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PROGRAM IN APPLIED MATHEMATICS

UNIVERSITY OF COLORADO  
AT BOULDER

BOULDER, COLORADO 80309-0526

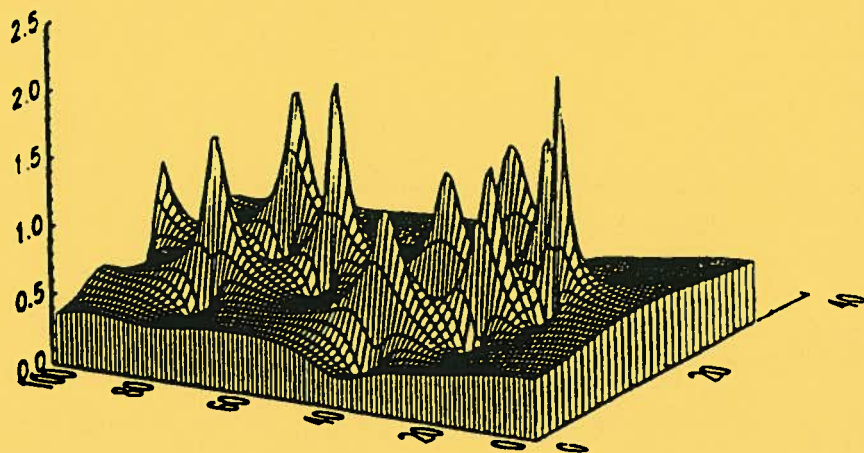
ANNUAL REPORT

1990-91

Mark J. Ablowitz, Director

James H. Curry, Associate Director

July 5, 1991





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## 1. OBJECTIVES

The objectives of the Program in Applied Mathematics at the University of Colorado at Boulder are varied. They are summarized below.

a) To provide undergraduate and graduate students with excellent courses and training in applied and computational mathematics. Students will be given the necessary background to meet the demands of careers in business, industry, and the laboratory and academic professions.

b) To offer and develop a broad curriculum that services the students of all departments and programs of the University.

c) To monitor and maintain excellence in the B.S., M.S. and Ph.D. degrees in Applied Mathematics.

d) To create and nourish an environment in which excitement, creativity and enjoyment of professional activities is of central importance and valued by the Program.

## 2. ORGANIZATION AND COMMENTS

### A. Overview

The Program in Applied Mathematics is configured along two tracks aimed at undergraduate and graduate students respectively. There is a core faculty who are actively involved in all aspects of applied mathematics. The Program has devoted special emphasis toward service of the applied mathematics courses and the undergraduate major in applied mathematics. The first four undergraduate courses in applied mathematics, taught by members of the Program, are taken by virtually all engineering students. There are a number of advanced undergraduate courses which have been introduced. These include methods in applied mathematics, discrete applied mathematics, modelling and computational mathematics. Adequate preparation in applied mathematics for engineers and scientists is essential. Consequently, the Program recognizes that the task of providing high quality instruction is critical.

The graduate level program in applied mathematics consists of core faculty as well as affiliated faculty members who are actively engaged in applied mathematics research from a wide array of disciplines at the University. Working with the graduate committee of the Program these faculty members can formally direct students toward a Ph.D. in applied mathematics. We are pleased with the interest and involvement by faculty and students here at the Boulder campus of the University, the Denver campus and nearby laboratories.

In 1990-91 the Program had 10 core faculty members. The core faculty in the Program are involved with a variety of research activities. These include nonlinear dynamics and chaos theory, analysis of nonlinear equations arising in physical phenomena, nonlinear waves,

The first part of the document is a letter from the Secretary of the Board of Directors of the University of California, dated August 1, 1950, to the President of the University of California, Berkeley, California. The letter discusses the proposed merger of the University of California, Berkeley, and the University of California, San Diego, and the proposed merger of the University of California, Berkeley, and the University of California, Los Angeles. The letter also discusses the proposed merger of the University of California, Berkeley, and the University of California, San Diego, and the proposed merger of the University of California, Berkeley, and the University of California, Los Angeles.

UNIVERSITY OF CALIFORNIA

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1991); Jürgen Moser, E.T.H., Switzerland (February, 1991); Ian Percival, Queen Mary and Westfield College, U.K. (March, 1991), Javier Villaroel, University of Salamanca, Spain (July-October, 1990).

