L. Ostrovsky, C. Schober, M. Spector, B. Stern, V. Tatarskii, and P. Weidman.

D. Los Alamos/Colorado Days, 1995

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 Boulder on March 17 and 18, 1995. Speakers and poster presenters were: O. Bauer, S. Blair, E. Bollt, L. Bradley, J.R. Cary, W. Choi, M. Coffey, C. Doering, A. Hagberg, S. Herod, R.M. Kerr, B. Luce, V. Makhankov, S. Mock, B. Nadiga, K. Naugolnykh, L.A. Ostrovsky, E. Phipps, R.D. Pierce, N.B. Tufillaro, M. Xiaokang, P. Weidman, Jeffrey Weiss, John Weiss, and T. Werckman.

E. University of Colorado Denver-University of Colorado Boulder Joint Seminars in Computational Mathematics, 1994-95

The Joint CU Denver-CU Boulder Computational Math Seminar was significantly expanded this year, with the regular lecture on Tuesdays at 12:30 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:

G. Starke, University of Karlsruhe, Germany and Program in Applied Mathematics, University of Colorado, Boulder, September 6, 1994 (in Denver)

“On the Combination of Multilevel and Krylov Subspace Methods”

R. Leveque, Applied Mathematics and Mathematics Department, University of Washington, and Program in Applied Math, Univ. of Colorado, Boulder, September 13, 1994 (in Boulder)

“Clawpack--A Software Package for Solving Hyperbolic Systems of Conservation Laws”

- D. Dean, University of Colorado, Denver, September 20, 1994 (in Denver)
 "Investigation of Mathematical Modeling of Groundwater Flow and Contaminant Transport: Scale Up, Mathematical Theory and Experimental Validation"
- W. Mitchell, Applied and Computational Mathematics Division, National Institute of Standards and Technology, Gaithersburg, MD, September 27, 1994 (in Boulder)
 "The Hierarchical Basis Approach to Multilevel Adaptive Methods and Partitioning Adaptive Grids"
- L. Adams, Dept. of Applied Math, Univ. of Washington, and Program in Applied Mathematics, Univ. of Colorado, Boulder, October 4, 1994 (in Denver)
 "Cartesian Grid Techniques for Problems with Irregular Boundaries"
- M. Berndt, Program in Applied Mathematics, University of Colorado, October 11, 1994 (in Boulder)
 "The Schwarz Alternating Procedure in Multilevel Methods"
- Z. Liu, Department of Mathematics, University of Colorado, Denver, October 18, 1995 (in Denver)
 "Multiple Scale Simulation for Transitional and Turbulent Flow"
- J. Ruge, Department of Mathematics, University of Colorado, Denver, October 25, 1994 (in Boulder)
 "A Nonlinear Multigrid Solver for a Semi-Lagrangian Potential Vorticity-Based Shallow Water Model on the Sphere"
- P. Oswald, Texas A&M, November 8, 1994 (in Boulder)
 "Besov Space Techniques for Multilevel Methods"
- A. Knyazev, Math Department, University of Colorado, Denver, November 15, 1994 (in Denver)
 "Accuracy Estimates for the Rayleigh-Ritz Method"
- M. Hanke, November 29, 1994 (in Boulder)
 "Regularization by Conjugate Gradients"
- K. Ressel, Math Department, University of Colorado, Denver December 6, 1994 (in Denver)
 "Least-Squares Finite-Element Solution of the Neutron Transport Equation in Diffusive Regimes"
- T. Stern, Applied Mathematics Department, University of Washington, January 24, 1995 (in Boulder)
 "Finite Volume Methods for Non-Uniform Grids"
- R. Trujillo, Center for Computational Mathematics, University of Colorado, Denver, January 31, 1995 (in Denver)
 "A Flux-Based Eulerian-Lagrangian Localized Adjoint Method for the Two-Dimensional Transient Advection Equation"
- X. Yu, Brown University and visitor at University of Colorado, Denver, February 7, 1995 (in Boulder)
 "Secondary Instability Problems in Boundary Layers"
- L. Stals, School of Mathematical Sciences, Australian National University, Canberra, Australia, February 21, 1995 (in Boulder)
 "Adaptive Multigrid in Parallel"
- W. Niethammer, University of Karlsruhe, Germany, February 21, 1995 (in Boulder)
 "Iterative Methods on the Maspar"

- C. Pflaum, Institut für Informatik, TU Muenchen, March 7, 1995 (in Boulder)
 “Discretization of Partial Differential Equations on Sparse Grids”
- L. Franca, Mathematics Department, University of Colorado, Denver, March 14, 1995 (in Boulder)
 “Bubble Functions Prompt Unusual Stabilized Finite Element Methods”
- A. Brandt, Weizmann Institute of Science, Israel, March 28, 1995 (in Denver)
 “New Directions in Multiscale Computations”
- J. Wang, University of Wyoming, April 18, 1995 (in Boulder)
 “Local Error Estimates for Approximate Solutions of Convection Diffusion Problems by Finite Elements”

F. Special Seminars, 1994-95

We had several special seminars during the year:

