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13. ABSTRACT (Maximum 200 words)

The ongoing and primary goal of the research is the pursuit of understanding of nonlinear processes in natural phenomena arising in optics and fluids. A considerable share of our attention is devoted to nonlinear optics, a relatively young subject, extremely rich in scientific and technological potential. While the studies focus on scientific questions connected with laser diode arrays, beam instabilities and the behavior of light beams at interfaces between nonlinear dielectrics, the technological ramifications and future opportunities are in many cases obvious. Optics also serves as a useful paradigm for gaining an increased understanding in other fields. For example, turbulence in optics, the study of the complex space-time filaments, patterns and defects which appear in feedback cavities and counterpropagating beams, may be more analytically tractable than in other branches of continuous mechanics. There is little doubt that nonlinear optics is a subject in which interest is increasing.

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Arizona Center for Mathematical Sciences

REPORT FOR THE PERIOD
OCT 1991 - OCT 1992
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FINAL REPORT FOR THE PERIOD
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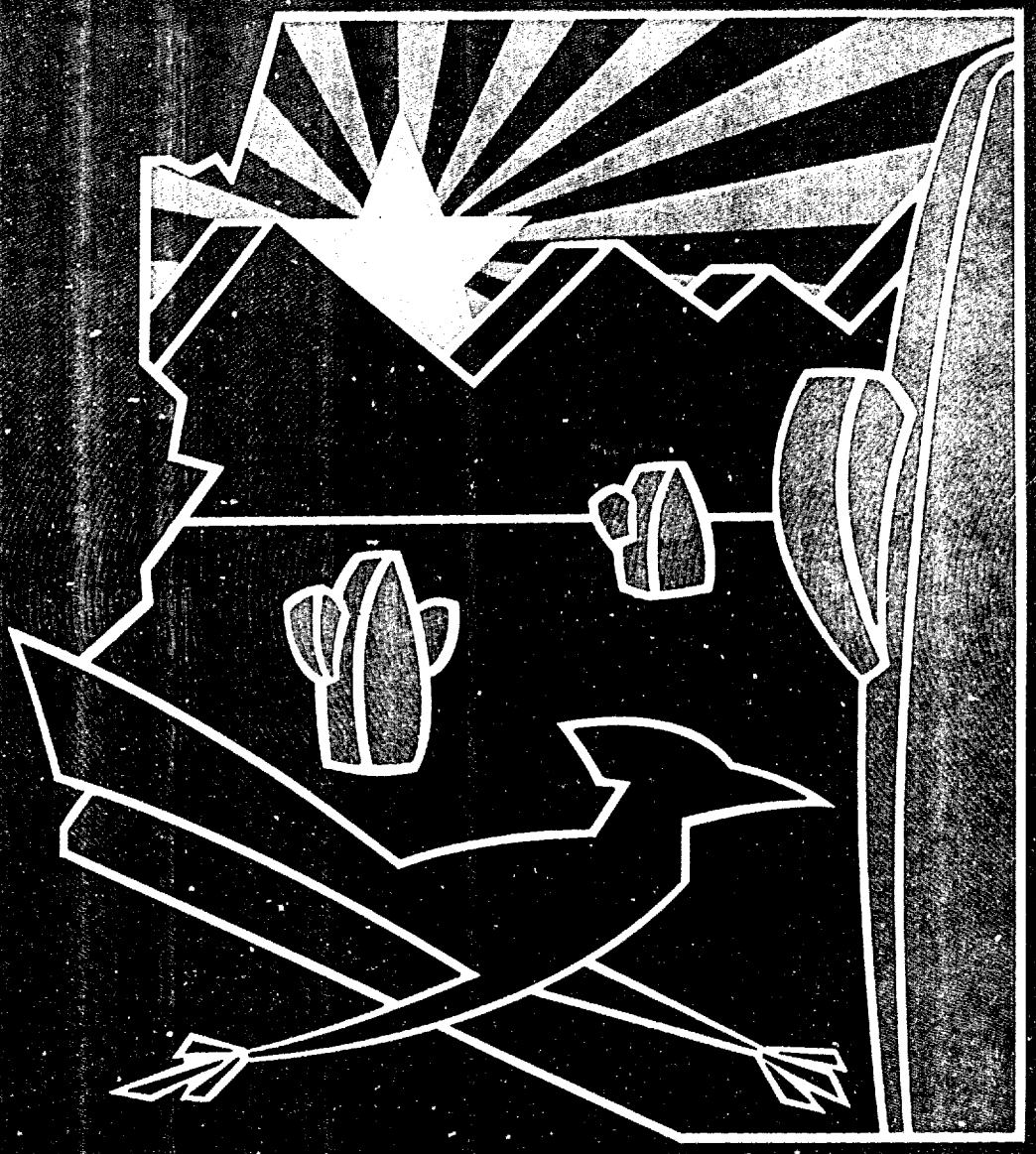