### C. Affiliated Faculty - Graduate Program in Applied Mathematics

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

Alberto Bressan (Mathematics), Differential Inclusions, Geometric Control Theory,  
Conservation Laws and Combustion Theory

Richard Byrd (Computer Science), Optimization, Nonlinear Data Fitting, Parallel Computation

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

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

Fred Glover (Graduate School of Business), Combinatorial Optimization, Heuristic Search,  
Large Scale Models

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

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

Karl Gustafson (Mathematics), Computational Fluid Dynamics, Neurocomputing, Partial  
Differential Equations, Mathematical Physics

Henry Hermes (Mathematics), Nonlinear Systems Theory, Control, Differential Equations

Elizabeth Jessup (Computer Science), Numerical Linear Algebra, Eigenvalue Problems,  
Parallel Computation

William Jones (Mathematics), Mathematics of Computation, Approximation Theory, Special  
Functions

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

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

Oliver McBryan (Computer Science), Large Scale Computation, Numerical Partial Differential  
Equations, Parallel Computations and Algorithms

Tom Mullis (Electrical Engineering), Digital Signal Processing and Linear Systems

Robert Sani (Chemical Engineering), Computational Fluid Mechanics and Transport

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

Robert Schnabel (Computer Science), Parallel Computation, Numerical Optimization,  
Languages

J. Michael Shull (Astrophysical, Planetary, and Atmospheric Sciences and Physics),  
Theoretical Astrophysics, Galactic Media, Quasars, Supernovae

1. The first part of the document is a letter from the Secretary of the State to the Governor, dated 18th March 1877. It contains a report on the progress of the work done during the year.

2. The second part is a report on the work done during the year, dated 18th March 1877. It contains a list of the names of the persons who have been appointed to various offices during the year.

3. The third part is a report on the work done during the year, dated 18th March 1877. It contains a list of the names of the persons who have been appointed to various offices during the year.

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- In two years the Program has rapidly grown to take on all of the aspects of a fully developed academic unit. The Program is servicing students at the undergraduate and graduate levels, curricula have been developed for our undergraduate and graduate students, five new faculty members have been recruited, three faculty have transferred into the Program, two new staff members added and a new complex of offices remodelled all in a short period of time. An enormous burden has been shouldered by the staff during this remarkable transition. Our sincere thank you for all the hard work and effective running of the Program during this period!

- During the past academic year the Program hosted an extremely active colloquium and seminar series with many external speakers and a number of distinguished long term visitors. Long term visitors included Professor Richard McGehee from the University of Minnesota who was the Visiting Ulam Chair in the Department of Mathematics, and Dr. Leon Takhtajan from the Steklov Mathematical Institute in Leningrad. Short term visitors included Professors Jurgen Moser from ETH in Switzerland and Professor Ludwig Faddeev from the Steklov Mathematical Institute in Leningrad. We remark that both of them have been recent presidents of the International Mathematical Union! As evidenced by these visitors, colloquium speakers came from institutions all over the world and, in addition to the long term visitors mentioned above, included such distinguished applied mathematicians as Professors Herb Keller and Philip Saffman from the California Institute of Technology, David Benney from M.I.T., Klaus Schmitt from the University of Utah, Rodney Baxter from the Australian National University, Ian Percival from Queen Mary College of the University of London, amongst others.

- The Program continued its collaborative workshop with the Center for Nonlinear Studies at Los Alamos National Laboratories. This year a number of Program members, visitors, and graduate students went to Los Alamos where the "Colorado Days" workshop was held. A good time was had by all. Particularly valuable was the opportunity for our students and junior faculty members to speak at the meeting and interact with the scientists at Los Alamos. Special thanks to Dr. Robert Easton and Dr. Gregor Kovacic for organizing this year's workshop.

- The Program jointly sponsored a novel telecourse with the Mathematics Department at the University of Colorado at Denver. The telecourse was entitled "New Directions and Classical Problems in Applied Mathematics". Numerous students and faculty listened to the various lectures. Eight faculty participated in giving lectures, four from Denver and four from Boulder. The list of topics for the Boulder faculty is included at the end of this report under Videotapes of the Program. The telecourse concept allows us the possibility of offering advanced courses which would not be feasible to support by either group alone. We are currently investigating the possibility of jointly offering another set of courses for the upcoming academic year. The Program has taped each sequence of lectures and, as with our