- A. Dervieux, INRIA-Sophia, August 25, 1994
 “New Attempts for Additive Multilevel Methods”
- T. Nakao, Dept. of Physics, University of Tokyo, Japan, September 27, 1994
 “A Useful Auxiliary Linear System for Davey-Stewartson Hierarchy”
- M. Phillips and R. Wicklin, The Geometry Center, University of Minnesota, Saturday, October 15, 1994
 “Catching up with Technology in a Changing World”--Geometry and Computer Graphics Workshop
- M. Gekhtman, Weizmann Institute, Israel, October 18, 1994
 “Non-Abelian Integrable Lattice Equations”
- L. Vozovoi, Tel-Aviv University, February 9, 1995
 “High Order Fast Elliptic Solver in Rectangular Regions”
- S. Mori, Department of Physics, University of Tokyo, February 23, 1995
 “Statistical Physics of Random Surfaces: Self-avoiding Randomly Polymerized Membrane”
- H. Ujino, Department of Physics, University of Tokyo, February 23, 1995
 “An Algebraic Approach to Quantum Calogero Model”
- K. Nakayama, Department of Physics, University of Tokyo, February 23, 1995
 “Reaction-Diffusion System in Curved Space and the KPZ Equation”
- M. Wadati, Department of Physics, University of Tokyo, March 7, 1995
 “Motion of Curves and Surfaces”
- S. Marakami, Department of Physics, University of Tokyo, March 7, 1995
 “Thermodynamics of Quantum Nonlinear Schrödinger Models”
- V. Le, University of Utah, March 23, 1995
 “Some Global Bifurcation Results for Variational Inequalities”
- A.M. Rubenchik, Lawrence Livermore National Laboratory and UC Davis, May 26, 1995
 “Pulse Dynamics in Multidimensional Fiber Arrays”

4. COMMITTEES

A. Undergraduate Committee--John Williamson, Chair

The members of the Program Undergraduate Committee this year were John Williamson (chair), Bob Easton, Tom Manteuffel and Jim Meiss.

The Program in Applied Mathematics has fifty-one undergraduate majors. Nineteen of our majors were on the Dean's list last semester with grade point averages of 3.5 or better, and Eric Phipps won the 1995 Frank Prouty Memorial Scholarship. Eleven 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 a graduate teaching assistant with the help of several undergraduate assistants. The undergraduate assistants are enthusiastic about getting the teaching experience, and they are good role models for the students in the course.

The new Minor in Applied Mathematics, available to students in the College of Arts and Sciences, continues to grow. There are now eleven students in the program.

The Undergraduate Curriculum guide was updated this year. Our thanks to John Williamson for the effort he put into this.

Two new courses recently added to our offerings, "An Introduction to Nonlinear Systems: Chaos" (APPM 3010) and "An Introduction to Symbolic and Numerical Computation" (APPM 3050) were taught again this year. Thanks to Jim Meiss and Scott Herod for their efforts with this.

Our undergraduate student chapter of SIAM (the Society for Industrial and Applied Mathematics) continues to be very active. There are twenty members in the chapter. Events this past year included meetings, mentor lunches, field trips and "Professors' Nights Out." Officers were: Kate Lainson, President; Jennifer Oursler, Vice President; Chris Dozier, Treasurer; Lisa Schauer, Secretary; Chris Mehl, UCEC representative.

B. Graduate Committee--Harvey Segur, Chair

The Program Graduate Committee consists of Jerry Bebernes, Congming Li, Steve McCormick, and Harvey Segur (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 about 40 graduate students during 1994-95, of whom 13 began last fall. Three students received their PhDs and four their MS degrees within the last year. For the fall semester of 1995, there were 66 applicants, of whom 4 received new TA positions (an usually small number due to a large number of continuing students). In addition, 2 more incoming students were awarded NSF Graduate Traineeships. An important event occurred this year when the graduate students initiated the Graduate Student Organization (GSO) to represent their common concerns.

The number of (funded) Teaching Assistantships has remained at about 16-19 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 23%-41%. Minority students still are under-represented in the Program, but their numbers increased (to about 7%) in the last year.

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

In summary, the graduate program of PAM is now coming of age. While it is not perfect, we believe it is developing nicely.

5. FACULTY SERVICE TO THE UNIVERSITY, PROGRAM AND SOCIETIES, CALENDAR YEAR 1994

Mark Ablowitz: Program Director, 1/1/94-6/30/94; member of Council of Chairs in the College of Arts and Sciences, 1/1/94-6/30/94; CRCW fellowship 1994-95

Jerrold Bebernes: member of Program Graduate Committee and the Advisory Committee to University Mathematics Program

Gregory Beylkin: member of Program Graduate Committee and Program Faculty Search Committee

James Curry: member of Chancellor's Search Committee, Vice Chancellor's Advisory Committee, and Campus Policy Board on Information Technology; sabbatical 1994-95

Robert Easton: Program Interim Director (from 7/94); member of Program Instructor Search Committee; Chair, Educational Policy and Planning Committee (Engineering); member of Committee on Complexity (Graduate School)

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

Tom Manteuffel: member of Program Undergraduate Committee, Program Computer Committee, and University Applied Math PhD Coordinating Committee

Steve McCormick: member of Program Graduate Committee, Program Faculty Search Committee, and Program Computer Committee

