PROGRAM IN APPLIED MATHEMATICS

UNIVERSITY OF COLORADO AT BOULDER

BOULDER, COLORADO 80309-0526

ANNUAL REPORT

1989-90

Mark J. Ablowitz, Director

James H. Curry, Associate Director

July 1, 1990
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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 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. There is a core faculty who are actively involved in all aspects of applied mathematics with special emphasis directed 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. Adequate preparation in applied mathematics for engineers and scientists is essential. Consequently, the task of providing high quality instruction is critical. The graduate level program in applied mathematics consists of core faculty as well as faculty who are actively engaged in applied mathematics research from a wide array of disciplines at the University. These faculty members can formally direct students toward a Ph.D. in applied mathematics. This year we have been extremely pleased by the interest and involvement by faculty and students here at the Boulder campus of the University, the Denver campus and nearby laboratories.

The program core has defined a number of areas of research focus. These include nonlinear dynamics, chaos theory, analysis of nonlinear equations arising in physical phenomena, nonlinear waves, soliton theory, computation and numerical analysis.
B. Core Faculty and Long Term Visitors

**Mark J. Ablowitz**, Director, Professor; PhD, M.I.T. Partial Differential Equations, Solitons, Nonlinear Waves.

**Pau Atela**, Instructor; PhD, Boston University. Dynamical Systems, Hamiltonian Mechanics and Complex Dynamics.

**Priscilla Cehelsky**, Visiting Assistant Professor; PhD, M.I.T. Fluid Mechanics, Applied Analysis.

**Sarbarish Chakravarti**, Visiting Assistant Professor; PhD, University of Pittsburgh. General relativity, Nonlinear Integrable Systems.

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

**Barend Herbst**, Visiting Associate Professor; PhD, University of the Orange Free State, So. Africa, Computational Solutions of Differential Equations, Computational Methods in Dynamical Systems.

**James D. Meiss**, Associate Professor; PhD, University of California at Berkeley. Dynamical Systems, Classical Mechanics, Hamiltonian Mechanics.

**Dorit Ron**, Visiting Instructor; PhD, Weizmann Institute in Israel. Numerical Analysis, numerical algorithms for large scale problems.

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

**Javier Villaroel**, Visiting Assistant Professor (Fulbright Fellow); PhD, University of Salamanca, Spain. Nonlinear Integrable Systems, Inverse Scattering.

**SHORT TERM VISITORS:** Peter Clarkson, Exeter University (August 1989); I.M. and T. Gel’fand, Moscow State University (April 1990); Nalini Joshi, Australian National University (April 1990); Martin Kruskal, Rutgers and Princeton Universities (Sept. 1989, April 1990); Leon Takhtajan, Steklov Institute of Mathematical Sciences, Leningrad, USSR (March 1990).

C. Affiliated Faculty - Graduate Program in Applied Mathematics


**Alberto Bressan**, Differential Equations, Geometric Control Theory, Analysis.


Michael Lightner. VSLI, Discrete Mathematics, Graph Theory.

*John Maybee. Applied Combinatorics and Matrix Analysis.


Renjeng Su. Control Theory, Robotics.


*Member of the core faculty as of July 1, 1990.

D. Staff

Janet Horn - Staff Assistant

Andrea Hennessy - Word Processing Operator

Janet Key - Student Coordinator/Receptionist
E. General Comments

- For the program, its faculty and staff, this has been an extremely busy year requiring a great deal of time and effort by members of the program and interaction with many people throughout the University. We are extremely grateful for all the help we have received from the Office of the Vice Chancellor, the offices of the Dean of Arts and Sciences, the Dean of Engineering, the Dean of the Graduate School/Associate Vice Chancellor for Research and many faculty and staff throughout the university; a deep and sincere thank you.

- Early in the year a number of meetings were held with interested faculty regarding the undergraduate and graduate programs in applied mathematics. These meetings held on weekends and evenings allowed for wide-ranging discussion and broad interaction between interested parties. Based upon comments and suggestions, we developed courses and initiatives. Some of these are discussed later in this report.

- A number of committees were organized to carry out the basic functions within the program. These include: an undergraduate, a graduate, and two faculty search committees -- one in computational mathematics and one in analysis. We are grateful to all the faculty who served on these committees and who made so many valuable contributions.