Department of Mathematics

THE UNIVERSITY OF
ARIZONA
TUCSON, ARIZONA

Sponsored by The Air Force Office of Scientific Research

ARIZONA CENTER FOR MATHEMATICAL SCIENCES

Sponsored by the Air Force Office of Scientific Research
under the University Research Initiative Program
Contract No. AFOSR-90-0021

October 1991 - October 1992
and
FINAL REPORT FOR THE PERIOD
December 1989 - November 1992

October 1992

University of Arizona
Tucson, Arizona 85721

I. OVERVIEW

A. SUMMARY

The Arizona Center for Mathematical Sciences (ACMS) was formed in 1986 with an initial three-year grant from the Air Force Office of Scientific Research under the University Research Initiative Program. A second three-year period of funding began in 1989. Offices and computer facilities for ACMS personnel and visitors are on the eighth floor of the Gould-Simpson Building adjacent to the Mathematics Building. Close ties are maintained with faculty in the Departments of Mathematics, Physics, Aerospace and Mechanical Engineering, Optical Sciences and the Applied Mathematics Program at the University of Arizona.

The ongoing and primary goal of the research is the pursuit of understanding of nonlinear processes in natural phenomena arising in optics and fluids. A considerable share of our attention is devoted to nonlinear optics, a relatively young subject, extremely rich in scientific and technological potential. While our studies focus on scientific questions connected with laser diode arrays, beam instabilities and the behavior of light beams at interfaces between nonlinear dielectrics, the technological ramifications and future opportunities are in many cases obvious. Optics also serves as a useful paradigm for gaining an increased understanding in other fields. For example, turbulence in optics, the study of the complex space-time filaments, patterns and defects which appear in feedback cavities and counterpropagating beams, may be more analytically tractable than in other branches of continuous mechanics. There is little doubt that nonlinear optics is a subject in which interest is increasing.

The Center has been an enormous success as demonstrated by the calibre of regular visitors, the superior quality of recent postdoctoral fellows and graduate students, the reputation of the workshops, the productive interactions with AFWL at Kirtland, Brooks AFB at San Antonio, and CNLS at Los Alamos, and the steady output of the faculty (nearly 250 publications since 1986). We are extremely grateful for the continued support of the Air Force Office of Scientific Research and strive to maintain their level of confidence in our research efforts.

We are also very happy to announce three new appointments. Mike Tabor has taken over as Chairman of the Program in Applied Mathematics this year Vladimir Zakharov, broadly acknowledged as one of the outstanding scientists of our time, has joined the Mathematics Department as a permanent faculty member. He will spend six months a year in Tucson. Yves Pomeau, Corresponding Member of the French Academy and a world leader in dynamical systems and pattern formation also has a permanent half-time appointment. All three will play central roles in ACMS.

B. MISSION

The Center's primary intent has been and continues to be to provide an environment for research and learning in the Mathematical Sciences. Basic research themes include the modelling, understanding and applicability of nonlinear processes in optics, fluids, neural networks, and random distributed systems with continuing investigations into pattern dynamics, percolation, behavior of lattice gases, nonlinear stability, low dimensional chaos, turbulence, dynamical systems and the nature of integrable systems of differential equations.

Research is carried out on several levels. First, there is the long-range, ongoing research focusing on the themes listed above by permanent members of the faculty, colleagues with regular visiting arrangements, postdoctoral fellows, and graduate students.[1] Second, there are collaborations with one-time visitors from other universities, national laboratories and Air Force research centers who come for extended visits in connection with our special years' programs. Third, there is a regular series of workshops which (i) address

[1] In contrast to the NSF Centers at Berkeley, Minnesota and Santa Barbara, this is our principal activity.

areas which look to the future, and which, in our judgment, are rich in promise and potential; (ii) have a pedagogic nature and are designed to communicate the importance and promise of several of the fields mentioned above to undergraduate and potential graduate students and to other scientific colleagues; and (iii) are special purpose and have a relatively narrow focus on topics of particular interest to Center faculty and collaborators.

Learning takes place at all levels. The breadth of activity and spectrum of interest and talent among visiting colleagues serves to stimulate interdisciplinary work and promote the cross fertilization of ideas. It is very important to stress the value of interdisciplinary and crossdisciplinary interaction. As a simple example, our work in fluid patterns and our knowledge that various planforms such as hexagons are a manifestation of symmetries rather then a function of explicit details of the underlying governing equations, led us to expect the hexagon pattern which is found in the instabilities of counterpropagating beams shown in Section A.3. As a second example, our approach in treating the problem of retinal eye damage by short, high intensity pulses was motivated by studies of collapse behavior in plasma physics.