James Meiss: member of Program Undergraduate Committee; chair, Program Computer Committee; chair, Program Colloquium Committee; Chair, Goldwater Scholarship Committee for the University

Harvey Segur: Chair of Program Graduate Committee; member of Boulder Faculty Assembly

John Williamson: Chair of Program Undergraduate Committee; member of College of Engineering Scholarship Committee and College of Engineering Undergraduate Academic Affairs Committee

6. TEACHING ACTIVITIES

A. Courses Taught by Program Faculty, Academic Year 1994-95

(i) Undergraduate Courses

- APPM 1350 *Chakravarty, Dougherty, Seebass, Segur*, Calculus 1 for Engineers.
APPM 1360 *Chakravarty, Meiss, Norris, Segur*, Calculus 2 for Engineers.
APPM 2350 *Dwyer, Herbst, Herod, Manteuffel, McCormick*, Calculus 3 for Engineers.
APPM 2360 *Bebernes, Coffey, Kimura*, 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 *Chakravarty, Li*, Matrix Methods and Applications.
APPM 3570 *Williamson*, Applied Probability.
APPM 4350 *Kimura*, Boundary Value Problems, Methods in Applied Mathematics.
APPM 4360 *Schober*, Complex Variables, Methods in Applied Mathematics.
APPM 4520 (MATH 4520) *Holley*, Introduction to Mathematical Statistics.
APPM 4560 *Williamson*, Introduction to Probability Models.
APPM 4570 *Williamson*, 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 *Kimura*, Boundary Value Problems, Methods in Applied Mathematics.
APPM 5360 *Schober*, Complex Variables, Methods in Applied Mathematics.
APPM 5440 *Li*, Applied Analysis 1.
APPM 5450 *Li*, Applied Analysis 2.
APPM 5470 (MATH 5470) *Bebernes*, Partial Differential Equations, Methods in Applied Mathematics.
APPM 5480 (MCEN 7120) *Weidman*, Perturbation Methods, Methods in Applied Mathematics.
APPM 5520 (MATH 5520) *Holley*, Introduction to Mathematical Statistics.
APPM 5570 *Williamson*, Statistical Methods.
APPM 5580 *Little/Williamson*, Statistical Applications Software Methods.
APPM 5600 (MATH 5600) *Manteuffel*, Numerical Analysis 1.
APPM 5610 (MATH 5610) *Kimura*, Numerical Analysis 2.

- APPM 6550 *Williamson*, Introduction to Stochastic Processes.
- APPM 7100 *Meiss*, Mathematical Methods in Dynamical Systems.
- APPM 7300 *Segur*, Mathematical Methods in Nonlinear Waves and Integrable Equations.
- APPM 7400 *McCormick*, Topics in Applied Mathematics--Multigrid Methods.
- 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 8000 Seminar in Applied Mathematics

B. Summer Courses, 1995

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

7. RESEARCH ACTIVITIES FOR CALENDAR YEAR 1994

A. Research Publications for Calendar Year 1994

Mark Ablowitz:

- "Solutions to the 2+1 Toda Equation", J. Villarroel and M.J. Ablowitz, *J. Phys. A*, **27** (1994) 931-941.
- "Parametric Forcing, Bound States and Solutions of a Nonlinear Schrödinger Type Equation", M.J. Ablowitz and S. De Lillo, *Nonlinearity*, **7** (1994) 1143-1153.
- "Wave Collapse and Instability of Solitary Waves of a Generalized Nonlinear Kadomtsev-Petviashvili Equation", X.P. Wang, M.J. Ablowitz, and H. Segur, *Physica D*, **78** (1994) 241-265.
- "Homoclinic Manifolds and Numerical Chaos in the Nonlinear Schrödinger Equation", M.J. Ablowitz and C. Schober, *Mathematics and Computers in Simulation*, **37** (1994) 249-264.
- "Effective Chaos in the Nonlinear Schrödinger Equation", M.J. Ablowitz and C. Schober, *Contemporary Mathematics*, **172** (1994) 253-268.
- "Hamiltonian Integrators for the Nonlinear Schrödinger Equation", M.J. Ablowitz and C. Schober, in *Proceedings of the 2nd IMACS Conference on Computational Physics*, Ed. J. Potvin, World Scientific, Singapore, (1994) 219-224.
- "Numerical Stochasticity, Hamiltonian Integrators and the Nonlinear Schrödinger Equation", M.J. Ablowitz and C.M. Schober, *Three Dimensional Dynamical Systems*, (Ed. Dr. Kandrup), Annals New York Academy of Sciences, 1994.

Jerrold Bebernes

- "Asymptotics of blowup for weakly quasilinear parabolic problems" (with S. Bricher and V. Galaktionov), *Nonlinear Analysis*, **23** (1994) 489-514.

Gregory Beylkin:

- "Inversion and Application of the Generalized Radon Transform" in *75 Years of Radon Transform*, International Press, 1994.
- "Fast and Accurate Computation of the Fourier Transform of an Image", in *Proceedings of SPIE 1994*.

Sarbarish Chakravarty:

- "A class of integrable conformally self-dual metrics", S. Chakravarty, *Class. Quantum Grav.*, **11** (1994).