- As most people in academia realize, the staff associated with programs and departments are absolutely crucial in the effective running and organization process. They take care of a myriad of activities and details, e.g. budgetary matters, faculty and student concerns, preparation of technical manuscripts, arrange for offices and furniture . . . . At the beginning of the year we had but one staff assistant, Ms. Janet Horn. She had the nearly impossible task of satisfying all of the above needs for our students, faculty and visitors. Moreover, the program's offices were not ready until January. She had to coordinate the move, arrange for the renovation, moving of books, desks, computers, etc. from temporary locations. All of this was done in addition to her normal activities. Especially trying was the correspondence needed for our faculty search process which generated 500+ applications! This was a tour de force -- done with grace and aplomb. We are sincerely and deeply appreciative of all she has done. Additionally, during this year we hired a word processing operator, Andrea Hennessy. (Andrea replaced Sharon Foote, who resigned in March.) Andrea is an excellent typist, and has helped us in all of our activities. She is an accomplished
musician as well -- double bass! On June 11 we added a student coordinator/receptionist, Janet Key. Janet is also pursuing a graduate degree in communication disorders here at the University and comes to us from Norlin Library. We look forward to a long and fruitful collaboration with all of our staff.

As mentioned above, the offices of the Program in Applied Mathematics and faculty in the Program were relocated in January. The permanent offices are on the second floor of the Engineering Center. Program office: OT 2-6, Janet Horn: OT 2-3, James Curry: OT 2-4, Mark Ablowitz: OT 2-1, Conference room: OT 2-5. The conference room also provides a location for informal discussion, reading room and area for coffee and tea before seminars and colloquia.

Professor James Curry worked tirelessly this year as associate director of the program, chair of the graduate committee, director of computing within the program, advisor to numerous graduate and undergraduate students, director of the successful NSF program Research Experiences for Undergraduates, etc. Curry played a key and central role in the organization of the program. The program deeply appreciates his invaluable efforts.

A workshop, "Los Alamos - Colorado Days", was held April 12-14. The purpose of the workshop (this was the first of an annual affair in alternating years to be held in Boulder and Los Alamos) is to provide a forum for active researchers in nonlinear science and applied mathematics from Los Alamos and Colorado to lecture and informally discuss recent results and directions in this rapidly changing field. Special thanks to the co-organizers Darrel Holm from Los Alamos National Laboratory and Harvey Segur from the Program in Applied Mathematics. This was Harvey's first year with the program. He came to us from SUNY at Buffalo. He is an invaluable faculty member.

We are happy to announce that professors Jerrold Bebernes, Robert Easton and John Maybee will be joining the program as of July 1, 1990. They are well known applied mathematicians and bring a great deal of expertise and experience to PAM. The program will organize a small reception to officially welcome them in the early fall.

We are pleased to note the support, interest and help our colleagues at the University of Colorado at Denver have provided, especially important during the beginning phases of the program's development. They have attended colloquia, seminars, the Los Alamos workshop, informal program meetings, assisted during our faculty search endeavors. We have a joint PhD program with Denver and appreciate their value to us and the university. Special thank yous to Chair
Richard Lundgren, Director of the Computational Math Group Tom Manteuffel, Achi Brandt (visiting from Israel), William Briggs, Jr., Ben Fox (colloquium chair) and Steven McCormick.

-We are pleased to note that Professor James Meiss was interviewed on Australian National television (along with B. Mandelbrot and R. May) as part of the conference Chaos in Australia during his visit to Australia this past winter. We are also most grateful for Jim's efforts in organizing our own internal computing (Macintosh) network. He spent innumerable hours doing this important and valuable task. This is Jim's first year in the program. He came to Colorado from the University of Texas at Austin. We are delighted to have him here.

F. Applied Mathematics Colloquia and Seminars

-An Applied Mathematics Colloquia series was organized this year. The time of the colloquia is Friday afternoons at 3:00 p.m. with coffee and tea preceding at 2:45 p.m. Additionally, the program maintains two weekly seminar series on Thursday afternoons. The Nonlinear Waves and Integrable Systems Seminar is at 2:00 p.m. and the Dynamical Systems and Chaos Seminar is at 4:00 p.m. This year we had a total of 42 off campus speakers at our colloquia and seminars. A list of visiting speakers and the titles of their talks follows:

**Applied Mathematics Colloquia**

**Martin Kruskal**, Rutgers and Princeton Universities Sept. 1, 1989: Surreal Numbers; What is the Cube Root of Infinity?