Graduate students interested in applied mathematics enjoy a unique environment in which they can experience first hand the unity in the approaches (modeling, simulation, analysis, and involvement in experiments) with which mathematical scientists tackle a diverse set of problems from all areas of the physical sciences. There are several ongoing weekly working seminars in addition to regular departmental colloquia, in the areas of applied analysis, computation, dynamical systems, nonlinear optics, neural networks, integrable systems, and mathematical physics. In addition, we have had particular success with the introductory workshops which expose undergraduate seniors and potential graduate students to the exciting challenges of applied mathematics.

The support of the Air Force Office of Scientific Research under the University Research Initiative Program has continued to provide the Center with the flexibility, resources, and the critical mass in the sub areas of concentration, an important criterion for a large scale research effort.

C. REASONS FOR SUCCESS

There are several factors, beyond the financial support, which continue to contribute to the Center's success. The first is the presence of a strong core of high quality, active faculty members whose research interests reflect the main themes of research in the Center. Second, there has always been a strong University and Departmental commitment to the applied areas, complementing the support provided by the Air Force. The Applied Mathematics Program at Arizona, in existence for nearly fifteen years, with an international reputation, is a source of excellent students providing the framework for genuinely interdisciplinary interactions. The University's commitment included twelve new positions to the Department of Mathematics, including post-doctoral fellows, doubling the number of teaching assistantships, and providing funds for special years a year before the Center was inaugurated. The University also has committed space for the Center in a beautiful setting on the northern-facing side of the eighth floor of the Gould-Simpson Building. In addition, the Mathematics Department takes particular pride in and has a continuing commitment to its applied components. This makes Arizona somewhat unique. Third, with a combination of University and Air Force support, the Center successfully built a first rate computational environment, with easy access of permanent and visiting faculty to SUN and IRIS workstations, mini-supercomputers (Convex 240), the CRAY-II at Kirtland Air Force Base and the CRAY-YMP at Pittsburgh. A key factor in the success of this computer environment is the hard work of outstanding support personnel. Robert Indik, a Princeton Ph.D. in Number Theory, is not only a first rate software consultant but is also actively involved in many Center projects, particularly in Optics. Bob Condon, an outstanding Computer Facilities Coordinator for the Mathematics Department, was principally responsible for setting up our network.

D. CENTER FACULTY AND STAFF

Director

Alan C. Newell, Professor and Chairman, Department of Mathematics.

Center Faculty

Bruce Bayly, Assistant Professor, Mathematics
Moysey Brio, Assistant Professor, Mathematics
Nick Ercolani, Associate Professor, Mathematics
Rob Indik, Adjunct Associate Professor, Mathematics
C. David Levermore, Professor, Mathematics
Jerome V. Moloney, Professor, Mathematics
Yves Pomeau, Professor, Mathematics
Michael Tabor, Director, Program in Applied Mathematics
Ewan Wright, Assistant Professor, Optical Sciences and Physics
Vladimir Zakharov, Professor, Mathematics

External Faculty Who Spend Regular, Extended Periods at the Center

Pierre Coullet, University of Nice, France
William Firth, University of Strathclyde, Glasgow
Evgenie Kuznetsov, Plasma Physics, Novosibirsk, USSR
David Rand, Warwick University, England
Sasha Rubenchik, Institute of Automation and Electrometry, Novosibirsk, USSR

Post-Doctoral Fellows and Visiting Faculty Closely Associated with the Center

Douglas Abraham, (Ph.D., 1968, King's College, Statistical Mechanics), 1987-1988, currently at Oxford University

Alejandro Aceves, (Ph.D., 1988, University of Arizona, Nonlinear Optics), 1988-1989, currently at University of New Mexico

Wayne Arter, (Ph.D., 1983, Trinity College, Cambridge, Computational Science), 1986-1987, currently at Culham Lab, England

David Barsky, (Ph.D., 1987, Rutgers University, Statistical mechanics), 1988-1989, currently at University of California at Davis

Andrew Bernoff, (Ph.D., 1985, Trinity College, Cambridge, Nonlinear Dynamics), 1988-1989, currently at University of California at Berkeley

Jean-Guy Caputo, (Ph.D., 1986, University of Grenoble, Dynamical Systems), 1987-1988, currently at Ins a de Rouen, France

Martin Casdagli, (Ph.D., 1985, Warwick University, England, Dynamics), 1986-1987, currently at Queen Mary College, London

Patrick Dunne, (Ph.D., 1987, M.I.T., Hydrodynamic Stability, Nonlinear Waves), 1987-1988.

