SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS

CONFERENCE PROGRAM

OCTOBER 15 - 19, 1992

SNOWBIRD RESORT AND CONFERENCE CENTER

SNOWBIRD, UTAH

Sponsored by SIAM Activity Group on Dynamical Systems

Conference Themes

Applications in the life sciences • Applications in optics and beam dynamics
Complex behavior in physical systems • Determination and description of chaos
Hamiltonian systems and their perturbations

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DEADLINE DATES

Hotel Registration
September 21, 1992

Advance Conference Registration
October 2, 1992

FUNDING AGENCIES

SIAM would like to thank both the Office of Naval Research , Department of Energy, and the National Science Foundation for their support in conducting this conference.

ORGANIZING COMMITTEE

Peter W. Bates (Co-chair)
Department of Mathematics
Brigham Young University

Christopher K.R.T. Jones (Co-chair)
Division of Applied Mathematics
Brown University

GET-TOGETHERS

SIAM Welcoming Reception
Wednesday, October 14, 1992
6:30 PM - 8:30 PM
Golden Cliff
(Level B of Cliff Lodge)
Cash Bar and mini hors d'oeuvres.

Business Meeting
SIAM Activity Group on Dynamical Systems
Friday, October 16, 1992
8:00 PM - 9:00 PM
Ballroom 1&2
Anyone interested in the activity group is welcome to attend.

Poster Session
Saturday, October 17, 1992
7:30 PM - 9:30 PM
Golden Cliff
(Level B of Cliff Lodge)
Come and talk with your colleagues and enjoy complimentary beer, sodas and chips.

Trip to Salt Lake City and Mormon Temple (Tabernacle Choir)
Sunday, October 18, 1992
7:30 AM - 12:00 Noon
Board buses in front of Cliff Lodge at 7:45 AM. You will enjoy a continental breakfast while a guide offers a description of Little Cottonwood Canyon. This canyon played a significant part in the settling of the Salt Lake Valley. Today, the canyon is home to a gigantic genealogical records vault which is carved in the granite walls that line the canyon. Little Cottonwood is also home to two major ski resorts. Once in Salt Lake, which is an hour's drive from Snowbird, you will stop at Historic Temple Square for the live radio broadcast of the Mormon Tabernacle Choir. Following the broadcast, you will visit the Capitol and Beehive House, city founder Brigham Young's home. You will be served refreshments on your trip back to Snowbird. Cost $25.00

Following are subject classifications for the sessions. The codes in parentheses designate session type and number. The session types are Contributed (CP), Invited (IP), Minisymposium (MS), and Poster (P).

Applications in Biological Sciences
- AIDS Epidemiology and Dynamical Models (MS4, page 7)
- Bifurcations and Traveling Waves in a Delayed Partial Differential Equation (IP8, page 12)
- Biological Applications 1 and 2 (CP23, page 16; CP26, page 17)
- Bursting Oscillations in Biological Systems (MS25, page 15)
- Chaos and Fractals in Physiology and Medicine (IP9, page 13)
- Coupled Oscillators (MS7, page 8)
- Neural Networks (MS21, page 13)
- The Dynamics for Patterns in Excitable Media (MS17, page 12)
- Poster Session (partial) (page 14)

Applications in Physical Sciences
- Applications of Dynamical Systems Methods in Nonlinear Optics (MS31, page 17)
- Dynamical Problems in Theoretical Chemistry (MS12, page 10)
- Dynamical Systems Problems for the Superconducting Super-Collider (IP7, page 11)
- Dynamics of Motion (CP5, page 8)
- Nonlinear Optics (MS20, page 13)
- Nonlinear Optics and Hamiltonian Systems (MS16, page 12)
- Physical Applications 1, 2 and 3 (CP19, CP21, CP24, pages 13, 15, 16)
- Stationary and Turbulent Patterns in a Reaction-Diffusion System (IP10, page 15)
- Poster Session (partial) (page 14)

Chaotic Behavior
- Chaotic Motion (CP7, page 8)
- Chaotic Transport for Hamiltonian Systems (MS32, page 17)
- Geometric Methods for Maps of the Plane (MS2, page 6)
- New Methods of Embedding and Analysis for Noisy Chaotic Data (MS30, page 17)
- Signal Processing and Chaos — 1 and 2 (MS27, MS33, pages 16, 17)
- Poster Session (partial) (page 14)

Computations and Dynamical Systems
- Computation of Global Structures (CP1, page 7)
- Computational Complexity and Chaos (IP5, page 10)
- Computational Dynamical Systems 1 and 2 (CP18, CP25, pages 13, 17)
- Computer Techniques for the Numerical Study of Dynamical Systems (MS24, page 15)
- Inertial Manifolds and Low Dimensional Dynamics of PDEs — 1 and 2 (MS22, MS26, pages 14, 16)
- Poster Session (partial) (page 14)

Control of Dynamical Systems
- Controlling Chaos (MS10, page 9)
- Control of Dynamical Systems (CP16, page 12)
- Nonlinear Control, Dynamics and Estimation (MS3, page 6)
- Poster Session (partial) (page 14)

Ergodic and Statistical Properties of Flows
- Application of Dynamical Systems to Information Theory (MS 23, page 15)
- Ergodic Theory of Strange Attractors (IP2, page 7)
- Stochastic Resonance (MS13, page 10)
- Phase Space Reconstruction and Time Series, 1 and 2 (CP8, CP12, pages 9, 11)

Fluids and Turbulence
- Fluids, 1 and 2 (CP17, CP20, pages 12, 13)
- Metaphors, Models and Mathematics, or How Strange is Turbulence? (IP1, page 6)
- Taylor-Couette Flow (CP11, page 10)
- Turbulence and Wavelets (MS6, page 7)
- Poster Session (partial) (page 14)

Geometry of Flows and Maps
- Complex Polynomial Dynamics (IP3, page 8)
- Fractals and Invariant Measures (CP14, page 11)
- Homoclinic Orbits and Chaos, 1 and 2 (CP15, CP22, pages 11, 15)
- Hyperbolicity in Skew-Product Flows (MS5, page 7)
- Invariant Manifolds (MS15, page 11)
- Oscillation and Invariance, 1 and 2 (CP2, CP9, pages 7, 9)
- Resonances (CP6, page 8)
- Saddle Orbits (MS11, page 9)
- Stability and Approximation (CP4, page 8)
- Poster Session (partial) (page 14)

Hamiltonian and Integrable Systems
- Infinite Dimensional KAM Theory (MS8, page 8)
- Dynamics of Mechanical Systems (MS18, page 12)
- Chaos in Near-Integrable Systems (IP4, page 9)
- Splitting Separatrices and Arnol'd Diffusion (IP6, page 11)
- Integrable Systems (MS1, page 6)
- Poster Session (partial) (page 14)