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- Leon Takhtajan, University of Colorado, Boulder and Steklov Mathematical Institute, Leningrad, USSR, Oct. 5, 1990: Conformal field theory and quantum groups
- Vladimir Korepin, Institute for Theoretical Physics, SUNY Stony Brook and Steklov Mathematical Institute, Leningrad, USSR, Oct. 12, 1990: Quasicrystals
- Philip Saffman, California Institute of Technology, Oct. 19, 1990: Bifurcation and instabilities in water waves
- Ellen Zweibel, University of Colorado at Boulder, Nov. 2, 1990: Evolution to nonequilibrium in simple models of magnetic filaments
- Tom Manteuffel, University of Colorado at Denver, Nov. 9, 1990: Preconditioning with equivalent operators
- Hassan Aref, University of California at San Diego, Nov. 16, 1990: Lagrangian computational fluid dynamics
- William Troy, University of Pittsburgh, Nov. 30, 1990: An exact reduction of Maxwell's equations
- V.T. Buchwald, University of New South Wales, Australia, Dec. 7, 1990: The response of a strait to an oscillating wind stress
- Edriss Titi, Cornell University, Jan. 18, 1991: Helical flows for the 3-D Navier-Stokes equations
- Rodney Baxter, Australian National University, Australia, Jan. 25, 1991: Solvable models in statistical mechanics
- Anthony Bloch, Ohio State University, Feb. 1, 1991: Control of nonlinear systems with constraints
- Jurgen Moser, ETH, Switzerland, Feb. 8, 1991: Stability in dynamical systems
- Gregory Beylkin, Schlumberger-Doll Research Laboratories, Feb. 15, 1991: Wavelets in numerical analysis
- Michael Tabor, Columbia University and University of Arizona, Feb. 22, 1991: Material elements in a turbulent flow: a kinematic approach
- Ian Percival, Queen Mary and Westfield College, United Kingdom, March 1, 1991: Exact results on the chaotic boundary in Hamiltonian dynamics
- Ann Stanley, Iowa State University, March 8, 1991: Mathematical modelling of the AIDS epidemic
- L.D. Faddeev, Director, Steklov Mathematical Institute, Leningrad, USSR, March 8, 1991: Elementary introduction to quantum groups
- Mikhail Nezhlin, Academy of Sciences USSR, Kurchatov, April 5, 1991: Long-lived solitary anticyclones in the planetary atmospheres, oceans, plasmas, in laboratory experiments and in theory
- Ivan Cherednick, Academy of Sciences USSR, Moscow, and Yale University, April 12, 1991: On a mathematical approach to optical solitons



Solomon Alber, University of Nevada at Reno, Feb. 21, 1991: Meromorphic Hamiltonian systems

Congming Li, University of Pennsylvania, Feb. 28, 1991: The moving planes method and its applications

Boris Malomed, USSR Academy of Sciences, Moscow, March 7, 1991: Bound states of solitons in the nonlinear Schrödinger/Ginzburg-Landau equation

L.D. Faddeev, Director Steklov Mathematical Institute, Leningrad, USSR, March 14, 1991: From integrable models to quantum groups

M. Daniel, Bharanthisadan University, India, April 4, 1991: Singularity analysis of a generalized Heisenberg spin chain: nonintegrability and chaos

Bill Briggs, University of Colorado at Denver, April 11, 1991: Wavelets and multigrid

Stephen Bricher, University of Colorado at Boulder, May 2, 1991: Blowup patterns for semilinear heat equations via center manifold theory

#### Seminar on Dynamical Systems

John Cary, University of Colorado at Boulder, Sept. 20, 1990: Symplectic integration of guiding center orbits

Alfred Osborne, University of Torino, Italy, Oct. 18, 1990: Fractal Hamiltonian mechanics with applications

Hassan Aref, University of California at San Diego, Nov. 15, 1990: Integrable and chaotic motions of point vortices

Bruce Peckham, University of Minnesota at Duluth, Nov. 29, 1990: Some bifurcation phenomena for forced oscillators

Eduardo Tabacman, University of Colorado at Boulder, Dec. 6, 1990: How to make Newton's method work: Sutherland's work

Xiao Wang, Mathematical Sciences Research Institute, Feb. 14, 1991: Singular solutions of the nonlinear Schrödinger and Zakharov equations

Michael Tabor, Columbia University and University of Arizona, Feb. 21, 1991: Singularities and symmetries of nonlinear evolution equations

Philip Rosenau, Technion, Israel, Feb. 28, 1991: Leaving the small gradient paradise

Robert Easton, University of Colorado at Boulder, March 7, 1991: Transport of phase space volume near isolated invariant sets

I. Bakas, University of Maryland, March 14, 1991: Self-duality, integrable systems and W-algebras

Richard McGehee, Ulam Chair, University of Colorado at Boulder and University of Minnesota, March 21, 1991: Iterating a relation

1. The first part of the report deals with the general situation of the country and the position of the various groups. It is a very interesting and well-written account of the country and its people. The author has done a great deal of research and has written a very interesting and well-written account of the country and its people. The author has done a great deal of research and has written a very interesting and well-written account of the country and its people.