Tom Manteuffel:

- "A Parallel Version of a Multigrid Algorithm for Isotropic Transport Equations," (with S.F. McCormick, J.E. Morel, S. Oliveira and G. Yang), *SIAM J. Sci. and Stat. Comp.*, Vol. 15 No. 2 (1994) 474-493.
- "An Upper Bound on the Diameter of a Graph from Eigenvalues Associated with its Laplacian", (with V. Faber and F. Chung), *SIAM J. of Dis. Math.*, Vol. 7, No. 3 (1994) 443.

- “On the Roots of the Orthogonal Polynomials and Residual Polynomials Associated with a Conjugate Gradient Method”, (with J.S. Otto), *Journal of Numerical Linear Algebra*, Vol. 1 (5) (1994) 449-475.
- “First-order System Least Squares for Second-Order partial Differential Equations: Part I”, (with Z. Cai, R. Lazarov, and S. McCormick) *SIAM J. Numer. Anal.*, Vol. 31, No. 6 (1994).
- “Variable Metric Conjugate Gradient Methods”, (with T.L. Barth), proceedings of the 10th International Symposium on Matrix Analysis and Parallel Computing, Keio University, Yokohama, Japan, March 14-16, 1994.
- “Multilevel Projection Methods for First-order System Least-squares”, (with S. McCormick) *Proc. ASME Fluids Eng. Div. Summer Meeting*, Lake Tahoe, CA, June 9-23, 1994.

Steve McCormick:

- “A Parallel Version of a Multigrid Algorithm for Isotropic Transport Equations,” (with T. Manteuffel, J.E. Morel, S. Oliveira and G. Yang), *SIAM J. Sci. and Stat. Comp.*, Vol. 15 No. 2 (1994) 474-493.
- “A Fast Multigrid Algorithm for Isotropic Transport Problems I”, (with T. Manteuffel, J. Morel and S. Oliveira) *SIAM J. Sci. Comp.*, **15** (1994).
- “Multilevel Adaptive Methods for Elliptic Eigenproblems”, *SIAM J. Num. Anal.*, **31** (1994).
- “First-order System Least Squares for Second-Order partial Differential Equations: Part I”, (with Z. Cai, R. Lazarov, and T. Manteuffel), *SIAM J. Num. Anal.*, **31** (1994).
- “Multilevel projection methods for first-order system least squares”, (with T. Manteuffel), *ASME Summer Series*, (1994).
- “Numerical Integration of the Primitive Variables Based on the Semi-Lagrangian Advection of Potential Vorticity”, (with J.R. Bates, A. Brandt, Y. Li and J. Ruge, *Proceedings of Symposium on Cyclones*, Bergen, Norway (1994).

James Meiss:

- “Self-Consistent Chaos in the Beam-Plasma Instability”, J.L. Tennyson, J.D. Meiss and P.J. Morrison, *Physica D*, **71** (1994) 1-17.
- “Transient Measures for the Standard Map”, J.D. Meiss, *Physica D*, **74** (1994) 254-267.
- “An Approximate Renormalization for the Break-up of Invariant Tori with Three Frequencies”, R.S. MacKay, J.D. Meiss, and J. Stark, *Physics Lett. A*, **190** (1994) 417-424.

Constance Schober:

- “Homoclinic Manifolds and Numerical Chaos in the Nonlinear Schrödinger Equation”, M.J. Ablowitz and C. Schober, *Mathematics and Computers in Simulation*, **37** (1994) 249-264.
- “Effective Chaos in the Nonlinear Schrödinger Equation”, M.J. Ablowitz and C. Schober, *Contemporary Mathematics*, **172** (1994) 253-268.
- “Hamiltonian Integrators for the Nonlinear Schrödinger Equation”, M.J. Ablowitz and C. Schober, in *Proceedings of the 2nd IMACS Conference on Computational Physics*, Ed. J. Potvin, World Scientific, Singapore, (1994) 219-224.
- “Numerical Stochasticity, Hamiltonian Integrators and the Nonlinear Schrödinger Equation”, M.J. Ablowitz and C.M. Schober, *Three Dimensional Dynamical Systems*, (Ed. Dr. Kandrup), Annals New York Academy of Sciences, 1994.

Harvey Segur:

- “Wave Collapse and Instability of Solitary Waves of a Generalized Nonlinear Kadomtsev-Petviashvili Equation”, X.P. Wang, M.J. Ablowitz, and H. Segur, *Physica D*, **78** (1994) 241-265.
- “A Note on the Motion of Surfaces”, R.I. McLachlan and H. Segur, *Phys. Lett. A*, **194** (1994) 165-172.