Infinite Dimensional Dynamical Systems
- Defects and Singularities (MS9, page 9)
- Delay Equations (CP13, page 11)
- Dynamics of Infinite-Dimensional Problems (MS19, page 12)
- Qualitative Results for Partial Differential Equations (MS28, page 16)
- Recent Developments in Differential-Delay Equations (MS14, page 10)
- Spatial Structures (CP3, page 8)
- Stability, Instability and Bifurcation by the Energy-Momentum Method (IP12, page 17)
- Poster Session (partial) (page 14)

Symmetries in Dynamical Systems
- Symmetric Chaos (IP11, page 15)
- Symmetry in Dynamical Systems (CP10, page 10)
- The Numerical Treatment of PDEs with Symmetry (MS29, page 16)
- Poster Session (partial) (page 14)

WEDNESDAY, OCTOBER 14

6:00 PM-8:00 PM
Registration opens
Ballroom Foyer

THURSDAY, OCTOBER 15

7:45 AM **Registration opens**
Ballroom Foyer

8:45 **Opening Remarks**
Peter W. Bates and Christopher K.R.T. Jones
Ballroom 1&2

9:00 **IP1** **Metaphors, Models and Mathematics, or How Strange is Turbulence?**
Philip Holmes
Ballroom 1&2

10:00 **Coffee**
Golden Cliff Room

10:15 **Concurrent Sessions**

MS1 **Integrable Systems**
Organizers: Athanassios S. Fokas and Israel M. Gel'fand
Ballroom 1&2

MS2 **Geometric Methods for Maps of the Plane**
Organizer: Marcy Barge
Magpie Room

MS3 **Nonlinear Control, Dynamics, and Estimation**
Organizer: Christopher I. Byrnes
Wasatch Room

MS4 **AIDS Epidemiology and Dynamical Models**
Organizer: Ann Stanley
Maybird Room

CP1 **Computation of Global Structures**
Superior B Room

CP2 **Oscillation and Invariance 1**
Superior A Room

12:15 PM **Lunch**

1:30 **IP2** **Ergodic Theory of Strange Attractors**
Lai-Sang Young
Ballroom 1&2

2:30 **Concurrent Sessions**

MS5 **Hyperbolicity in Skew-Product Flows**
Organizer: Russell A. Johnson
Magpie Room

MS6 **Turbulence and Wavelets**
Organizer: Katepalli R. Sreenivasan
Wasatch Room

MS7 **Coupled Oscillators**
Organizer: Steven H. Strogatz
Maybird Room

MS8 **Infinite Dimensional KAM Theory**
Clarence E. Wayne
Ballroom 1&2

CP3 **Spatial Structures**
Superior B Room

CP4 **Stability and Approximation**
Superior A Room

4:30 **Coffee**
Golden Cliff Room

5:00 **IP3** **Complex Polynomial Dynamics**
John Milnor
Ballroom 1&2

6:00 **Concurrent Sessions**

CP5 **Dynamics of Motion**
Magpie Room

CP6 **Resonances**
Wasatch Room

CP7 **Chaotic Motion**
Maybird Room

FRIDAY, OCTOBER 16

7:30 AM **Registration opens**
Ballroom Foyer

8:30 **IP4** **Chaos in Near-Integrable Systems**
David W. McLaughlin
Ballroom 1&2

9:30 **Coffee**
Golden Cliff Room

10:00 **Concurrent Sessions**

MS9 **Defects and Singularities**
Organizers: Paul Fife and Peter Sternberg
Ballroom 1&2

MS10 **Controlling Chaos**
Organizer: David F. Delchamps
Magpie Room

MS11 **Saddle Orbits**
Organizer: Eric Kostelich
Wasatch Room

CP8 **Phase Space Reconstruction and Time Series 1**
Superior A Room

CP9 **Oscillation and Invariance 2**
Superior B Room

CP10 **Symmetry in Dynamical Systems**
Maybird Room

12:00 PM **Lunch**

1:30 **IP5** **Computational Complexity and Chaos**
Lenore Blum
Ballroom 1&2

2:30 **Concurrent Sessions**

MS12 **Dynamical Problems in Theoretical Chemistry**
Organizers: Gregory Ezra and and Stephen Wiggins
Magpie Room

MS13 **Stochastic Resonance**
Organizer: Kurt Wiesenfeld
Ballroom 1&2

MS14 **Recent Developments in Differential-Delay Equations**
Organizers: John Mallet-Paret and Roger Nussbaum
Wasatch Room

CP11 **Taylor-Couette Flow**
Maybird Room

CP12 **Phase Space Reconstruction and Time Series 2**
Superior B Room

4:30 **Coffee**
Golden Cliff Room

5:00 **IP6** **Splitting Separatrices and Arnol'd Diffusion**
Giovanni Gallavotti
Ballroom 1&2

6:00 **Concurrent Sessions**

CP13 **Delay Equations**
Wasatch Room

CP14 **Fractals and Invariant Measures**
Superior B Room

CP15 **Homoclinic Orbits and Chaos 1**
Maybird Room

8:00 **Business Meeting**
SIAM Activity Group on Dynamical Systems
Ballroom 1&2

SATURDAY, OCTOBER 17

7:30 AM **Registration opens**
Ballroom Foyer

8:30 **IP7** **Dynamical Systems Problems for the Superconducting Super-Collider**
James A. Ellison
Ballroom 1&2

9:30 **Coffee**
Golden Cliff Room

10:00 **Concurrent Sessions**

MS15 **Invariant Manifolds**
Organizer: Kening Lu
Magpie Room

MS16 **Nonlinear Optics and Hamiltonian Systems**
Organizer: William L. Kath
Ballroom 1&2

MS17 **The Dynamics for Patterns in Excitable Media**
Organizer: James P. Keener
Wasatch Room

MS18 **Dynamics of Mechanical Systems**
Mark Levi
Maybird Room

CP16 **Control of Dynamical Systems**
Superior A Room

CP17 **Fluids 1**
Superior B Room

12:00 PM **Lunch**

1:30 **IP8** **Bifurcations and Traveling Waves in a Delayed Partial Differential Equation**
Michael C. Mackey
Ballroom 1&2

2:30 **Concurrent Sessions**

MS19 **Dynamics of Infinite-Dimensional Problems**
Organizer: Shui-Nee Chow
Ballroom 1&2

MS20 **Nonlinear Optics**
Organizer: Jerome V. Moloney
Magpie Room

MS21 **Neural Networks**
Organizer: Stephen Grossberg
Wasatch Room

CP18 **Computational Dynamical Systems 1**
Maybird Room

CP19 **Physical Applications 1**
Superior A Room

CP20 **Fluids 2**
Superior B Room

4:30 **Coffee**
Golden Cliff Room

5:00 **IP9** **Chaos and Fractals in Physiology and Medicine**
Ary L. Goldberger
Ballroom 1&2