**Darryl Holm**, Los Alamos, Sept. 8, 1989: Hamiltonian Chaos in Nonlinear Oscillators

**Greg Forest**, Ohio State University, Sept. 15, 1989: Asymptotic Closure Models for Non-Newtonian Jets

**Peter Clarkson**, Exeter University, Sept. 22, 1989: Nonclassical Symmetry Reductions Associated with Nonlinear Evolution Equations

**Achi Brandt**, CU Denver and Weizmann Institute, Sept. 30, 1989: Multilevel Computational Methods; Survey and Recent Developments


Robert Krasny. University of Michigan, Feb. 16, 1990: Vortex Sheets; Singularity Formation and Roll-up


Leon Takhtajan. Steklov Institute, Leningrad, March 9, 1990: Introduction to Quantum Groups

Yannis Kevrekidis. Princeton University, March 16, 1990: Global Bifurcations in Maps of the Plane and in Rayleigh-Benard Convection

H. Knoblock. West Germany, April 6, 1990: Control Theory and the Applied Sciences

David Campbell. Los Alamos, April 13, 1990: New Directions in Nonlinear Science

Albert Libchaber. University of Chicago, April 20, 1990: Dynamics of a Moving Nematic Isotropic Interface


Robert Dewar. Australian National University, May 4, 1990: Bifurcations in Resistive Magnetohydrodynamics


Miki Wadati. University of Tokyo, May 18, 1990: Soliton Phenomena in Unstable Media
Seminar on Nonlinear Waves and Integrable Systems

Peter Clarkson, Exeter University, Sept. 21, 1989: Solutions to Classical Nonlinear Differential Equations

Olivier Thual, NCAR, Oct. 12, 1989: Pulse-like Solution for a Complex Ginsberg-Landau Type Equation


Anil Deane, Princeton University, Nov. 2, 1989: Lyapunov Exponents, Attractor Dimension and the Proper Orthogonal Decomposition

Robert Kerr, NCAR, Nov. 9, 1989: Three Dimensional Vortex Dynamics: Is There a Singularity in Finite Time?

B.K. Shivamoggi, University of Central Florida, Dec. 7, 1989: On the Number of Effective Modes for the Nonlinear Schrödinger Equation in 2 and 3 Dimensions

A. Perelomov, Fermi Laboratories and Institute of Theoretical and Exp. Physics, Moscow, Dec. 14, 1989: Integrable Models & Conformal Field Theories

Robert Krasny, University of Michigan, Feb. 15, 1990: Vortex Sheets; Wakes, Dipoles and Roll-up at a Sharp Edge

Robert McLachlan, Caltech, March 1, 1990: Multigrid Methods and High Reynolds Number Laminar Flows

Leon Takhtajan, Steklov Institute, Leningrad, April 6, 1990: Quantum Groups

Orlando Ragnisco, University of Rome, April 13, 1990: Discrete Hamiltonian Systems

Bengt Fornberg, Exxon Research, April 20, 1990: Steady Incompressible Flow Past Blunt Bodies at High Velocities


Seminar on Dynamical Systems

Diane Henderson, Scripps Institute of Oceanography, Sept. 28, 1989: Subharmonic and Superharmonic Resonances in Faraday Waves

Christopher Golf, University of Minnesota, Oct. 19, 1989: The Energy Gradient Flow Attached to Twist Maps
Jeffrey Weiss, NCAR, Oct. 26, 1989: Point Vortex Dynamics in a Periodic Domain
Richard McGehee, University of Minnesota, Nov. 16, 1989: A Metric Approach to Attractors
Stephane Laederich, University of Minnesota, Nov. 30, 1989: Qualitative Dynamics of Free Chains
Robert Devaney, Boston University, Feb. 22, 1990: Dynamics of Complex Polynomials and Automorphisms of the Shift
Ferenc Varadi, UCLA, March 1, 1990: Hamiltonian Perturbation Theory Applied to Planetary Motions
Yannis Kevrekidis, Princeton University, March 15, 1990: Low-Dimensional Dynamics and Inertial Manifolds for the Kuramoto-Shivashinski Equation