B. Invited Lectures and Meetings Attended for Calendar Year 1994

Mark Ablowitz:

- Conference on Modern Group Analysis---Theory and Applications, Mathematics Dept., Univ. of Witwatersrand, Johannesburg and University of Orange Free State, Blomenfontein, South Africa, “Are All Soliton Equations Reductions of Self-Dual Yang Mills?”, Jan. 10-20, 1994.
- Nonlinear Optics and Communications Workshop, Breckenridge, Colorado, “Multisoliton Interactions in Nonlinear Optical Fibers”, April 11-12, 1994.
- Workshop: Symmetries and Integrability of Difference Equations, Montreal, Canada, “Computational Chaos in Integrable Systems--Truncation and Roundoff”, May 22-24, 1994.
- AFOSR Meeting on Computational and Physical Mathematics, Kirtland AFB, New Mexico, “Numerical Chaos in Coherent Systems”, June 1-3, 1994.
- Workshop on Twenty Years of the Nonlinear Schrödinger Equation and Recent Developments, Landau Institute for Theoretical Physics, Moscow, Russia, “Computational Chaos in the Nonlinear Schrödinger Equation”, July 23-31, 1994.
- University of Alberta, Department of Mathematics, Edmonton, Alberta, “Computational Chaos in Integrable Systems”, Sept. 8-10, 1994.
- NEEDS Workshop, Los Alamos National Laboratory, Los Alamos, NM, “Integrability, Computation and Nonlinear Optics”, Sept. 11-14, 1994.
- University of Tokyo, Physics Department, “Reductions of the Self Dual Yang Mills Equations and Novel Integrable Systems”, Nov. 8, 1994; “Numerical Chaos: Truncation Roundoff”, Nov. 9, 1994.
- University of Tokyo, Applied Mathematics Department, “Novel Integrable Systems”, Nov. 9, 1994.
- University of Science and Technology, Mathematics Department, Hong Kong, “Computational Chaos in Integrable Systems”, Nov. 16, 1994.
- Hong Kong Polytechnic, Hong Kong, Mathematics Department, “Computational Chaos in Integrable Systems”, Nov. 17, 1994.

Jerrold Bebernes:

- Dept. Math. Colloquium, Univ. Utah, SLC, “The Origin of Reaction Waves”, Feb. 28, 1994
- Program in Applied Mathematics Colloquium, University of Colorado, Boulder, “Beyond Blowup”, Oct. 14, 1994
- Dept. Math. Colloquium, Univ. Maryland, Baltimore County, “Understanding Beyond Blowup”, Nov. 11, 1994

Gregory Beylkin:

Technion, Israel, "Implementation of Operators via Vilter Banks, Autocorrelation Shell and Hardy Wavelets", May 1994

SPIE, Sand Diego, Ca, "Fast and Accurate Computation of the Fourier Transform of an Image", July 1994

ARPA Program Review, Arlington, VA "Fast Numerical Algorithms and SAR Applications", Aug. 3-5, 1994

Environmental Research Institute of Michigan (ERIM), Ann Arbor, MI "Unequally Spaced FFT and SAR Processing", September 1994.

IMA workshop, tutorial and 2 lectures, Minneapolis, MN, Fall, 1994

Sarbarish Chakravarty:

Mathematics Department Colloquium, IUPUI, Indianapolis, "Reduction of Self-Dual Yang-Mills Equations and Integrable Systems", February 25, 1994.

Rocky Mountain Meeting in Nonlinear Optics, Breckenridge, "Frequency Shifts Due to Nonlinear Interactions in WDM Soliton Pulses", April 11, 1994.

Applied Mathematics Seminar, "Self Dual Yang Mills Equations and Their Symmetry Reductions", University of New South Wales, Australia, August 17, 1994.

Bob Easton:

Mathematics Department Colloquia, Colorado School of Mines, Golden, CO, "Isolating Blocks for Discrete Dynamical Systems", October 21, 1994.

Ben Herbst:

Colorado School of Mines, Golden, CO, "Can One Trust Numerical Solutions of Integrable Infinite Dimensional Hamiltonian Systems?"

Rocky Mountain IV, Program in Applied Mathematics, University of Colorado, Boulder, "How Good Are Symplectic Discretizations of Integrable Infinite Dimensional Hamiltonian Systems?", August 3, 1994.

Program in Applied Mathematics, University of Colorado, Boulder, "On the Numerics of Integrable Discretizations" October 21, 1994.

Scott Herod:

Program in Applied Mathematics, University of Colorado, "Exact Families of Solutions of the Barotropic Vorticity Equation Derived from Symmetry Reductions", October 6, 1994.

Yoshi Kimura:

Rocky Mountain Experience IV, Program in Applied Mathematics, University of Colorado, Boulder, "Dynamics of Complex Singularities for Burgers' Equation", August 3, 1994.

Frontiers of Geostrophic Turbulence and Subgrid Modeling Workshop, Center for Nonlinear Studies, Los Alamos National Laboratory, "Diffusion in stratified turbulence with and without rotation", August 10, 1994.

NEEDS Conference, Oppenheimer Study Center, Los Alamos National Laboratory, "Dynamics of Complex Singularities for Burgers' Equation" (poster), Sept. 12, 1994

The American Physical Society, Division of Fluid Dynamics meetings, Atlanta, GA, "Diffusion in stably stratified turbulence with and without rotation," Nov. 21, 1994

Congming Li:

PDE Conference, Iowa, "A Note on the Kazdan-Warner Type Conditions", March 25-27, 1994.

Tom Manteuffel:

10th International Symposium on Matrix Analysis and Parallel Computing, Keio University, Yokohama, Japan, "Variable Metric Conjugate Gradient Methods", March 14-16, 1994.

Workshop on Numerical Linear Algebra and Applications, Oberwolfach, Germany, "First-order Systems Least-squares Functionals", April 10-16, 1994.