7:30-9:30 **Poster Session**
Golden Cliff Room and Ballroom Foyer

SUNDAY, OCTOBER 18

7:30 AM **Buses leave for Salt Lake City tour and Mormon Temple**
Cliff Lodge

12:00 PM ***Buses return from tour***

12:00 **Registration opens**
Ballroom Foyer

12:30 – 3:00

MS22 **Inertial Manifolds and Low Dimensional Dynamics of PDEs (Part 1 of 2)**
Organizers: Yannis Kevrekidis and Edriss S. Titi
Ballroom 1&2

1:00 **Concurrent Sessions**

MS23 **Application of Dynamical Systems to Information Theory**
Roy L. Adler
Magpie Room

MS24 **Computer Techniques for the Numerical Study of Dynamical Systems**
Organizer: Celso Grebogi
Wasatch Room

MS25 **Bursting Oscillations in Biological Systems**
Organizers: David H. Terman and John Rinzel
Maybird Room

CP21 **Physical Applications 2**
Superior A Room

CP22 **Homoclinic Orbits and Chaos 2**
Superior B Room

3:00 **Coffee**
Golden Cliff Room

3:30 **IP10** **Stationary and Turbulent Patterns in a Reaction-Diffusion System**
Harry L. Swinney
Ballroom 1&2

4:30 **IP11** **Symmetric Chaos**
Martin Golubitsky
Ballroom 1&2

7:30 **Concurrent Sessions**

MS26 **Inertial Manifolds and Low Dimensional Dynamics of PDEs (Part 2 of 2)**
Organizers: Yannis Kevrekidis and Edriss S. Titi
Ballroom 1&2

MS27 **Signal Processing and Chaos (Part 1 of 2)**
Organizer: Louis M. Pecora
Magpie Room

MS28 **Qualitative Results for Partial Differential Equations**
Organizers: Norman Dancer and Peter Hess
Wasatch Room

MS29 **The Numerical Treatment of PDEs with Symmetry**
Organizer: Michael Dellnitz
Maybird Room

CP23 **Biological Applications 1**
Superior B Room

CP24 **Physical Applications 3**
Superior A Room

MONDAY, OCTOBER 19

8:00 AM **Registration opens**
Ballroom Foyer

8:30 **IP12** **Stability, Instability and Bifurcation by the Energy-Momentum Method**
Jerrold E. Marsden
Ballroom 1&2

9:30 **Coffee**
Golden Cliff Room

10:00 **Concurrent Sessions**

MS30 **New Methods of Embedding and Analysis for Noisy Chaotic Data**
Organizer: Robert Cawley
Magpie Room

MS31 **Applications of Dynamical Systems Methods in Nonlinear Optics**
Organizer: Darryl Holm
Wasatch Room

MS32 **Chaotic Transport for Hamiltonian Systems**
Organizer: James D. Meiss
Maybird Room

MS33 **Signal Processing and Chaos (Part 2 of 2)**
Organizer: Louis M. Pecora
Ballroom 1&2

CP25 **Computational Dynamical Systems 2**
Superior A Room

CP26 **Biological Applications 2**
Superior B Room

12:00 PM **Conference Adjourns**

CP = Contributed Presentation
IP = Invited Presentation
MS = Minisymposium

THURSDAY MORNING, OCTOBER 15

7:45/Ballroom Foyer

Registration opens

8:45/Ballroom 1&2

Opening Remarks

Peter W. Bates, Brigham Young University and Christopher K.R.T. Jones, Brown University

9:00/Ballroom 1&2

IP1/Chair: Peter W. Bates, Brigham Young University

Metaphors, Models and Mathematics, or How Strange is Turbulence?

The speaker will reflect a little on the place of applied mathematics between the physical world and the world of pure mathematics, and on the relations between modelling and analysis. He will illustrate the general discussion by describing work on low dimensional models for the dynamics of coherent structures in turbulent flows done at Cornell over the past seven years by Armbruster, Aubry, Berkooz, Elezgaray Guckenheimer, Lumley, Stone and himself.

For turbulent flow one has an excellent mathematical model: the Navier-Stokes equation. The difficulty is, of course, that it appears insoluble in any reasonable sense, even if the technical difficulties of global existence in three dimensions could be overcome. A full numerical simulation certainly provides a "solution", but it provides little understanding of the process per se. However, three recent developments offer some hope: the discovery, by experiment, of coherent structures in certain fully developed turbulent flows, the suggestion, by Ruelle, Takens and others, that strange attractors and other ideas from dynamical systems theory might play a role in the analysis of the governing equations, and the introduction of the statistical technique of Karhunen-Loeve or proper orthogonal decomposition (by Lumley in the case of turbulence). The speaker will describe how these three threads might be drawn together to weave low dimensional models that yield understanding of basic mechanisms of turbulence generation.

Philip Holmes
Department of Theoretical and Applied Mechanics
Cornell University

10:00/Golden Cliff Room

Coffee

Note:
For presentations with two or more authors, the speaker's name is in italics.

10:15 AM-12:15 PM

CONCURRENT SESSIONS

MS1/Ballroom 1&2

Integrable Systems

Many apparently disparate nonlinear systems exhibit integrable behavior, in particular they possess coherent structures (solitons, instantons, gravitons, dromions, etc,). The study of integrable phenomena has enhanced our understanding of certain physical nonlinear mechanisms and has also led to beautiful mathematical results such as the solution of the Schottky problem and the introduction of quantum groups.

The speakers in this minisymposium will discuss four new developments: A general and rigorous method for analyzing the asymptotics of integrable equations will be presented. The Painléve equations which apparently play in nonlinear physics the same role that the classical special functions play in linear physics, will be reviewed with emphasis on their appearance in 2D quantum gravity. Recent experimental and theoretical developments concerning commercial applications of solitons in fiber optics will be presented. The transition from integrability to stochasticity will be discussed for a discrete sine-Gordon equation.

Organizers: Athanassios S. Fokas
Clarkson University, and
Israel M. Gel'fand,
Rutgers University

10:15 **The Painléve Transcendents in Nonlinear Mathematical Physics**
Alexander R. Its, Clarkson University

10:45 **Steepest Descent Method for Oscillatory Riemann-Hilbert Problems with Applications to Dynamical Systems**
P. Deift, Courant Insitute of Mathematical Sciences, New York University and X. Zhou, Yale University

11:15 **Statistical Critical Phenomena in a Near-Integrable Discrete Sine-Gordon Lattice**
M. Gregory Forest, Christopher G. Goedde and Amarendra Sinha, Ohio State University, Columbus

11:45 **Recent Progress on a Long-Distance and High-Bit-Rate Optical Soliton Communication System**
Yuji Kodama, Ohio State University, Columbus

MS2/Magpie Room

Geometric Methods for Maps of the Plane

The introduction of certain topological techniques into the study of two-dimensional diffeomorphisms has yielded a deeper understanding of the structure of their periodic orbits and other minimal sets. These techniques include the Thurston Theory applied to the plane punctured by the removal of periodic orbits, continuum theoretic considerations on invariant one-dimensional subsets (such as the closure of the unstable manifold), and index arguments. The common theme of the presentations in this minisymposium is the coordination of the above methods to provide an understanding of various rotational behaviors for two-dimensional maps. Recent work along these lines has helped organize the dynamical complexity of periodically forced nonlinear oscillators and other such complicated systems that possess periodic orbits of infinitely many periods.