2. The second part of the report deals with the economic situation of the country. It is a very interesting and well-written account of the country and its people. The author has done a great deal of research and has written a very interesting and well-written account of the country and its people. The author has done a great deal of research and has written a very interesting and well-written account of the country and its people.

similar to a minor, and there is one option for each of the (seven) other degree programs in the School of Engineering and Applied Science. Each option consists of a list of recommended courses relevant to the major field in question. We anticipate that many of our students will simply choose one of the options, and follow it. However, the options are not required, so a student can modify options, or can design his/her individual curriculum (provided it contains the required courses). The revised curriculum was approved by the faculty of the School of Engineering and Applied Science on May 8, 1991.

2) The Colorado Commission on Higher Education requires that each graduating senior satisfy an "outcomes assessment" requirement. After some negotiation, the Program in Applied Mathematics decided to ask each of its seniors to take the first in the series of nation-wide exams given by Society of Actuaries. This exam covers two semesters of calculus, plus linear algebra, all of which are required courses in the Program. The class of 1991-1992 will be the first class for which this exam is mandatory.

3) A widely-held sentiment within the Program in Applied Mathematics is that APPM 2360, which tries to cover both ordinary differential equations and linear algebra, actually does not cover either in sufficient depth. Since the course is required for most of the engineering disciplines, it is difficult to change it radically. Instead, we introduced APPM 2380, a new sophomore-level course in ordinary differential equations. Our intention is that the students will learn about differential equations in APPM 2380, and applied linear algebra in APPM 3310. The course is still under review by the College of Arts & Sciences Committee on Courses.

There were 45 Applied Mathematics undergraduate students this year. Ten of these students graduated in May. Jeffery Stout, graduated with distinction with a GPA of 3.93.

#### **B. Graduate Committee - James Curry, Chair**

The Graduate Program in Applied Mathematics had a productive year. Four graduate courses were offered in the areas of Applied and Numerical Analysis and Methods of Applied Mathematics as well as two seminars (Nonlinear Waves and Dynamical Systems). A total of 10 graduate courses are scheduled to be taught in 1991-92 with several advanced seminars also being offered.

A Graduate Committee was formed in the Fall. James Curry was the committee Chair with three faculty, one student and one staff member: Jim Meiss, Jerrold Bebernes, John Maybee, Scott Herod and Janet Glasser. The Committee met several times throughout the year to discuss such topics as recruitment of graduate students, content and procedures for administering the preliminary examinations, and graduate student policy.





David Sholl (Australia National University)  
Lisa Ward (George Washington University)

Teaching Assistants- 1991-92:

Kimberly Baugh	Jennifer McDiarmid
Erik Bollt	Fethi Migaou
Juri Burlakov	Renay Oshop
Robert Cramer	Tara Rao
Marianne Danehy	Carlin Rogers
David Deininger	Elizabeth Ryan
Glenn Ennis	David Sholl
James Keiser	Alejandro Spina

**C. Faculty Search Committees**

During this academic year we received over 400 applications in response to our advertisements for visiting and tenure track faculty positions. We carried out the search process by circulating complete files (vitae and letters of recommendation) to members of the relevant committees. Most applicants were divided into separate categories: (i) computational mathematics or (ii) analysis, although a few applicants were deemed suitable for both. Each committee member ranked files in three categories -- high, medium or low interest. A number of meetings were held to carefully discuss the candidates. Members of the committees are listed below:

(i) Computational Mathematics

Mark Ablowitz  
Richard Byrd (Computer Science)  
James Curry  
Martin Goldman (APAS)  
John Maybee  
James Meiss  
Harvey Segur  
Juri Toomre (APAS)



**D. Faculty Service to the University, College and Societies**

Mark Ablowitz: Member of Council on Research and Creative Work of The Graduate School; Organized the Applied Mathematics Seminar on Nonlinear Waves and Integrable Systems