-In addition, we hosted a number of SPECIAL LECTURES. These included:
Mary Brewster, RPI, March 12, 1990: Thinplates and Compressive Membrane Solutions
Mary Brewster, RPI, March 13, 1990: Bifurcation Analysis of Free Boundary Problems
Martin Kruskal, Princeton and Rutgers Universities, April 12, 1990: Integrability and Differential Equations
I.M. Gel'fand, Moscow State University, April 23, 1990: Spectral Theory of Third Order Ordinary Skew Symmetric Differential Equations
I.M. Gel'fand, Moscow State University, April 24, 1990: A-discriminant and Determinants of a Cubic Matrix
Tanya Alekseyevskaya Gel'fand, Moscow State University, April 24, 1990: The Investigation and a Class of Exact Solutions to a Quasi-Linear System Governing Electrophoresis

We had a joint coffee and tea with the departments of Physics and Astrophysical, Planetary and Atmospheric Sciences at 3:30 - 4:00 p.m. each Thursday. We are certainly appreciative of the support of the staff of these departments and the use of their seminar rooms during these periods.
3. COMMITTEES

The following committees were organized during the 1989-90 academic year: undergraduate, graduate and two recruiting committees -- one in computational mathematics and one in analysis. A brief summary of activities are described below.

A. Undergraduate Committee - Harvey Segur, Chair

The undergraduate program has two main parts: (i) an undergraduate major in Applied Mathematics, granted within the College of Engineering; (ii) service courses, primarily in calculus and differential equations, taught to the Engineering students.

Here are some statistics about the undergraduate majors:

*Fall, 1989*

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<td>Freshmen</td>
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<td>Sophomores</td>
<td>8</td>
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<td>Juniors</td>
<td>14</td>
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<td>Seniors</td>
<td>7</td>
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<tr>
<td>5th year seniors</td>
<td>2</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>39</strong></td>
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The main goal of the undergraduate committee this year was to revitalize the undergraduate program. There were several aspects to this task.

(i) Seven new, upper-division, undergraduate courses in Applied Mathematics were created and approved by the College of Arts & Sciences. A detailed listing is given later in this report. These included 2 service courses (3310, 3570), 3 courses that will be cross-listed with existing Math courses (3170, 4650, 4660), and 2 entirely new courses (4380, 4955). These courses will play an important role in a revised curriculum for the undergraduate major.

(ii) Revising the curriculum for the Applied Mathematics majors is now underway. We hope to complete these revisions within the next month, in time for the 1991-1992 catalogue.

(iii) A new option for the undergraduate major, based on Discrete Mathematics, has been discussed. It will be a major topic of discussion over the next year. Also for next year, a major concern of the committee will be to determine a vehicle for
satisfying the needs of undergraduates in Arts and Sciences who wish to pursue applied mathematics.

(iv) A new student chapter of SIAM (Society of Industrial and Applied Mathematics) was created.

B. Graduate Committee - James Curry, Chair

The graduate program had an extremely busy and productive year.

A total of nine graduate courses will be offered by the program as part of its educational mandate. The course offerings include opportunities for study in discrete applied mathematics, mathematical methods in applied mathematics, applied analysis, and computation. Several advanced courses and seminars will also be offered by the Program.

In addition to graduate courses, the degree requirements for the Ph.D. and M.S. degrees are also nearing a final form. These include the following requirements:

(i) graduate students in the Program must complete a year-long sequence of courses in an area where mathematics has a significant application;

(ii) students are expected to participate in seminars on a regular basis.

The Program has been successful in recruiting graduate students this year and it expects to do even better next year. The majority of the students who will begin graduate studies with the fall semester 1990 have grade point averages that exceed 3.5. Further, with the fall semester, there will be at least ten graduate students working towards the Ph.D. in the Program. The majority of new students will be supported by teaching assistantships and/or partial fellowships. The Program will experience additional growth when its full complement of seventeen TA positions are realized in the Fall semester 1991. New graduate students for 1990-91 are listed below.