Alecsander Dyachenko, (Ph.D., 1988, Moscow Phy Tech Inst, Physics), Spring 1990 and 1991, currently at USSR Scientific Council

G.R. Grimmett, (Ph.D., 1974, Mathematical Institute, Oxford, Probability), 1987-1988, currently at University of Bristol, England.

Wanda Henry, (Ph.D., 1988, Australian National University - I.A.S., Optics), 1988-1989, currently at King's College, Cambridge

Per Jakobsen, (Ph.D., 1990, University of Arizona, Wave Propagation in Nonlinear Optics), 1990-

Joceline Lega, (Ph.D., 1989, Universite de Nice, Physics), 1990- , from Lab de Phy Theor, France

Carlangelo Liverani, (Ph.D., 1988, Rutgers University, Mathematics), 1989-1990, currently at Rutgers University

Gregory Luther,(Ph.D., 1991, University of Rochester, Mechanical and Aerospace Sciences), 1991-

Alistair Mees, (Ph.D., 1973, Cambridge University, Dynamical Systems), 1987-1988, currently at University of Western Australia

Ehud Meron,(Ph.D., 1986, Weizmann Institute) 1991-

Edward Overman, II, (Ph.D., 1978, Ohio State University, Computational Science), 1986-1987, currently at Ohio State University

Thierry Passot, (Ph.D., 1987, Observatoire de Nice, Turbulence, Painlev/'e Analysis), 1987- , from CNRS, France

James Powell, (Ph.D., 1990, University of Arizona, Nonlinear Phenomena), 1990-1991, currently at Utah State University

Andrei Pushkarev, (Ph.D., 1988, Moscow Phy Tech Inst, Physics), Spring 1990 and 1991, currently at USSR Scientific Council on Complex Problems

Ping Ru, (Ph.D., 1990, Drexel University, Lasers), 1990-

Vadim Shvets, (Ph.D., 1980, Inst for Theor Phy, USSR, Physics), Spring 1990, currently at Auburn University

M'Hamed Souli, (Ph.D., 1984, Universite de Nice, Computational Science), 1988-1989, currently at University of Nice, France

Stefan Wabnitz, (Ph.D., Applied Physics), Spring 1990, currently at Fondazione Ugo Bordoni, Italy

H.G. Winful, (Ph.D., 1990, University of Michigan)

Henryk Zoladek, (Ph.D., 1983, Moscow State University, Bifurcation Theory), 1987-1988, currently at Warsaw University

Center Staff

Robert Condon, Coordinator for Academic and Research Computing

Robert Indik, Computer Software Specialist

Daisy Cheung, Secretary, Administrative

Megan Rzonca, Secretary, Administrative

E. AREAS AND PROJECTS

The following is a list of the main areas of activity.

Nonlinear Optics

- Turbulence, Defects, Spatial Patterns in Optics
- Dynamics of Free-Running and Injection-Locked Laser diode Arrays
- Diffraction/diffusion Mediated Instabilities in Self-focusing/Defocusing Nonlinear amplifying Media
- Counterpropagating Beam Instabilities in Nonlinear Bulk Media

- Counterpropagating Laser Beams in Brillouin-active media
- Spatio-Temporal Pattern Formation in Raman Laser/Two-Photon Laser Systems
- Externally Encoded and Spontaneous Pattern Formation in a Nonlinear Optical Ring Cavity
- Coupled Reaction-Diffusion Equations in Laser Excited Semiconductor Slab media
- Theoretical Study of Optical Phase Conjugation in Stimulated Brillouin Scattering
- Collapse Structures in Optics: Filaments and Black Holes
- Anomalous Ocular Damage from Ultra-Short Laser Pulses
- Nonlinear Optical Switching at Multiple Interfaces
- Exact Solutions for an Extended Nonlinear Schrödinger Equation
- Counterpropagating Beam Instabilities in Optical Fibers
- Localized States in Fluid Convection and Multi-Level Lasers

Turbulence

- Turbulence in Optics and in Fluids
- Intermittency
- Weak Turbulence and the Role of Conservation Laws
- Local Adaptive Galerkin Bases for Large Dimensional Dynamical Systems
- Local Inertial Manifolds
- Complex Ginzburg-Landau Equation
- Roll-up of Vortex Sheets
- Hydrodynamic Stability and Dynamo Theory
- Density Variations and Turbulence in Weakly Compressible Fluid Flows
- Patterns, Spatio-temporal Chaos, and PDF Closures for Coupled Systems of Reaction-Diffusion Equations

Fluids, Fronts, Stability and Transition

- Convective Patterns Far From Onset
- Localized States in Fluid Convection
- The Theory of Compressible Fluids
- Kinetic Theory of Fluids
- The Stability of Multidimensional Traveling Waves