Jerrold Bebernes: Member of Program Graduate Committee; Member of Program Faculty Recruiting Committee

Mary Brewster: Member of the Program Undergraduate Committee; Organized Program participation with the Industrial Affiliates

James Curry: Member of Arts & Science Personnel Committee; Chair of Program Graduate Committee; Member of Program Faculty Recruiting Committee; Chair of Computer Science Internal Review Committee; Member of Salary Equity Committee; Member of University Committee on Computing in the 90's

Robert Easton: Member of Program Undergraduate Committee; Member of Program Faculty Recruiting Committee; Organized Dynamical Systems Seminar; Member of Educational Policy and Planning Committee, College of Engineering; Member of Undergraduate Academic Affairs Committee, College of Engineering

Johns Maybee: Member of Program Graduate Committee; Member of Program Faculty Recruiting Committee

James Meiss: Member of Program Graduate Committee; Member of Program Faculty Recruiting Committee; APAS Committee on Plasma Physics at CU

Harvey Segur: Chair of Program Undergraduate Committee; Chair of Program Colloquium Committee

**4. TEACHING ACTIVITIES**

**A. Courses Taught by Program Faculty During Academic Year 1990-91**

**(i) UNDERGRADUATE COURSES**

APPM 1350, Atela, Bressan, Chakravarty, and Easton, Calculus 1 for Engineers. Limits, derivatives and integration of algebraic and transcendental functions, applications of derivatives, and integration.

APPM1360, Chakravarty, Kriegh, and Maybee, Calculus 2 for Engineers. Applications of the definite integral, methods of integration, improper integrals, Taylor's theorem, and infinite series.



3310. Matrix Methods and Applications. Linear algebra and matrices with emphasis on applications, methods to solve systems of linear algebraic and linear ordinary differential equations and computational algorithms. (To be taught Fall '91).

4380. Modelling in Applied Mathematics. An exposition of a variety of mathematical models arising in the physical and biological sciences. Models may be taken from applications in classical and celestial mechanics, fluid dynamics, traffic flow, population dynamics, economics and elsewhere. (To be taught Spring '92)

(ii) GRADUATE COURSES (all APPM)

6620. Numerical Computation in Applied Math 1: Ordinary Differential Equations.

Numerical solution of ordinary and partial differential equations, initial and boundary value problems. (To be taught Fall '91.)

6630. Numerical Computation in Applied Math 2: Partial Differential Equations.

Numerical solution of ordinary and partial differential equations, initial and boundary value problems, stability and convergence of difference schemes. (To be taught Spring '92.)

7100. Mathematics Methods in Dynamical Systems. Dynamical systems, mappings and differential equations, period doubling route to chaos, Hamiltonian mechanics, action-angle variables, results from KAM and bifurcation theory, phase plane analysis, Melnikov theory, strange attractors. (To be taught Spring '92.)

7300. Mathematical Methods in Nonlinear Waves & Integrable Equations. Basic results associated with linear dispersive wave systems, first order nonlinear wave equations, nonlinear dispersive wave equations, solitons and methods of the inverse scattering transform. (To be taught Fall '91.)

**C. Summer Courses, 1991**

APPM 1350, Allan, Calculus I for Engineers.

APPM 1360, Nesbitt, Calculus II for Engineers.

APPM 2350, Chakravarty, Calculus III for Engineers.

APPM 2360, Herod, Intro to Linear Algebra and Differential Equations.

APPM 4650, Schober; Intermediate Numerical Analysis I.



*On Reductions of Self-Dual Yang-Mills Equations*, S. Chakravarty and M.J. Ablowitz, Proceedings of NATO Advanced Research Workshop "Asymptotics and Physical Applications", Eds. P. Winternitz and D. Levi, Montreal, October 1990.

*High symmetry solutions of the anti-self-dual Yang-Mills equations*, Sarbarish Chakravarty, S.L. Kent and E.T. Newman, Journal of Math. Physics, Vol. 31, No. 9, Sept. 1990.

*Canonical structures on anti-self-dual four-manifolds and the diffeomorphism group*, S. Chakravarty, Lionel Mason and Ezra T. Newman, Journal of Math. Physics, Vol. 32, No. 6, June 1991.

**Robert Easton:**

*Transport Through Chaos*, Nonlinearity 3, 1991, 8 pages.