Erik Bollt (University of California, Berkeley)
Jan Borichevsky (University of Vermont, Burlington)
Terry Chen (University of Colorado, Denver)
David Deininger (Furman University, Greenville, SC)
Diane Denny (New York University)
James Donahoe (University of Minnesota, Minneapolis)
John Evans (Montana State University, Bozeman)
Anna Kallergi (University of Crete, Greece)
Ma, Wenxiu (Computing Center of Academia Sinica, Beijing, China)
Matthew St. John (University of Colorado, Boulder)
Eduardo Tabacman (University of Minnesota, Minneapolis)

Among the key items which will foster further growth of the Graduate Program is external fellowship support for graduate students and in particular advanced graduate students. With the increased interest in mathematics at the national level we hope and anticipate that there will be new opportunities for graduate student support.

Another source of graduate student funds is provided by summer teaching/research experiences. For example, during the summer of 1990 the Program was able to place seven applied mathematics graduate students in such positions. In the case of the Program's own first year students one was supported by a generous fellowship, a second by a research grant and the third with a TA and supplement from a research grant. The Program understands that providing such summer support is vital to the overall health of the graduate program.

Finally, as mentioned earlier, a key item which will be necessary to investigate and develop over the upcoming few years will be external grants. The graduate committee will actively pursue various opportunities in the future.

C. Faculty Search Committees

During this academic year we received over 500 applications in response to our widely advertised announcements. We carried out the search process by circulating complete files (vita 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:

(i) Computational Mathematics
Mark Ablowitz
Richard Byrd (Computer Science)
James Curry
Robert Easton (Mathematics)
Martin Goldman (Astrophysical, Planetary & Atmospheric Sciences)
Karl Gustafson (Mathematics)
Oliver McBryan (Computer Science)
James Meiss
Harvey Segur

(ii) Analysis
Mark Ablowitz
Jerrold Bebernes (Mathematics)
William Blumen (Astrophysical, Planetary & Atmospheric Sciences)
James Curry
Henry Hermes (Mathematics)
David Kassoy (Mechanical Engineering)
James Meiss
Duane Sather (Mathematics)
Harvey Segur

After a careful, exhaustive (and exhausting) search, the following people will be joining the program:

Dr. Mary Brewster; Assistant Professor. Mary got her Ph.D. from Caltech in 1987 and spent the past few years at R.P.I. Mary won the Richard DiPrima Award from the Society of Industrial and Applied Mathematics (SIAM) for the best Ph.D. thesis in 1988. Her fields of interest are classical analysis, asymptotic and computational methods of applied mathematics.

Dr. Robert McLachlan; Instructor. Robert just finished his Ph.D. at Caltech. His specialty is computational mathematics especially as applied to fluid dynamics.

Finally, Dr. Yannis Kevrekidis is expected to join the program in September, 1991 as Visiting Associate Professor. Yannis is a member of the Chemical Engineering faculty and Program in Applied Mathematics at Princeton University. His specialty is scientific computation, nonlinear dynamics and bifurcation analysis.
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 Colloquium series and Seminar on Nonlinear Waves and Integrable Systems;

Paul Atela: Co-organizer of the Dynamical Systems Seminars;

James Curry: Member of Dean's Personnel Committee, Chair of Program Graduate Committee, Liaison between Associate Dean's office and Program regarding development of new courses in applied mathematics;

James Meiss: Co-organizer of the Dynamical Systems Seminars;

Harvey Segur: Chair of Program Undergraduate Committee, Organizer of the Los Alamos Days Workshop.

4. TEACHING ACTIVITIES

A. Courses Taught by Program Faculty During Academic Year 1989-90

(i) UNDERGRADUATE COURSES

APPM 1350. Atela and Chakravarty. Calculus I for Engineers.

APPM 2350. Segur. Calculus III for Engineers.

APPM 2360. Ablowitz, Curry, Bebernes, Easton and Meiss. Linear Algebra and Differential Equations.

APPM 4350. Segur. Advanced Math for Engineers.

MATH 3130. Chakravarty. Linear Algebra.


(ii) GRADUATE COURSES


MATH 8805. Atela. Dynamical Systems.
B. New Courses Approved by University Curriculum Committee

(i) UNDERGRADUATE COURSES

3170. Discrete Applied Mathematics. (To be taught Spring '91.)
3310. Matrix Methods and Applications. (To be taught Fall '90.)
3570. Applied Probability and Statistics. (To be taught Fall '91.)
4380. Modelling in Applied Mathematics. (To be taught Spring '91.)
4650. Intermediate Numerical Analysis 1. (To be taught Fall '90.)
4660. Intermediate Numerical Analysis 2. (To be taught Spring '91.)
4955. Undergraduate Seminar in Applied Mathematics. (To be taught Spring '92.)