- Mode Crossings and Triads in a Two-Layer Shear Flow
- Wake Flows
- Bounds on Secondary Instability
- Waves, Compressible Boundary Layer
- Defects in Hexagonal Patterns
- Nonvariational Effects
- Phase Instability in One-Dimensional Patterns
- A Model for Helical Structures in Biology
- Nongeneric Connections Corresponding to Front Solutions
- Singularities in Euler's Equations

Computational Science

- Computational Studies in MHD
- Lattice Gas Hydrodynamics
- Hypersonic Fluid Dynamics: Beyond Navier-Stokes
- Self-Focusing Phenomena in Lasers
- Continuation through Blow-up in Discrete NLS Systems

Integrable Systems and Geometry

- Construction of Constant Mean Curvature Surfaces
- Singular Limits of Dispersive Waves
- Painlevé Analysis of the Toda Lattice
- Momentum Mappings
- Nonlinear Poisson Brackets

F. WORKSHOPS

The Workshops have each focused attention on new challenges and stressed the connections which exist between various mathematical sciences, connections which often are ignored but which provide dividends when pursued. Examples are the fundamental role of nonlinearity in optics, the interplay between the coherence of solitons and the scattering (Anderson localization) effects of randomness, and the value in looking at numerical algorithms from the perspective of dynamical systems.

- Numerical Solutions of Nonlinear Differential Equations, January 1987
- Random Schrödinger Equations, February 1987

- State of the Art Developments in Nonlinear Optics, March 1987
- Singularities in Nonlinear Partial Differential Equations, March 1988
- The Lagrangian picture of Fluid Dynamics, October 1988
- Space-Time Complexity in Nonlinear Optics, March 1990
- Semiconductor Laser Dynamics, March 1991
- Turbulence, March-April 1991
- Computational Optics: Its Links with Computational Third Dynamics, March 18-21, 1992

In addition, several special purpose workshops have been held with colleagues from Kirtland Air Force Base at Albuquerque, New Mexico, Brooks Air Force Base at San Antonio, Texas, and Center for Nonlinear Studies (CNLS) at Los Alamos, New Mexico.

Kirtland Air Force Base Workshops

- December 1986 at Arizona
- March 1988 at Kirtland
- October 1988 at Arizona
- October 1989 at Kirtland

Los Alamos Days Conferences

- October 1986 at Arizona
- January 1988 at Los Alamos
- February 1989 at Arizona
- December 1989 at Los Alamos

Brooks Air Force Base Workshops

- June 1990 at San Antonio

We have had six workshops for undergraduates and potential graduate students.

- I Annual Undergraduate Workshop in Nonlinear Science, March 1987
- II Annual Undergraduate Workshop in Nonlinear Science, March 1988
- III Annual Undergraduate Workshop in Nonlinear Science, March 1989
- IV Annual Undergraduate Workshop in Nonlinear Science, March 1990
- V Annual Undergraduate Workshop in Nonlinear Science, March 1991
- VI Annual Undergraduate Workshop in Nonlinear Science, March 1992

G. COLLABORATIONS WITH COLLEAGUES AT THE PHILLIP'S LABORATORY, KIRTLAND AIR FORCE BASE, ALBUQUERQUE, NEW MEXICO

Ongoing interactions with colleagues in the Nonlinear Optics group at the Phillip's Laboratory are being maintained with current focus relating to feedback instabilities in external cavity semiconductor lasers. Of particular significance is a new ACMS spearheaded collaboration with the PILOT group at the Phillip's Laboratory. The effort will involve a team of mathematicians, laser physicists and semiconductor theorists based at ACMS working in close laison with the experimental and device fabrication group at Kirtland. A major goal of this interdisciplinary team effort is to develop a reliable semiconductor laser theory and device simulation capability to aid in the design of reliable coherent high power wide aperture semiconductor lasers. The theory will incorporate the relevant microscopic many-body physics and will make redundant existing ad hoc phenomenological semiconductor laser theories.

H. COLLABORATIONS WITH COLLEAGUES AT AIR FORCE SCHOOL OF AEROSPACE MEDICINE, BROOKS AIR FORCE BASE, SAN ANTONIO, TEXAS

We have established a direct link with the medical laser group at Brooks AFB which is under the direction of Dr. Don Farrer. Our direct contact with the group is through Dr. Richard Albanese. The focus of this research activity relates to laser damage mechanisms in the eye resulting from ultra-short laser pulses. We have built a theory which appear to agree, at least qualitatively, with experimental observations.