Colorado Conference on Iterative Methods, Breckenridge, CO, April 5-9, 1994.

Workshop on Least-Squares Finite Element Methods, Ohio Aerospace Institute, Cleveland, OH, October 12-14, 1994

Pacific Northwest Numerical Analysis Conference, Washington State University, "FOSLS: A New Methodology for the Numerical Solution of Partial Differential Equations", October 21-22, 1994.

Steve McCormick:

Computer Science Department Colloquium, University of Colorado at Boulder, "Multigrid methods", March 15, 1994.

Department of Mathematics colloquium, University of Southern California, Los Angeles, CA "Least Squares", April 1, 1994

Conference on Iterative Methods, Breckenridge, CO, "FOSLS", April 3, 1994

Department of Mathematics Colloquium, Colorado State University, Fort Collins, Colorado, "Multilevel Methods for PDEs", April 14, 1994.

National Workshop, Australian National University, Canberra, Australia, "Multilevel Methodology", April 15-28, 1994.

NASA, Langley, VA, "Advanced Computation", May 23, 1994.

Los Alamos National Lab, Los Alamos, NM, "FOSLS", May 25, 1994.

Contractors' meeting, AFOSR, Albuquerque, NM, "Large Scale Computation", June 2, 1994.

SIAM, Snowbird, UT, "Multilevel Image Processing", June 15, 1994.

ASME, Tahoe, CA, "Multilevel Electromagnetics", June 21, 1994.

Distinguished lecturer, University of California at San Diego, La Jolla, CA, "Multilevel Methodology", July 24-29, 1994.

IMA, Minneapolis, MN, "Multilevel Methodology", October 12, 1994.

NASA Lewis, Cleveland, OH, "FOSLS in CFD", October 14, 1994.

James Meiss:

University of Arizona, Tucson, Arizona "Break-up of Invariant Tori: An Approximate Renormalization", February 11, 1994.

APAS, University of Colorado, Boulder, "Break-up of Invariant Tori: An Approximate Renormalization", February 25, 1994.

Nagoya University, Nagoya, Japan, "Numerical Study of Ergodicity in Area Preserving Maps", May 20, 1994.

Dynamics Days, Melbourne University, Australia, "Break-up of Invariant Tori: Approximation Renormalization", June 14-15, 1994.

Queensland ANZIAM Conference, Melbourne University, Australia "Self Consistent Chaos", June 14-15, 1994.

Physics, ANU, Canberra, Australia, "Transient Measures for Area Preserving Maps", June 23, 1994.

University of New South Wales, Sydney, Australia, "Controlling Chaotic Transport Through Recurrence", July 1, 1994.

Lucas Monzón:

Program in Applied Mathematics, University of Colorado, "Wavelets and Quadrature Mirror Filters", January 26, 1995.

Constance Schober:

Colorado Days, Los Alamos National Laboratories, NM, "Numerical Simulation of Quasi-periodic Solutions of the Sine-Gordon Equation", May 1994.

Rocky Mountain Experience IV, University of Colorado, Boulder "On the Numerical Solution of the Sine-Gordon Equation", August 3, 1994.

Harvey Segur:

Conference on Waves in the Ocean, Mathematical Sciences Research Institute, Berkeley, CA "Periodic Waves in Shallow Water", February 7-11, 1994.

C. Research Grants for Calendar Year 1994

Mark Ablowitz:

amount for 1994

NSF, Mathematics Division: 1994-96	\$25,000
AFOSR, Mathematics: 1994-96	\$88,000
ONR, Mathematics: 1994-97	\$46,000
Air Force AASERT: 1993-96	\$43,000
ONR AASERT: 1994-97	\$48,000
CRCW:	\$1,500

Jerrold Bebernes:

NSF, Mathematics Division: 1994-95	\$20,000
NATO: 1993-96	\$2,300

Gregory Beylkin:

ONR, Mathematics Division: 1993-95	\$30,000
AASERT - ONR - Mathematics Division: 1992-95	\$78,000
ARPA: 1993-96	\$148,000
IMA: 1994	\$24,000
ERIM (Environmental Research Institute of Mich.)	\$20,000

James Curry:

ONR, 1992-94	\$52,500
AASERT, ONR, Physics/Oceanography Div.: 1992-94	\$14,500

DOE Grant: 1993-95	\$54,000
NSF Statewide Systemic Initiative: 1993-96	\$17,000
NSF (SCREMS): 1994-95	\$65,000

Congming Li:

NSF	\$20,000
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Tom Manteuffel:

DOE, Applied Mathematics: 1993-96	\$101,000
NSF, Mathematics Division: 1994-97:	\$50,000
NSF, Special Projects: 1994-97:	\$12,000

Steve McCormick:

AFOSR: 1994-95:	\$200,000
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
NATO: 1993-94	\$2,800
CRCW: 1993-94	\$1,700

Harvey Segur:

NSF, Mathematics Division: 1993-96	\$20,000
ONR, Physics/Oceanography Division: 1992-94	\$52,500
AASERT, ONR, Physics/Oceanography Div.: 1992-94	\$14,500
NSF, CISE Minority Fellowship (R. Charles):	\$6,000

Total	\$1,450,300
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Granting Agencies:

NSF:	National Science Foundation
AFOSR	Air Force Office of Scientific Research
ONR:	Office of Naval Research
CRCW:	Committee on Research and Creative Work, University of Colorado
AASERT:	Augmentation Awards for Science and Engineering Research Training
ARPA:	Advanced Research Project Agency

D. Miscellaneous for Calendar Year 1994

Mark Ablowitz:

CRCW Fellow, 1994-1995

Editorial boards: *SIAM Journal on Applied Mathematics*; *Journal of Engineering Mathematics*; *Studies in Applied Mathematics*

Advisory boards: *Chaos*, *Inverse Problems*

Reviewer: NSF, Air Force and DOE 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; book for *Bulletin of the American Mathematical Society*

Jerrold Bebernes:

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

Reviewer: book for *Bulletin of the American Mathematical Society*

Gregory Beylkin:

Visiting Professor, Institute for Mathematical Applications (IMA), Minneapolis, Minnesota, Fall, 1994.

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

Sarbarish Chakravarty:

Reviewer: *Journal of Mathematical Physics*; *Physics Letters A*; *Communications in Mathematical Physics*; *Physical Review Letters*; *Physical Review E*, *Nonlinearity*, *Journal of Physics A: Mathematical and General*

James Curry:

Sabbatical 1994-1995

Co-PI: Colorado State Systemic Initiative

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

Designated President's Teaching Scholar, 1993-1995

Reviewer: *Journal of Atmospheric Science*

Robert Easton:

Editorial Board: *Communications on Applied Nonlinear Analysis*, Reviewer: NSF; research journals; graduate text for Houghton-Mifflin

Yoshi Kimura:

Reviewer: *Journal of Atmospheric Science*, *SIAM Journal of Applied Mathematics*, *Physica D*

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*

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 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, 3rd Colorado Conference on Iterative Methods, Copper Mountain, CO, April 5-9, 1994.

Member: Council of the Society of Industrial and Applied Mathematics (SIAM) and Program Committee of SIAM

Workshop Chairman: Workshop on First Order Least System System Squares Functionals for Solving Partial Differential Equations, CNLS, Los Alamos National Lab, May 25-27, 1994.

Organizer, Workshop on Least-squares Finite Element Methods, Ohio Aerospace Institute, Cleveland, OH, October 12-14, 1994.

Stanislaw Ulam Scholar at Center for Nonlinear Studies at Los Alamos National Lab, Oct. 1993-Aug. 1994.

Steve McCormick:

Editor: *SIAM Journal on Scientific Computing*

Reviewer: grant proposals; *Math Reviews*; *Zentralblatt*

Co-Chair, 3rd Colorado Conference on Iterative Methods, Copper Mountain, CO, April 5-9, 1994.

James Meiss:

Editor: *Physica D*

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

Visited during sabbatical: University College, London; University of Warwick; University of New South Wales; Nagoya University; and La Trobe University.

Harvey Segur:

Boulder Faculty Assembly Teaching Excellence Award, 1994

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

Organizer: Mathematical Sciences Research Institute, Waves in the Ocean Workshop,
Berkeley, CA, February, March, 1994; SIAM, Nonlinear Water Waves Workshop, San
Diego, CA, July 1994.

8. PREPRINTS OF THE PROGRAM: 1994-95

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 Margy Lanham, Program in Applied Mathematics, Campus Box 526, University of Colorado, Boulder, CO 80309-0526.

No.

205. "First-Order System Least Squares for Second-Order Partial Differential Equations: Part II", Z. Cai, T. Manteuffel and S. McCormick, July 1994.
206. "Fast and Accurate Computation of the Fourier Transform of an Image", G. Beylkin, July 1994.
207. "Towards an Understanding of the Break-up of Invariant Tori", J.D. Meiss, May 1994.
208. "Asymptotics of Blowup for Weakly Quasilinear Parabolic Problems", by J. Bebernes, S. Bricher and V.A. Galaktionov, June 1993.
209. "Some Reductions of the Self-Dual Yang-Mills Equations to Integrable Systems in 2+1 Dimensions", S. Chakravarty, S.L. Kent, and E.T. Newman, August 1994.
210. "Numerical Simulation of Quasi-Periodic Solutions of the Sine-Gordon Equation", M.J. Ablowitz, B.M. Herbst and C.M. Schober, September 1994.
211. "On Classification of Blow-up Patterns for a Quasilinear Heat Equation", J. Bebernes and V.A. Galaktionov, October 1994.
212. "On Symmetric and Nonsymmetric Blow-up for a Weakly Quasilinear Heat Equation", J. Bebernes, A. Bressan, and V.A. Galaktionov, October 1994.
213. "Families of Exact Solutions for the Barotropic Vorticity Equation", S.A. Herod, November 1994.
214. "On the Numerical Solution of the Sine-Gordon Equation", M.J. Ablowitz, B.M. Herbst, and C.M. Schober, November 1994.
215. "On the Numerics of Integrable Discretizations", M.J. Ablowitz, B.M. Herbst, and C.M. Schober, November 1994.
216. "Chaos in Symplectic Discretizations of Planar Hamiltonian Systems, an Overview", B.M. Herbst, G.J. le Roux and M.J. Ablowitz, November 1994.
217. "Mel'nikov Analysis of Numerically Induced Chaos in the Nonlinear Schrödinger Equation", A. Calini, N.M. Ercolani, D.W. McLaughlin and C.M. Schober, November, 1994.