(ii) GRADUATE COURSES

5180. Discrete Applied Mathematics. (To be taught Fall '91.)
5440. Applied Analysis 1. (Real/complex analysis and applications. To be taught Fall '90.)
5450. Applied Analysis 2. Continuation of 5440. (To be taught Spring '91.)
5470. Methods of Applied Mathematics 3 (PDE's. To be taught Fall '90.)
5480. Methods of Applied Mathematics 4. (Asymptotic and perturbation methods. To be taught Spring '91.)
6620. Numerical Computation in Applied Math 1. (To be taught Fall '91.)
6630. Numerical Computation in Applied Math 2. (To be taught Spring '92.)
7100. Mathematics Methods in Dynamical Systems. (To be taught Spring '92.)
7300. Mathematical Methods in Nonlinear Waves & Integrable Equations. (To be taught Fall '91.)

C. Graduate Students

This year we had 9 students enrolled as graduate students in the Program in Applied Mathematics. They are:

Fathi Allan, Rolan Christofferson, Bruce Fast, Scott Herod, James Keiser,
Arthur Mizzi, Elizabeth Ryan, Kervin Smith and Linda Sundbye.

In addition, there are 7 students working on graduate degrees with faculty in the Program. They are:

Ron Antweiler (Mathematics - Curry)
Chang, Yi-Hua (SUNY at Buffalo - Segur)
Garry Cox (Mathematics - Curry)
H.F.H. Khalfan (Mathematics - Meiss)
Martha Nesbitt (Mathematics - Curry)
Amy Solomon (Mathematics - Curry)
T. Weissert (Physics - Meiss)

5. RESEARCH ACTIVITIES (1989-90)

A. Research Publications

Mark Ablowitz:

James Curry:

Barend Herbst:
James Meiss:

Harvey Segur:

B. Invited Lectures and Meetings Attended

Mark Ablowitz:
Colorado School of Mines, Mathematics Department, Nov. 20, 1989 -- "Solitons and All That Nonlinear Stuff"
Oberwolfach, W. Germany, Jan 13-20, 1990 -- "Aspects of Integrability and Chaos" Workshop on Chaos and Order, Australian National University, Canberra, Feb. 1-3, 1990 -- "Integrability and Cellular Automata"
Conference on Chaos, University of New South Wales, Sydney, Feb. 4-10, 1990 -- "Numerically Induced Chaos"
University of Colorado at Denver, Mathematics Department, Feb. 28, 1990 -- "Solitons and All That Nonlinear Stuff"
Conference on Recent Advances in General Relativity, University of Pittsburgh, May 3-5, 1990 -- "Integrability, Reductions of Self Dual Yang Mills Fields and Classical Systems"
University of Georgia, Physics Department, Athens, GA, May 6-9, 1990 -- "Integrability, Chaos and Patterns"

Pau Atela:
Midwest Dynamical Systems Conference, Northwestern University, Nov., 1989
Conformal Dynamics, SUNY Stony Brook, NY, Nov. 1-4, 1989
Colorado School of Mines, Jan., 1990 -- “Dynamics of Complex Quadratic Polynomials”
Slow Pitch Colloquium, Dept. of Mathematics, Jan., 1990 -- "What is a Julia Set? What is the Mandelbrot Set?"
Workshop on Twist Maps and their Applications, University of Minnesota, March, 1990 -- "A Trip Around the Mandelbrot Set: Bifurcations of Dynamic Rays"

Priscilla Cehelsky:
NCAR, Mesoscale and Microscale Meteorology Division, May 1990: "Towards a Model for Lake Effect Storms"
NCAR, Climate and Global Dynamics Division, June 1990: "Nonlinear Baroclinic Adjustment"

James Curry:
University of California, Davis, CA, May, 1989 -- "On the Geometry of Factorization Algorithms"
University of Minnesota, April, 1990 -- "On the Numerical Solutions of Two-Point Boundary Value Problems"
Colorado School of Mines, April, 1990 -- "On Iterative Methods for Solving Equations"