I. THE TRAINING OF STUDENTS AND POSTDOCTORAL FELLOWS

A very important part of the Center mission is the training of graduate students and postdoctoral fellows. There are several key ways in which the Center has greatly improved the learning environment. First, there is a critical mass of people (faculty, postdocs and students) in each of the areas of emphasis who meet on a regular basis in working seminars. Second, the constant stream of first rate visiting colleagues serves as a continuing stimulus and exposes our students to a broad variety of challenges in the Mathematical Sciences. Moreover, students directly experience the parallel transport of ideas from one area to another. This involvement in projects and discussion acts as a catalyst to bring out the best in the student and to give him the widest possible exposure to all areas of the Mathematical Sciences. Third, because we have been able to develop a first rate computer environment (with advanced laboratory courses in computational science) and because our students are exposed to experimental work by our colleagues in Optical Sciences and Aerospace and mechanical Engineering, our young people are taught the value of the interplay between the three modes of modern investigation, experiment, analysis and numerical simulation.

J. THE FUTURE

It is not an exaggeration to say that ACMS has established itself as a leading center in nonlinear science and nonlinear optics. The research, computational and training environment are such that Arizona is a very good place to visit, work and learn. We attract first rate mathematical scientists. We enjoy excellent relations with several of the Air Force National Laboratories. The acquisition of several new permanent

faculty members, including Zakharov, suggests that the future looks very promising indeed. We will continue to emphasize basic science, and in particular the basic understanding of fundamental nonlinear processes. We believe strongly in synergy, that understanding behavior in one context often provides enlightenment in another. We also expect that the rapidly growing and tremendously exciting and young field of nonlinear optics will occupy much of our attention. The interface and interaction with colleagues at the National Laboratories (AFL, Kirtland and Brooks) has provided much stimulus to our efforts and will continue. We have learned much from them and hope that the advantages have been mutual.

V. BIOGRAPHIES

A. FACULTY

BRUCE BAYLY, 31, Ph.D. 1986, Princeton University. Postdoctoral visiting member 1986-88 at Courant Institute of Mathematical Sciences; Assistant professor, Mathematics, University of Arizona, 1988-

Research Interests: Kinematic and dynamical problems in three dimensional steady state flows.

MOYSEY BRIO, 39, Ph.D. 1984, University of California, Los Angeles. Assistant Research Physicist, Physics, UCLA, 1984-87; Assistant Professor, mathematics, University of Arizona, 1987-

Research Interests: Magnetohydrodynamics, fluid dynamics.

NICHOLAS M. ERCOLANI, 39, Ph.D. 1980, University of California at Berkeley. Assistant professor, Ohio State University 1980-84; Associate Professor, University of Arizona, 1984- , National Science Foundation Fellow 1984-87; Sloan Foundation Fellow 1987-88

Research Interests: Algebraic geometry, complex function theory, spectral theory, integrable pde.

WILLIAM J. FIRTH, 47, Ph.D. 1975. Visiting Researcher, Heidelberg University 1987-79; Senior Lecturer Heriot-Watt University, 1982-85; Professor in Physics, Strathclyde University, 1985-

Research Interests: Tranverse diffusion and diffraction in optical bistability, optical memory arrays, instabilities in nonlinear optical systems, phase conjugation and four-wave mixing in Kerr media, bistability and instabilities in semiconductor laser amplifiers.

CHARLES DAVID LEVERMORE, 40, Ph.D. 1982, Courant Institute, New York University. Mathematician Lawrence Livermore National Laboratory, 1982-88; Associate Professor, University of Arizona, 1988-

Research Interests: Nonlinear partial differential equations, computational mathematics, cellular automata.

E. MERON, 38, Ph.D. 1986, Weizmann Institute of Science, Israel. Postdoctoral Research Associate, University of Chicago and Columbia University, 1986-1988. Scientist, Weizmann Institute, 1988-1991. Visiting Assistant professor, Mathematics, University of Arizona, 1991-

Research Interests: Nonlinear wave phenomena in reaction-diffusion systems, hydrodynamics and optics.

JEROME V. MOLONEY, 43, Ph.D. 1977, Univeristy of Western Ontario, Canada. Reader in Physics, Heriot-Watt, 1988-90; Regular long-term visitor of Mathematics, University of Arizona, 1984-89; Professor, Mathematics and a joint appointment in Optical Sciences, University of Arizona, 1990-

Research Interests: Nonlinear optics, stability and propagation of nonlinear waves in planar waveguides, transverse switching waves and solitary waves in optical bistability, instabilities and chaos in lasers.

ALAN C. NEWELL, 50, Ph.D. 1966, Massachusetts Institute of Technology. Chairman, Department Math. Comp. Sci., Clarkson University, 1971-79; Chairman, Applied Mathematics Program, University of Arizona, 1981-85; Chairman, Department of Mathematics 1985- ; Guggenheim Fellow 1976-77; Humboldt Fellowship 1988-89; Member and Chairman 1987-88; NSF Advising Board on Math. Sciences 1986-89; Member, Board of Mathematical Sciences National Academy 1987-90

Research Interests: Pattern Dynamics, Nonlinear Optics, Nonlinear Wave Propagation, Turbulence.