Organizer: Marcy Barge
Montana State University

10:15 **Rotation Intervals for Diffeomorphisms of the Plane**
Kathleen T. Alligood, George Mason University

10:45 **Periodic Orbits Created by Rigid Rotation**
Glen R. Hall, Boston University

11:15 **Fixed Points in the Plane and Rotation Numbers**
Richard Swanson, Montana State University

11:45 **A Poincaré-Birkhoff Theorem for Dissipative Maps of the Plane**
Marcy Barge, Organizer

MS3/Wasatch Room

Nonlinear Control, Dynamics, and Estimation

During the past decade, the field of nonlinear control has reached a remarkable state of maturity, culminating in the development of several systematic methodologies for the design of feedback laws achieving a variety of important control objectives. Indeed, theory and simulation now suggest that the nonlinear control methods have the potential to become comparable in scope to the method of classical and state space design methods for linear systems - a view supported by current design methods developed in the aerospace industry.

In the early 1980s, nonlinear control theorists returned en masse to the most basic yet challenging design problems that are now part of a systematic design methodology for nonlinear control. This trend had its origin in two independent developments - the discovery of necessary and sufficient conditions for (local) linearization of a nonlinear system via state feedback and coordinate changes and for (local) decoupling of a disturbance channel via feedback and coordinate changes. The geometric underpinnings of these two important advances clarified a decade of earlier work and, when combined with an increasing application of nonlinear dynamics, has pointed the way to a host of other advances, including methods for asymptotic tracking, disturbance attenuation and rejection, feedback stabilization and modeling filter and observer design.

The speakers will present some of the recent advances in control and estimation made possible by the incorporation of concepts and techniques drawn from nonlinear dynamics.

Organizer: Christopher I. Byrnes
Washington University

10:15 **Global Solutions and Shock Waves for the Riccati Partial Differential Equations of Nonlinear Optimal Control**
Christopher I. Byrnes, Organizer

10:45 **On the Nonlinear Dynamics of Fast Filtering Algorithms**
Anders Lindquist, Royal Institute of Technology, Sweden

11:15 **Nonholonomic Systems and Control**
Anthony Michael Bloch, Ohio State University

11:45 **Dynamic Systems and Universal Observability**
Clyde Martin, Texas Tech University, Lubbock

10:15 AM-12:15 PM

CONCURRENT SESSIONS

MS4/Maybird Room

AIDS Epidemiology and Dynamical Models

Mathematical models of the spread of AIDS have provided important insights into the dynamics driving the epidemic. Models have demonstrated the importance of certain key factors, including social structures, mixing rates between social groups, and variations in infectiousness with the course of disease. The spread of HIV is a nonlinear, nonlocal process, and, because of this, different types of social structures and transportation networks can result in very different epidemic patterns. Recent Monte Carlo simulations have demonstrated that correlations between random events can greatly influence the spread of the epidemic even in large populations.

Organizer: Ann Stanley
Iowa State University

10:15 **Comparison of Deterministic and Stochastic SI Models**
Carl Simon and John Jacquez, University of Michigan, Ann Arbor

10:45 **The Importance of Interregional Mobility for Infectious Disease Spread in Bounded Geographic Areas**
Lisa Sattenspiel, University of Missouri, Columbia

11:15 **Title to be announced**
Michael Altmann, University of Minnesota, Minneapolis

11:45 **Social Mixing Patterns and the Spread of AIDS**
Ann Stanley, Organizer

CP1/Superior B Room

Computation of Global Structures

Chair: Andrew M. Stuart, University of Bath, United Kingdom and Stanford University

10:15 **Numerical Computation of Homoclinic Orbits**
Stephen Schecter, North Carolina State University

10:35 **Computation of Heteroclinic Connections in Gradient PDEs Part 1**
Fengshan Bai, University of Bath, United Kingdom and Tsinghua University, People's Republic of China; Alastair Spence, University of Bath, United Kingdom; and *Andrew M. Stuart*, University of Bath, United Kingdom and Stanford University

10:55 **Computation of Heteroclinic Connections in Gradient PDEs Part II**
Fengshan Bai, University of Bath, United Kingdom and Tsinghua University, People's Republic of China; Alastair Spence, University of Bath, United Kingdom; and Andrew M. Stuart, University of Bath, United Kingdom and Stanford University

11:15 **Numerical Methods for Dissipative and Gradient Dynamical Systems**
Antony R. Humphries and Andrew M. Stuart, University of Bath, United Kingdom and Stanford University

11:35 **The Complex Ginzburg-Landau Equation: Numerical Schemes and Absorbing Set**
Gabriel James Lord, University of Bath, United Kingdom and Andrew M. Stuart, University of Bath, United Kingdom and Stanford University

11:55 **Accurate Computation and Continuation of Heteroclinic Orbits**
Mark J. Friedman, University of Alabama, Huntsville; Eusebius J. Doedel, California Institute of Technology; and Anand C. Monteiro, University of Alabama, Huntsville

CP2/Superior A Room

Oscillation and Invariance I

Chair: Russell Johnson, Università di Firenze, Italy and University of Southern California

10:15 **Breakdown of Stability of 2-Tori**
Russell Johnson, Università di Firenze, Italy and University of Southern California and Ying-Fei Yi, Georgia Institute of Technology

10:35 **Recurring Anti-Phase Behavior in Coupled Nonlinear Oscillators: Random Noise or Deterministic Chaos?**
Kwok Yeung Tsang and Ira B. Schwartz, Naval Research Laboratory, Washington, DC

10:55 **A Singularly Perturbed Nonlinear Oscillator with Applications to Structural Dynamics**
Ioannis T. Georgiou, Anil K. Bajaj and Martin J. Corless, Purdue University, West Lafayette

11:15 **Bifurcations and Chaos in a Bilinear Hysteretic Oscillator**
Rudra Pratap, S. Mukherjee and F.C. Moon, Cornell University

11:35 **Mode-Locking Structure in Billiards with Spin**
Kwang Il Kim, Yoo Tae Kim and *Seunghwan Kim*, Pohang Institute of Science and Technology, Korea

11:55 **On the Dynamics of Aeroelastic Oscillators with One Degree of Freedom**
Adriaan P.H. van der Burgh and *Timber I. Haaker*, Delft University of Technology, The Netherlands

THURSDAY AFTERNOON, OCTOBER 15

12:15-1:30

Lunch

1:30/Ballroom 1&2

IP2/Chair: Christopher K.R.T. Jones, Brown University

Ergodic Theory of Strange Attractors

The theory of Sinai, Bowen and Ruelle tells us that for uniformly hyperbolic attractors the statistics of typical trajectories are governed by a very special invariant measure. The speaker will present and discuss recent results along similar lines for the Henon attractors.