*Capture orbits and Melnikov integrals in the planar three body problem*, Celestial Mechanics, June 1991, 16 pages.

**John Maybee:**

*An application of generalized competition graphs to the channel assignment problem*.  
Congressus Numerantium 71 (1990) 217-224 (with R. Lundgren and C. Rasmussen).

*Biclique covers of bigraphs and digraphs and minimum semiring ranks of  $\{0,1\}$ -matrices*.  
Congressus Numerantium 71 (1990) 115-122 (with K. Hefner, T. Henson, and J.R. Lundgren).

*Partly zero eigenvectors*, Linear and Multilinear Algebra 28 (1990) 83-92 (with D. Olesky and P. van den Driessche).

*Tournament matrices and their generalizations I*. Linear and Multilinear Algebra 28 (1990) 57-70 (with N. Pullman).

*Minimum boolean factorizations of tournament codes*. Congressus Numerantium 78 (1990) 61-70 (with G. Bain and J. R. Lundgren).

*Some properties of a class of recursively defined digraphs*, to appear in J. of Combinatorics, Information and System Sciences in May 1991 (with K. Hefner, J.R. Lundgren).

*Qualitative analysis of Schur complements*, 65th anniversary volume in honor of Victor Klee, with C.R. Johnson, American Math. Society, June 1991.

*Biclique coverings and partitions of unipathic digraphs*, in 60th anniversary volume in honor of Norman Pullman, with K. Hefner and J.R. Lundgren, June 1991.





**Jerrold Bebernes:**

*"Asymptotic Similarity"*, Asian Mathematical Congress, Hong Kong, August 13-17, 1990, invited.

*"Final time solution profiles"*, Math. Institute, Fudan University, Shanghai, China, Aug. 21, 1990.

*"Final time solution profiles"*, Math. Institute, Academica Sinica, Beijing, China, Aug. 23, 1990.

*"Refined Asymptotics for Blowup"*, Dynamical Systems Conference, Oberwolfach, March 25-29, 1991, invited.

**Mary Brewster:**

*"Instabilities of Viscous Fluid Flow in a Curved Channel"*, Applied Mathematics Seminar, CU Boulder, October 9, 1990.

*"Instabilities of Viscous Fluid Flow in a Curved Channel"*, Dow Chemical Co., Midland, MI, Oct. 15, 1990.

*"Wrinkled Flame Fronts Induced by Spatial Inhomogeneities"*, Center for Combustion Research, CU Boulder, Nov. 19, 1990.

*"Wrinkled Flame Fronts Induced by Spatial Inhomogeneities"*, Rensselaer Polytechnic Institute, January 10, 1991.

Attended Colorado Combustion Society meeting, Sept. 19, 1990, Combustion Institute (Western States) March 17-19, 1991.

**James Curry:**

*"Seminar on Diversity:Mathematicians"*, University of California, San Francisco, April 1991.

**Robert Easton:**

*"Transport of Phase Space Volume Near Isolated Invariant Sets"*, International Dynamical Systems Conference, Northwestern University, March 24-28, 1991.

**Robert McLachlan:**

*"Multigrid solution of the Navier-Stokes equations at high Reynolds numbers"*, CMG, CU Denver, October 1990.

*"Triple Deck Theory-- is it resolved?"*, CU Boulder, November 1990.

Attended Midwestern Dynamical Systems Meeting, Evanston, March 1991.

*"The Accuracy of Symplectic Integrators"* at Colorado Days, Los Alamos, April 1991.

1970-1971

1972-1973

1974-1975

1976-1977

1978-1979

1980-1981

1982-1983

1984-1985

1986-1987

1988-1989

1990-1991

1992-1993

1994-1995

1996-1997

## C. Research Grants

### Mark Ablowitz:

NSF: Nonlinear Wave Motion

AFOSR: Nonlinear Wave Propagation

ONR: Nonlinear Waves & Inverse Scattering

University of Colorado, Telecourse on New Directions  
in Applied Mathematics (joint with UC Denver)

(Total: \$156,447)

### Jerrold Bebernes

ARO: Mathematical analysis of transient reactive gas dynamics phenomena

NSF: Mathematics of thermal explosion phenomena

(\$82,000)

### Mary Brewster

Dow Chemical Co./Filmtech, Inc: Instabilities of Viscous Fluid  
Flow in a Curved Channel

CRCW: Mathematical modelling of Premixed

Flames in a Dual-Source System

(\$21,670)

### James Curry

NSF: Scientific Research Equipment Grant, Co-P.I.