YVES POMEAU, 50, Ph.D. 1967, École Normale, Paris. Corresponding member of the French Academy of Science in the division of Sciences Mechanique. Consultant, Los Alamos National Laboratories

Research Interests: Statistical physics, fluid mechanics, and dynamical systems.

EWAN M. WRIGHT, 34, Ph.D. 1983, Heriot-Watt Unviersity, United Kingdom. Postdoctoral Max-Plank Institute 1983-85; Postdoctoral Optical Sciences Center, University of Arizona 1985-87; Ass. Professor 1987-

Research Interests: Nonlinear and quantum optics, laser physics and integrated optics.

V. E. ZAKHAROV, 51, Ph.D. 1971, Novosibirsk State University, USSR; Head, Plasma Theory Labs, Novosibirsk Institute of nuclear Physics, 1967-74; Landau institute for Theoretical Phys. Moscow, 1974-;

Visiting Professor, Mathematics Department, University of Arizona, 1990-1992; Professor, Mathematics Department, University of Arizona, 1992-
Research Interests: weak turbulence, optics, solitons, singularities, field theory, characterization of integrable systems, strong turbulence.

B. POST DOCTORAL FELLOWS

P. JAKOBSEN, 32, Ph.D. 1990, University of Arizona. Research Associate, Department of Mathematics, University of Arizona, 1990-1992
Research Interests: Stability, dynamics and bifurcation of externally driven and undriven arrays of diode lasers, linear stability of homogeneous solutions describing almost monochromatic plane waves propagating in a laser cavity.

J. LEGA, 28, Ph.D. 1989, Universite de Nice. Research Associate, Department of Mathematics, University of Arizona, 1989-1992
Research Interests: Physics of instabilities, ; numerical simulation of ODS's and PDE's; defects of macroscopic structure; Ginzburg-Landau approach of instabilities in macroscopic systems and pattern formation.

G. LUTHER, 29, Ph.D. 1991, University of Rochester. Research Associate, Department of Mathematics, University of Arizona, 1991-1992
Research Interests: Propagation and interaction of nonlinear waves in nonlinear optical media.

T. PASSOT, 32, Ph.D. 1987, Nice Observatory, France. Research Associate, University of Arizona, 1988-
Research Interests: Turbulence, convection patterns, compressible flows, self gravitation, numerical simulations, Painlevé analysis.

J. POWELL, 29, Ph.D. 1990, University of Arizona. Research Associate, Department of Mathematics, University of Arizona, 1990-
Research Interests: Propagation of fronts in Complex Ginzburg-Landau (CGL) type equations, asymptotic front speeds with asympototic spatial dependence, front stability in CGL.

P. RU, 26, Ph.D. 1990, Drexel University. Research Associate, Department of Mathematics, University of Arizona, 1990-
Research Interests: Optical physics, Laser Physics, Quantum optics, Nonlinear Optics, Nonlinear Dynamics, Stability and dynamics of semiconductor laser.

M. SOULI, 36, Ph.D. 1984, University Nice, France. Research Associate, University of Arizona, 1988-
Research Interests: Computational science, nonlinear optics, convection patterns.

C. STAFF

R. CONDON, 39, BA 1973, Harvard College. Coordinator for Academic and Research Computing, Department of Mathematics, University of Arizona, 1987-
Research Interests: Distributed processing systems, concurrent programming languages.

R. INDIK, 35, Ph.D. 1982, Princeton University. Assistant Professor, Brandeis University 1982-86. Computer Software Specialist, Mathematics Department, University of Arizona, 1987-
Research Interests: Nonlinear optics, number theory, algebraic geometry.

D. GRADUATE STUDENTS

A. CALINI - LAUREA, 1989, Universitaá Degli Studi di Milano, Italy. Ph.D. student in Applied Mathematics. Enrolled in 1989. Studying the critical exponents for solvable random matrix models.