Lai-Sang Young
Department of Mathematics
University of Arizona and University of California, Los Angeles

2:30 PM - 4:30 PM

CONCURRENT SESSIONS

MS5/Magpie Room

Hyperbolicity in Skew-Product Flows

Hyperbolicity with respect to a general compact invariant set in a dynamical system can be effectively studied by introducing a skew product flow. In this way an autonomous vector field becomes non-autonomous, but the skew-product structure alleviates the main difficulty associated with non-autonomous systems, namely the breakdown of the flow property. The speakers in this minisymposium will survey applications of the skew-product construction to various problems having hyperbolic structure. Homoclinic phenomena and bifurcation problems will be discussed.

Organizer: Russell A. Johnson
Università di Firenze, Italy and University of Southern California

2:30 **Shadowing Orbits of Chaotic Differential Euqations**
Kenneth J. Palmer and Huseyin Kocak, University of Miami

3:00 **Smooth Invariant Foliations in Certain Dynamical Systems**
Yingfei Yi, Georgia Institute of Technology

3:30 **Homoclinic Twisting Bifurcations and Cusp Horsehoe Maps**
Bo Deng, University of Nebraska, Lincoln

4:00 **Breakdown of Stability of 2-tori**
Russell Johnson, Organizer and Yingfei Yi, Georgia Institute of Technology

MS6/Wasatch Room

Turbulence and Wavelets

The speakers in this minisymposium will present an overview of some recent work on the applications of wavelets (and their relatives) to the problem of fluid turbulence. The presentations will cover the following aspects: an examination of the wavelet transform as a link between physical and Fourier space descriptions of turbulence, the physical-space description and modeling of turbulent fields by the use of wavelets, the analysis of the Navier-Stokes equations in the orthonormal wavelet representation and the theoretical and experimental work on the probability density function of wavelet coefficients for passive admixtures in fully developed turbulence.

Organizer: Katepalli R. Sreenivasan
Yale University

2:30 **The Multiscale Structure of the Passive Scalar Field in Turbulent Water Jets**
R.M. Everson, Brown University and K.R. Sreenivasan, Organizer

3:00 **Analysis of Turbulence in the Orthonormal Wavelet Representation**
Charles Meneveau, Johns Hopkins University

3:30 **The Wavelet Transform as a Link between Physical Space and Fourier Space**
James G. Brasseur and Qunzhen Wang, Pennsylvania State University

4:00 **Wavelet Coefficient Probability Distribution Functions for Turbulent Flows**
Philippe L. Similon, Yale University

2:30 PM - 4:30 PM

CONCURRENT SESSIONS

MS7/Maybird Room

Coupled Oscillators

Nonlinear oscillators are among the oldest and best understood types of dynamical systems, but very little is known about their collective behavior. In other words, what can happen when an enormous number of oscillators are coupled together? This minisymposium will focus on the dynamics of large systems of nonlinear oscillators, with applications to condensed-matter physics, chemical reaction-diffusion systems, and populations of biological oscillators.

Organizer: Steven H. Strogatz
Massachusetts Institute of Technology

2:30 **Fireflies and Coupled Oscillators**
Steven H. Strogatz, Organizer

3:00 **Dynamics of Josephson Junction Arrays**
Kurt Wiesenfeld, Georgia Institute of Technology

3:30 **Nonlinear Oscillators, Biological Rhythms, and Landau Damping**
Renato E. Mirollo, Boston College

4:00 **Boundaries of Locking in Weakly Diffusive Chemical Systems**
G. Bard Ermentrout, University of Pittsburgh

MS8/Ballroom 1&2

Infinite Dimensional KAM Theory

Ideas which first arose in the study of finite dimensional dynamical systems have recently begun to find increasing numbers of applications in the study of partial differential equations. In particular, the Kolmogorov-Arnold-Moser theory has been used to construct regular solutions for a number of equations of importance in mathematical physics. What is more, numerous other possible applications present themselves in areas such as scattering theory of non-integrable equations, stability of solitary waves, and the formation of shocks in dispersive equations. The speakers in this minisymposium will present a review of known results and explore possible future avenues of investigation.

Organizer: Clarence E. Wayne
Pennsylvania State University

2:30 **Invariant Tori for Nonlinear Wave Equations**
Walter L. Craig, Brown University

3:00 **Approximation of Measure Preserving Transformations**
Peter D. Lax, Courant Institute of Mathematical Sciences, New York University

3:30 **The Forced Toda Problem**
Stephanos Venakides, Duke University

4:00 **Solitary Waves, Asymptotic Stability, and Hamiltonian Systems**
Michael I. Weinstein, University of Michigan, Ann Arbor

CP3/Superior B Room

Spatial Structures

Chair: Xiao-Biao Lin, North Carolina State University

2:30 **Dynamical Metastability in Cahn-Hilliard-Morral Systems**
Christopher P. Grant, Georgia Institute of Technology

2:50 **A New Passage to Generate Diffusive Patterns**
Xiao-Biao Lin, North Carolina State University

3:10 **Self-Trapping of Traveling-Wave Pulses**
Hermann Riecke, Northwestern University

3:30 **Domain Walls in Superstructures, Sources, Sinks and their Stability**
David Raitt and Hermann Riecke, Northwestern University

3:50 **Stability of Steady States of the Ginzburg-Landau Equation in Higher Space Dimensions**
Shuichi Jimbo, Okayama University, Japan and *Yoshihisa Morita*, Ryukoku University, Japan

4:10 **Interaction and Stochastic Dynamics of Localized States of Multidimensional Nonlinear Fields**
A.S. Lomov and M.I. Rabinovich, Russian Academy of Sciences, Russia

CP4/Superior A Room

Stability and Approximation

Chair: Natalia Sternberg, Clark University

2:30 **Systems with Intermittent Switching of the Activity—Distinguishing Random and Chaotic Processes**
Nathan Platt, Naval Surface Warfare Center, Silver Spring, MD; Charles Tresser, IBM Thomas J. Watson Research Center; and Edward Spiegel, Columbia University

2:50 **A Hartman-Grobman Theorem for Maps**
Natalia Sternberg, Clark University

3:10 **Closeness of the Solutions of Approximately Decoupled Damped Linear Systems to Their Exact Solutions**
S.M. Shahruz, Berkeley Engineering Research Institute and G. Langari, Texas A&M University, College Station

3:30 **On a Problem of Nirenberg Concerning Expanding Maps in Hilbert Space**
Janusz Szczepanski, Polish Academy of Sciences, Poland

3:50 **Structurally Stable Singularities of Line Element Fields on the Plane**
I.U. Bronstein and *I.V. Nikolaev*, Academy of Sciences of Moldora, Russia

4:10 **On Stability in Nonlinear Dynamical Systems with Perturbations**
Oleg V. Anashkin, Simferopol State University, Ukraine

4:30/Golden Cliff Room

Coffee

5:00/Ballroom 1&2

IP3/Chair: Sheldon E. Newhouse, University of North Carolina, Chapel Hill

Complex Polynomial Dynamics

The speaker will present a survey of research in the dynamics of iterated polynomial maps in one complex variable. He will describe some classical results and emphasize recent developments.