Barend Herbst:
EXXON Corporate Research, Numerically Induced Chaos
Princeton University, Chaos in Computations
University of Kentucky, Lexington, KY, Numerical Chaos
Courant Institute, New York University, New York, NY, Chaotic Phenomena in Computations

James Meiss:
Nonlinear Dynamics of Classical and Quantum Mechanical Systems, Telluride, CO, July 4-8, 1989 -- "Transport for Several Degree of Freedom Systems"
US-Japan Workshop, Boulder, CO, July 24-28, 1989 -- "Periodic Orbits for Four Dimensional Mappings"
Plasma Physics Bag Lunch Seminar, APAS, Boulder, CO, Oct. 31, 1989 -- "Canonical Coordinates for Guiding Center Motion in Tokamaks"
Transport for Hamiltonian Systems, Cornell University, Nov. 17-19, 1989 -- "Resonances and Transport in the Sawtooth Map"
Chaos and Order Miniconference, Centre for Mathematical Analysis, Australian National University, Canberra, Feb. 1-3, 1990 -- "Resonances and Cantori for Symplectic Mappings"
Royal Children's Hospital, Melbourne, Australia, Jan. 26, 1990 -- "Chaos Theory - Can It Be Applied to Human Development?"
Australian Psychoanalytic Society, Sydney, Australia, Feb. 4, 1990 -- "Chaos, an Introduction"
Chaos in Australia: The Conference, Sydney, Australia, Feb. 4-9, 1990 -- "Transport and Chaos in Symplectic Maps"
Slow Pitch Colloquium, Mathematics Dept., Boulder, CO, Apr. 4, 1990 -- "Chaos and Hamilton's Principle"
Coherence and Chaos is Complex Dynamical Systems, Aspen, CO, May 28-June 8, 1990 -- "Some Open Problems in Hamiltonian Chaos"

Harvey Segur:
UWA, Perth, Australia, Jan. 19, 1990 -- "Asymptotics Beyond All Orders"
Chaos and Order, Australian National University, Canberra, Australia, Feb. 1-3, 1990 -- "Two-dimensional Periodic Waves in Shallow Water"
Chaos in Australia, University of New South Wales, Sydney, Australia, Feb. 4-9, 1990 -- "Asymptotics Beyond All Orders"
University of California, Santa Barbara, CA, May 18, 1990 -- "Two-dimensional Periodic Waves in Shallow Water"
Nonlinear Science: the Next Decade, Los Alamos, NM, May 21-25, 1990 -- "Who Cares About Integrability?"

C. Research Grants

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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 Jan Horn, staff assistant for the program.

No.
5. Solitons by Harvey Segur, October, 1989.


44. Qualitative Analysis of Schur Complements by Charles R. Johnson and John Maybee, June, 1990.


46. Biclique Coverings of Bigraphs and Digraphs and Minimum Semiring Ranks of \((0,1)\)-Matrices by Kim Hefner, Teri Henson, J.R. Lundgren and John S. Maybee, June, 1990.


56. Asymptotics Beyond All Orders in a Model of Crystal Growth by Martin D. Kruskal and Harvey Segur, July 1990.
Current Affiliated Faculty

William Blumen (APAS)  David Kassoy (Mechanical Engineering)
Alberto Bressan (Mathematics)  Michael Lightner (Electrical Engineering)
Richard Byrd (Computer Science)  Oliver McBryan (Computer Science)
John Cary (APAS)  Tom Mullis (Electrical Engineering)
Thomas DeGrand (Physics)  Robert Sani (Chemical Engineering)
Fred Glover (College of Business)  Duane Sather (Mathematics)
Martin Goldman (APAS)  Robert Schnabel (Computer Science)
Vijay Gupta (Geological Sciences)  J. Michael Schull (APAS)
Henry Hermes (Mathematics)  Rex Skodje (Chemistry, JILA)
Elizabeth Jessup (Computer Science)  Renjeng Su (Electrical Engineering)
William Jones (Mathematics)  Juri Toomre (APAS)
Ellen Zweibel (APAS)

Prospective Members

Gary Stormo (Molecular, Cellular, and Developmental Biology)
Claudio Cioffi-Revilla (Political Science)
Patrick Weidman (Mechanical Engineering)