Advisor: N. Ercolani

J. B. GEDDES - B.Sc. 1990, Heriot-Watt University, Scotland. Ph.D. student in Applied Mathematics. Enrolled in 1990. Studying spontanous transverse pattern formation due to counterpropagating laser beams in both Kerr and Brillouin-active media. Topics include hexagonal pattern formation and defects. Advisor: J. V. Moloney

D. E. HART - B.S. 1990, University of Arizona. Ph.D. student in Applied Mathematics. Enrolled in 1991. Studying the effects of femtosecond laser pulses propagating through the human eye. Advisor: J. V. Moloney

C. LIZARRAGA - B.S. 1978, Universidad de Sonora, Mexico; M.S. 1980, Universidad de Mexico. Ph.D. student in Applied Mathematics. Enrolled in 1985. Involved in research in propagation in a random medium, and localization problems in one dimension, and (principally) optical ring cavity behavior in the presence of a finite material relaxation time, with one transverse dimension. Advisor: A. C. Newell

Y. LU - B.S. 1982, Fudan University, people's Republic of China. Ph.D. student in applied Mathematics. Enrolled in 1986. Working on Painlevé analysis of non-integrable discrete nonlinear Schrödinger equation.

$$i\dot{Q} = Q_{n+1} - 2Q - n + Qn - 1 + |Q_n|^{2\sigma}(Q_{n+1} + Q_{n-1}).$$

In particular, using a geometrical analysis and a Painlevé analysis to examine the behavior near infinity. Advisor: N. Ercolani

W. MACEVOY - B.S. 1989, Mesa State College, Grand Junction Colorado. Ph.D. student in Applied Mathematics. Working to study the singular limits of dispersive waves. Advisor: D. Levermore

S. WENDEN - B.S. 1989, University of St. Andrews, United Kingdom. Graduate student in Applied Mathematics. Enrolled in 1989. Research comprises both analysis and numerical computation of spatio-temporal pattern formation in a Raman laser with two transverse dimension. Advisor: J. V. Moloney

E. FORMER GRADUATE STUDENTS

A. ACEVES - Ph.D. 1988, University of Arizona. Thesis title "Snell's Laws at the Interface Between Nonlinear Dielectrics". Advisor was: A. C. Newell. Currently an Assistant Professor at the University of New Mexico.

P. JAKOBSEN - Ph.D. 1990, University of Arizona. Thesis title "Stability and Instability for Two Laser Models". Advisor was: A. C. Newell. He is presently a professor at the University of Tromsa, Norway.

S. JIN - B.S. 1982 and M.S. 1986, Fudan University, Shanghai, China. Ph.D. 1991, University of Arizona. Thesis title "Numerical Transport in Diffusive Regimes". Advisor was: C. D. Levermore. Currently at Princeton University, Institute for Advanced Study.

J. POWELL - Ph.D. 1990, University of Arizona. Thesis title "Nonlinear Fronts in a Quintic Amplitude Equation". Advisor was: A. C. Newell. Postdoctoral position with the University of Arizona from 1990-1991. Presently at Utah State University.

H. ROITNER - Dimplomprüfung, 1987, University of Technology, Vienna, Austria. Ph.D. 1991, University of Arizona, Advisor was: N. Ercolani. In his thesis he analyzed a perturbed KdV equation. He was able to establish the existence and assess the stability of all travelling wave solutions of this perturbed equation. His methods used a combination of center-manifold theory and perturbation theory for near integrable systems. He is presently in a tenure track position in the University of Stuttgart, Germany.

C. SCHOBER - B.S. 1978 and M.S. 1985, Courant Institute, New York University, New York. Ph.D. 1991, University of Arizona. Thesis title "Numerical and Analytical Studies of the Discrete Nonlinear Schrödinger Equation". Advisor was: N. Ercolani. Currently at the University of Colorado.

S. SINGER - Ph.D. 1991, Courant Institute. Advisor was: N. Ercolani. She is currently employed in a tenure track position in the Mathematics Department at Haverford College.

J. TSAY - B.S. 1981, National Taiwan University, Taiwan. Ph.D. 1991, University of Arizona. Thesis title "Wave Scattering in Random Media". Advisor was: W. B. Faris. Currently at Institute of Applied Mathematics, National Sun Yat-Sen University.

P. VARATHARAJAH - B.S. 1981, University of Jaffna, Sri Lanka; M.S. 1986 University of Arizona. Ph.D. 1991, University of Arizona. Thesis title "Diffuso in Effects in Propagation of Light Beams at the Interface of Two Nonlinear Dielectrics. Advisor was: A. C. Newell. Currently at New Jersey Institute of Technology, Department of Mathematics.

O. WRIGHT - Ph.D. 1991, Princeton University. His thesis dealt with an explicit construction of the Lax-Levermore zero dispersion limit of KdV. Advisor was: N. Ercolani. He is in a tenure track position at the the mathematics department of Ohio State University.

C. WU - B.S. 1982, Guizhou University People's Republic of China; M.S. 1984 Institute of Mathematical Sciences, Academia Sinica, People's Republic of China. Ph.D. 1990, University of Arizona. Thesis title "Percolation in Half Spaces and Markov Fields on Branching Planes". Advisor was: C. M. Newman. Currently holds a postdoctoral position at Courant Institute.

VI. LIST OF ACMS PUBLICATIONS

A. PUBLICATIONS

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B. FUTURE PUBLICATIONS

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