John Milnor
Department of Mathematics
State University of New York, Stony Brook

6:00 PM – 7:00 PM

CONCURRENT SESSIONS

CP5/Magpie Room

Dynamics of Motion

Chair: Michael Rose. Technical University of Denmark, Denmark

6:00 **Investigations of Chaos in a Train Wheelset with Adiabatically Varying Parameters**
Michael Rose, Technical University of Denmark, Denmark

6:20 **Transient Chaos in Wheel Dynamics**
Gabor Stepan, Technical University of Budapest, Hungary

6:40 **Dynamic Modeling of Vehicles Traveling on Bridges**
E. Esmailzadeh and M. Ghorashi, Sharif University of Technology, Iran

CP6/Wasatch Room

Resonances

Chair: Timothy J. Burns, National Institute of Standards and Technology

6:00 **Orbits Homoclinic to Resonances: The Hamiltonian Case**
Gyorgy Haller and Stephen Wiggins, California Institute of Technology

6:20 **Transfer of Capture During Passage Through Resonance**
Timothy J. Burns, National Institute of Standards and Technology and Christopher K.R.T. Jones, Brown University

6:40 **Second Order Averaging and Resonant Amplitude Dynamics of a Nonlinear Two Degree of Freedom System**
Bappaditya Banerjee, Anil K. Bajaj and Patricia Davies, Purdue University, West Lafayette

CP7/Maybird Room

Chaotic Motion

Chair: Troy Shinbrot, University of Maryland, College Park

6:00 **Piano-like Dynamics and Strange Nonchaotic Attractors**
M.S. El Naschie, Cornell University

6:20 **Transition to Hyperchaos in Coupled Generalized Van Der Pol Oscillators**
Willi-Hans Steeb, Rand Afrikaans University, South Africa

6:40 **Chaotic Model of Dry Friction Force**
Tomasz Kapitaniak, Technical University of Lodz, Poland

FRIDAY MORNING, OCTOBER 16

7:30/Ballroom Foyer

Registration Opens

8:30/Ballroom 1&2

IP4/Chair: Christopher K.R.T. Jones, Brown University

Chaos in Near-Integrable Systems

This presentation is an overview of numerical and theoretical studies of chaotic behavior in near integrable soliton systems, specifically for perturbations of the nonlinear Schrödinger equation. (The work has been done in various collaborations with A. Bishop, N. Ercolani, G. Forest, Y. Li, E. Overman, S. Wiggins, and C. Xiong.)

The speaker will begin with a brief summary of typical phenomena which have been observed numerically; and then focus upon the use of the spectral transform to display instabilities and hyperbolic structure in the integrable system. This hyperbolic structure is responsible for the system's sensitivity to perturbations. In particular, he will identify invariant critical tori and analytically represent their stable and unstable manifolds — whiskered tori —for this integrable soliton system. The spectral transform is used to monitor numerically the presence of this hyperbolic structure in the perturbed numerical experiments. Finally, the status of the geometric perturbation studies of the system will be reviewed.

David W. McLaughlin
Department of Mathematics and
Program in Applied and
Computational Mathematics
Princeton University

9:30/Golden Cliff Room

Coffee

10:00 AM - 12:00 PM

CONCURRENT SESSIONS

MS9/Ballroom 1&2

Defects and Singularities

The notion of defect, together with other singularities, plays a prominent role in many physical theories. These notions often have mathematical counterparts in the form of inherent singular behavior of nonlinear partial differential equations serving as models for the physical phenomena. Various approaches to understanding the nature of such mathematical models, in several physical contexts, will be given.

Organizers: Paul Fife
University of Utah, and
Peter Sternberg,
Indiana University, Bloomington

10:00 **On the Dynamics of Defect Structures in Liquid Crystal Materials**
M. Carme Calderer, Pennsylvania State University, University Park

10:30 **Motion of Defects**
J. Rubinstein, Technion - Israel Institute of Technology, Israel

11:00 **Regularization of the Coulomb Singularity**
John Neu, University of California, Berkeley

11:30 **A Topological Defect Model of Superfluid**
Neil Carlson, Purdue University, West Lafayette

MS10/Magpie Room
(This session will run until 12:30 PM)

Controlling Chaos

Many interesting and difficult theoretical and practical problems in control system design involve complicated nonlinear dynamical phenomena in fundamental ways. The growing body of descriptive work on chaotic systems has a relevance and applicability to such problems that control theorists have only recently begun to appreciate. Concurrently, the dynamic systems community has started to recognize how the control theorists' prescriptive attitude not only casts a fresh light on old problems but engenders important new questions about practical situations that dynamical systems theory is well-equipped to answer. Each speaker in this minisymposium considers a class of nonlinear control systems whose dynamics exhibit chaos in one form or another. The first three speakers address the problem of suppressing an open-loop system's chaotic behavior using feedback control; while the first two speakers approach their problems from a purely deterministic standpoint, the third speaker models his system's complicated open-loop dynamics probabilistically. The fourth speaker considers a situation in which chaos results from controlling a nominally well-behaved system; the asymptotic statistical properties of the closed-loop system's chaotic dynamics depend upon the control scheme, and are therefore subject to the designer's influence.

Organizer: David F. Delchamps
Cornell University

10:00 **Control of Systems with Homoclinic and Heteroclinic Structures**
Anthony M. Bloch, Ohio State University, Columbus and Jerrold E. Marsden, University of California, Berkeley

10:30 **Bifurcation Control of Chaotic Dynamical Systems**
Hua Wang and *Eyad H. Abed*, University of Maryland, College Park

11:00 **Analysis and Control of Nonlinear Systems with Complicated Behavior**
Kenneth A. Loparo and Xiangbo Feng, Case Western Reserve University

11:30 **Invariant Densities and the Macroscopic Asymptotic Behavior of Digitally Controlled Continuous-Time Systems**
David F. Delchamps, Organizer

12:00 **Destabilizing Limit-Cycles in Delta-Sigma Modulators with Chaos**
Richard Schreier, Oregon State University

MS11/Wasatch Room

Saddle Orbits

Saddle periodic orbits provide an important characterization of dynamical systems. The speakers in this session describe both theoretical results and applications to experiments. They will discuss how saddle orbits can be extracted from experimental data to construct a geometric model of the dynamics of the experiment; the characterization of knots produced by flows in three-dimensional systems such as the Lorenz equations; the creation and destruction of hyperbolic and nonhyperbolic fixed points as a parameter is varied; and symmetry, fixed points, and what they imply about the structure of attractors.