(\$8,667)

### Robert Easton

NSF: Scientific Research Equipment Grant, Co-P.I.

Council for the Enhancement of Undergraduate Education:

Computer Demonstrations for Applied Mathematics (\$10,390 in equipment)

(\$19,057)

### John Maybee

CRCW: Computer programming support in computing  
maximal sign nonsingular matrix patterns for  $n=7,8,9$ .

ONR: with Prof. J. Lundgren

(\$35,000)



Robert Easton

Organized Los Alamos Days

Helped formulate the new degree requirement for the BS Applied Math. degree.

John Maybee

Associate Editor SIAM Journal on Matrix Analysis and Applications

James Meiss:

Referee for more than 8 journals and over 25 papers in 1990

8 Reviews for *Mathematical Reviews*

Organizer at Summer meeting at the Aspen Center for

Physics, May/June 1990

Harvey Segur:

Co-Director, Nato Advanced Research Workshop on "Asymptotics Beyond all Orders", held in La Jolla, CA January 7-11, 1991.



1. The first part of the report

is devoted to a general survey of the

state of the art in the field of

2. The second part of the report

deals with the results of the

3. The third part of the report

is devoted to a detailed study of

the various methods used in the

investigation and the results

obtained.

4. The fourth part of the report

is devoted to a discussion of the

conclusions drawn from the



64. *Cantori for Symplectic Maps Near the Anti-integrable Limit* by R.S. MacKay and J.D. Meiss, October 1990.
65. *Thin Plates and Compressive Membrane Solutions II: A Nonexistence Result* by Mary E. Brewster, October 1990.
66. *Minimizing Flux* by J.D. Meiss and R.L. Dewar, November 1990.
67. *On Network Structure Function Computations* by Edward C. Waymire, December 1990.
68. *On Particles and Interaction Properties of the Parity Rule Filter Automata* by Mark J. Ablowitz and James M. Keiser, January 1991.
69. *Forced and Semiline Solutions of Burger's Equation* by M.J. Ablowitz and S. De Lillo, January 1991.
70. *An Asymptotic Symmetry of the Rapidly Forced Pendulum* by Yi-Hua Chang and Harvey Segur, January 1991.
71. *The Geometric Model of Crystal Growth-- an Overview* by Harvey Segur, February 1991.
72. *Transport of Phase Space Volume Near Isolated Invariant Sets* by Robert W. Easton, March 1991.
73. *Wrinkled Flame Fronts Induced by Transverse Nonuniformity* by M.E. Brewster, March 1991.
74. *A Class of Stable Multi-State Time-Reversible Cellular Automata with Rich Particle Contents* by Mark J. Ablowitz, James M. Keiser and Leon A. Takhtajan, March 1991.
75. *Stable Multi-State Time-Reversible Cellular Automata with Rich Particle Content* by Mark J. Ablowitz, James M. Keiser and Leon A. Takhtajan, March 1991.
76. *The Accuracy of Symplectic Integrators* by Robert I. McLachlan and Pau Atela, April 1991.





90. *Algebraic Multiplicity of the Eigenvalues of a Tournament Matrix* by D. de Caen, D.A. Gregory, S.J. Kirkland, M.J. Pullman and J.S. Maybee, June 1991.
91. *Vanishing Minor Conditions for Inverse Zero Patterns* by Charles Johnson and John Maybee, June 1991.
92. *High-Speed Reaction Zone Structure for Variable Mole Chemistry* by David Kasso and K. Kirkkopru, June 1991.
93. *Thermally Initiated Detonation Through Deflagration to Detonation Transition* by D. Kasso and A.A. Sileem, June 1991.
94. *Weak Shocks Initiated by Power Deposition on a Spherical Source Boundary* by David Kasso and Sutrisno, June 1991.
95. *Transient Acoustic Processes in a Low Mach Number Shear Flow* by David Kasso and M. Wang, June 1991.
96. *Dissociation-Recombination Relaxation Behind a Normal Shock* by D. Kasso and K. Kirkkopru, June 1991.
97. *Standing Acoustic Waves in a Low Mach Number Shear Flow* by D. Kasso and M. Wang, June 1991.
98. *Thermoacoustic and Natural Convection in Confined Gaseous Helium Subjected to Boundary Heating* by D. Kasso and Sutrisno, June 1991.