218. "Targeting Chaotic Orbits to the Moon Through Recurrence", E.M. Bollt and J.D. Meiss, December 1994.
219. "Integrability, Computation and Applications", M.J. Ablowitz, S. Chakravarty and B.M. Herbst, January 1995.
220. "Schwarz Alternating Procedure for Elliptic Problems Discretized by Least Squares Mixed Finite Elements", Z. Cai and S. McCormick, April 1995.
221. "Data-Dependent Timing Jitter in WDM Soliton Systems", R.B. Jenkins, J.R. Sauer, S. Chakravarty and M.J. Ablowitz, April 1995.
222. "Integrability, Monodromy Evolving Deformations and Self-Dual Bianchi IX Systems", S. Chakravarty and M.J. Ablowitz, April 1995.
223. "Effect of Super Conductor Phase Fluctuations Upon Penetration Depth", M.W. Coffey, December 1994.
224. "Vortices in Stratified and Nonlocal Superconductors", M.W. Coffey, December 1994.
225. "Pancake Vortex in a Superconducting Cylinder", M.W. Coffey, January 1995.
226. "Effect of Phase Fluctuations Upon Penetration Depth", M.W. Coffey, January 1995.
227. "Closed Form Magnetostatic Interaction Energies and Forces in Magnetic Force Microscopy", M.W. Coffey, March 1995.
228. "Vortices in Stratified Superconductors: Application to Magnetic Force Microscopy", M.W. Coffey and E.T. Phipps, May 1995.
229. "Magnetic Levitation Force of Semi-infinite Type-II Superconductors", M.W. Coffey, April 1995.
230. "Closed Form Magnetostatic Interaction Energies and Forces in Magnetic Force Microscopy", M.W. Coffey, March 1995.
231. "Nearly Sign-nonsingular Matrices", G. Lady, T. Lundy, and J. Maybee, May 1994.
232. "On Maximal Sign-nonsingular Matrices", T. Lundy, J. Maybee, and J. Van Buskirk, January 1995.
233. "A Characterization of Graphs with Interval Two-Step Graphs", J.R. Lundgren, J. Maybee, S. Merz and C. Rasmussen, March 1995.
234. "S-Inverse Matrices", T. Lundy, J. Maybee, and A. Sen, March 1995.
235. "Learning About Differential Equations From Their Symmetries", S.A. Herod, June 1995.
236. "Kinetic Phase Transitions and Bistability in a Model Surface Reaction, I: Monte Carlo Simulations", D.S. Sholl and R.T. Skodje, September 1994.

237. "Kinetic Phase Transitions and Bistability in a Model Surface Reaction , II: Spatially Inhomogeneous Theories", D.S. Sholl and R.T. Skodje, September 1994.
238. "A Model Surface Reaction on Stepped Surfaces", D.S. Sholl and R.T. Skodje, April 1995.
239. "The Diffusion of Clusters of Atoms and Vacancies on Surfaces and the Dynamics of Diffusion Driven Coarsening," D.S. Sholl and R.T. Skodje, May 1995.
240. "Exact Solutions of the Monomer-Monomer Reaction: Segregation, Poisoning, and Interface Evolution", D.S. Sholl and R.T. Skodje, May 1995.
241. "Multigrid with Overlapping Patches", M. Berndt and K. Witsch, March 1995.
242. "Surface Diffusion of H and CO on Cu/Ru(001): Evidence for Long-Range Trapping by Copper Islands", D.E. Brown, D.S. Sholl, R.T. Skodje, and S.M. George, May 1995.
243. "On Noninvertible Transformations of the Plane: Bairstow Methods", L. Billings and J.H. Curry, June 1995.
244. "The Korteweg-de Vries Equation in the Vortex Dynamics of an Ultraclean Type-II Superconductor", M.W. Coffey, June 1995.
245. "Cylindrical KdV Solitons in the Vortex Dynamics of an Ultraclean Type-II Superconductor", M. W. Coffey, June 1995.
246. "What Kinds of Singular Surfaces Can Admit Constant Curvature," W. Chen and C. Li, September 1994.
247. "A Necessary and Sufficient Condition for the Nirenberg Problem", W. Chen and C. Li, September 1994.
248. "Local Asymptotic Symmetry of Singular Solutions to Nonlinear Elliptic Equations" C. Li, February 1995.
249. "Travelling Fronts in Cylinders and Their Stability", J.W. Bebernes, C. Li, and Y. Li, April 1995.
250. "Nonlinear Vorticity Generation by Acoustic Wave Interaction with an Injected Gas Velocity Field in a Cylinder", Q. Zhao, D.R. Kassoy and K. Kirkkopru, 1994.
251. "The Generation and Evolution of Unsteady Vorticity in a Solid Rocket Motor Model", K. Kirkkopru, D.R. Kassoy and Q. Zhao, 1994.
252. "Unsteady Vorticity Generation and Evolution in a Model of a Solid Rocket Motor: Sidewal Mass Addition Transients", K. Kirkkopru, D.R. Kassoy and Q. Zhao, 1994.