Organizer: Eric Kostelich
Arizona State University

10:00 **Geometry from Saddle Cycles**
Robert Gilmore, Drexel University

10:30 **Structure of Attractors for Continuous Mappings**
Ian Melbourne, University of Houston

11:00 **Composite Knots in the Figure-8 Knot Complement can have any Number of Prime Factors**
Michael Sullivan, University of Texas, Austin,

11:30 **The Measure of Nonhyperbolicity in Chaotic Dynamical Systems**
Ying-Cheng, *Celso Grebogi* and James A. Yorke, University of Maryland, College Park

CP8/Superior A Room

Phase Space Reconstruction and Time Series 1

Chair: James Theiler, Los Alamos National Laboratory

10:00 **Mixed State Markov Models for Nonlinear Time Series**
Andrew M. Fraser, Portland State University

10:20 **Bleaching and Noise Amplification in Time Series Analysis**
James Theiler, Los Alamos National Laboratory

10:40 **Analyzing Chaotic Time Series Using Empirical Global Equations of Motion**
Jeffrey S. Brush, RTA Corporation, Springfield, VA and *James B. Kadtke*, University of California, San Diego

11:00 **Computing the Inferable Number of Dynamical Variables**
Joseph L. Breeden and Norman H. Packard, University of Illinois, Urbana

11:20 **Recursive Analysis of Chaotic Time Series**
Jaroslav Stark, GEC Hirst Research Centre, United Kingdom

11:40 **Dynamical Nonlinear Equations Obtained from Time Series**
Hans-Ruedi Moser and Peter F. Meier, University of Zurich, Switzerland

CP9/Superior B Room

Oscillation and Invariance 2

Chair: Carmen Chicone, University of Missouri, Columbia

10:00 **Numerical and Experimental Studies of Self-Synchronization and Synchronized Chaos**
Maria de Sousa Vieira, P. Khoury, A.J. Lichtenberg, M.A. Lieberman, and W. Wonchoba, University of California, Berkeley; J. Gullicksen, J.Y. Huang, R. Sherman and M. Steinberg, Loral Aerospace, San Jose, CA

10:20 **Invariants from Lengths of Caustics**
Edoh Y. Amiran, Western Washington University

10:40 **Collective Behavior in Limit-Cycle Oscillator Arrays**
Jeffrey L. Rogers and Luc T. Wille, Florida Atlantic University

11:00 **Lyapunov-Schmidt Reduction for Bifurcation of Periodic Solutions in Coupled Oscillators**
Carmen Chicone, University of Missouri, Columbia

11:20 **Chaotic Behavior in a Two-Frequency Perturbation of Duffing's Equation**
Kazuyuki Yagasaki, Tamagawa University, Japan

11:40 **Attractors of a Driven Oscillator with a Limit Cycle**
Ibere Luiz Caldas and Kai Ullmann, University of Sao Paulo, Brasil

CP10/Maybird Room

Symmetry in Dynamical Systems

Chair: Mary Silber, California Institute of Technology

10:00 **Bifurcations with Local Gauge Symmetries: Patterns in Superconductors**
Ernest Barany and Martin Golubitsky, University of Houston, University Park and Jacek Turski, University of Houston, Downtown

10:20 **Hidden Symmetries in Bifurcations of Surface Waves: Occurence and Detection**
John David Crawford, University of Pittsburgh

10:40 **Synchrony and Symmetry--Breaking in Laser Arrays**
Mary Silber, California Institute of Technology

11:00 **Mechanism of Symmetry Creation in a Plane**
Wai Chin and Celso Grebogi, University of Maryland, College Park and Ittai Kan, George Mason University

11:20 **G-mode Solutions of Classical Dynamical Systems**
Serge Prishepionok, Portland State University

11:40 **Dynamical Systems with Cosymmetry and Bifurcation Theory**
Victor I. Yudovich, Rostov State University, Russia

FRIDAY AFTERNOON, OCTOBER 16

12:00

Lunch

1:30/Ballroom 1&2

IP5/Chair: Sheldon E. Newhouse, University of North Carolina, Chapel Hill

Computational Complexity and Chaos

The theory of computation originated in the 1930's with the work of logicians who were interested in questions of decidability. This work was refined and further developed in the 1960's by computer scientists who were interested in the intrinsic difficulty of solving discrete problems.

The speaker will discuss her joint work with Shub and Smale on a new theory of computation and complexity that integrates key ideas from the classical theory in a setting more amenable to problems over continuous domains. This new theory yields results in the continuous setting analogous to the pivotal classical results of undecidability and NP-completeness over the integers. For example, over the reals, the Mandelbrot set, as well as most Julia sets, are undecidable.

Lenore Blum
International Computer Science Institute
Berkeley, CA

2:30 PM - 4:30 PM

CONCURRENT SESSIONS

MS12/Magpie Room

Dynamical Problems in Theoretical Chemistry

Dynamical systems theory is concerned with the global, geometrical aspects of the dynamics of nonlinear systems. There has recently been much interest in applying this approach to the formulation and study of a variety of problems of central importance in theoretical chemistry. For example, the phenomenon of intramolecular energy flow and its manifestations in chemical kinetics and spectroscopy is very naturally studied as a problem of phase space transport. The speakers in this minisymposium are chemists who will speak on different problems with the common theme of how insight from nonlinear dynamics can be fruitfully brought to bear on problems in chemistry.

Organizers: Gregory Ezra, Cornell University and Stephen Wiggins, California Institute of Technology

2:30 **Hierarchical Analysis of Molecular Spectra**
Michael J. Davis, Argonne National Laboratory

3:00 **Control over Molecular Motion: Issues and Paradigms**
Herschel A. Rabitz, Princeton University

3:30 **Local Random Matrix Models of Quantum Chaos in Many-Dimensional Systems**
P.G. Wolynes, University of Illinois, Urbana-Champaign

4:00 **Bifurcation Analysis of Highly Excited Molecular Spectra**
Michael E. Kellman, University of Oregon, Eugene

MS13/Ballroom 1&2

Stochastic Resonance

The term stochastic resonance refers to a peculiar physical phenomenon in which an increase in random noise can give rise to an improved signal-to-noise ratio. Originally put forward as an explanation for the approximate periodicity of Earth's Ice Ages, stochastic resonance involves the fundamental interplay between combined periodic and stochastic forcing of a nonlinear system. Stochastic resonance has been observed in a variety of controlled experiments, including those on optical, electrical, and mechanical systems. The speakers in this minisymposium will describe the current mathematical status of the subject, and discuss frontier issues in two areas of potential application.

Organizer: Kurt Wiesenfeld
Georgia Institute of Technology

2:30 **The Theory of Stochasic Resonance**
Peter Jung, University of Augsberg, Germany

3:10 **Stochastic Resonance in Optical Systems**
Rajarshi Roy, Georgia Institute of Technology

3:50 **Stochastic Resonance: A Potential Application in Neuroscience**
Frank Moss, University of Missouri, St. Louis

MS14/Wasatch Room

Recent Developments in Differential Delay Equations

This minisymposium will focus upon recent developments in the qualitative theory of time delay differential equations. Such equations arise in models in a number of scientific fields (biology, optics, electrical circuit theory, economics), and are studied using the ideas and tools of infinite dimensional dynamical systems. Methods are drawn from funtional analysis (semigroup theory), algebraic topology (degree theory, Conley index), and general techniques of dissipative systems (attractors, omega limit sets).

Organizers: John Mallet-Paret, Brown University and Roger Nussbaum, Rutgers University

2:30 **Functional Differential Equations Arising from Structured Population Models**
Hal L. Smith, Arizona State University

3:00 **Completeness of the System of Floquet Solutions**
Sjoerd Verduyn Lunel, Georgia Insitute of Technology, and Vrije Universiteit Amsterdam, The Netherlands

3:30 **Discrete Waves in Systems of Delay Differential Equations**
Jianhong Wu, York University, Canada

4:00 **Structure of the Attractor for Delay-Differential Equations with Negative Feedback**
Konstantin Mischaikow, Georgia Institute of Technology

CP11/Maybird Room

Taylor-Couette Flow

Chair: Rita Meyer-Spasche, Max Planck Institute für Plasmaphysik, Germany

2:30 **Double Eigenvalues and the Formation of Flow Patterns**
Rita Meyer-Spasche, Max Planck Institute fur Plasmaphysik, Germany

2:50 **Connecting Double Points in Taylor Vortex Flows**
John H. Bolstad, Lawrence Livermore National Laboratory

3:10 **Numerical Lyapunov-Schmidt Decomposition near Mode Interactions in the Taylor-Couette Flow**
John H. Bolstad, Lawrence Livermore National Laboratory and *Michael E. Henderson,* IBM Thomas J. Watson Research Center

3:30 **Low Dimensional Models of Taylor-Couette Flow**
Katie Coughlin and Philip S. Marcus, University of California, Berkeley

3:50 **Confinement Effects in Flow between Counter-Rotating Cylinders**
Randall P. Tagg, University of Colorado, Denver

4:10 **Spiral Vortices in Finite Cylinders**
Edgar Knobloch, University of California, Berkeley

CP12/Superior B Room

Phase Space Reconstruction and Time Series 2

Chair: Gottfried Mayer-Kress, Santa Fe Institute

2:30 **Chaotic System Identification Using Linked Periodic Orbits**
Stephen Hammel and James Heagy, Naval Surface Warfare Center, Silver Spring, MD

2:50 **Wavelet Reconstruction of Spatio-Temporal Chaos**
Gottfried Mayer-Kress, Santa Fe Institute and Ulrich Parlitz, Universität Darmstadt, Germany

3:10 **Nonlinear Prediction as a Way of Distinguishing Chaos from Random Fractal Sequences**
A.A. Tsonis, University of Wisconsin, Milwaukee and J.B. Elsner, Florida State University

3:30 **System Identification with Aperiodic and Chaotic Driving Forces**
Alfred Hubler, University of Illinois, Urbana

3:50 **Quantification of Recurrence Plots for Analysis of Physiologic Systems**
Joseph P. Zbilut, Rush Medical College, Chicago and VA Edward Hines, Jr. Hospital, Hines, IL and Charles L. Webber, Jr., Loyola University Medical Center, Maywood, IL

4:10 **On the Transferring of Chaotic, Periodic and Ergodic Properties from Subsystem to Extended Dynamical System**
Janusz Szczepanski and Eligiusz Wajnryb, Polish Academy of Sciences, Poland

4:30/Golden Cliff Room

Coffee

5:00/Ballroom 1&2

IP6/Chair: Peter W. Bates, Brigham Young University

Splitting Separatrices and Arnol'd Diffusion

Separatrices, which are ubiquitous in Hamiltonian systems, bound regions of contrasting dynamical behavior. The separatrices generally split apart under perturbations of the Hamiltonian system. If the perturbation is small, interesting dynamics associated with the corresponding homoclinic and heteroclinic intersections develop. For instance, phase space points can travel long distances, no matter how small the perturbation, as long as it is non-zero (Arnol'd diffusion).

Giovanni Gallavotti
Department of Physics
University of Rome I, Italy

6:00 PM - 7:20 PM

CONCURRENT SESSIONS

CP13/Wasatch Room

Delay Equations

Chair: Jacques Bélair, Université de Montréal, Canada

6:00 **Periodic Solutions of Differential Delay Systems**
Anatoli Fedorovich Ivanov, Ukrainian Academy of Sciences, Ukraine, and Universität Munchen, Germany

6:20 **Stability in a Delay-Differential Equation Modeling a System of Two Negative Feedback Loops**
Jacques Bélair, Université de Montréal, Canada and McGill University, Canada

6:40 **Non-Existence of Small Solutions for Scalar Differential Delay Equations**
Yulin Cao, University of Georgia

CP14/Superior B Room

Fractals and Invariant Measures

Chair: John C. Sommerer, The Johns Hopkins University

6:00 **A Fast $O(N)$ and Memory Efficient Algorithm for Box Counting**
Gerald R. Chachere, Howard University

6:20 **A Physical Fractal with a Pedigree**
John C. Sommerer, The Johns Hopkins University and Edward Ott, University of Maryland, College Park

6:40 **Approximating the Invariant Measures of Finite Dimensional Maps**
Fern Hunt, National Institute of Standards and Technology

7:00 **The Singularity Spectrum of Self--Affine Fractals with a Bernoulli Measure**
Jorg Schmeling and Rainer Siegmund-Schultze, Institute for Applied Analysis and Stochastics, Germany

CP15/Maybird Room

Homoclinic Orbits and Chaos 1

Chair: Sue Ann Campbell, Université de Montréal, Canada

6:00 **Application of Melnikov's Method to an Aeroelastic Oscillator**
Oded Gottlieb, Massachusetts Institute of Technology and Ronald B. Guenther, Oregon State University

6:20 **A Structurally Stable Double Pulse Heteroclinic Orbit**
Sue Ann Campbell, Université de Montréal, Canada

6:40 **Mel'nikov Analysis of Some Homoclinic-Heteroclinic Bifurcations of a Nonlinear Oscillator**
Mark Francis Dabbs and Peter Smith, Keele University, United Kingdom

7:00 **The Existence of Homoclinic Solutions for Autonomous Dynamical Systems in Arbitrary Dimension**
Joseph R. Gruendler, North Carolina A&T State University

8:00/Ballroom 1&2

Business Meeting

SIAM Activity Group on Dynamical Systems

SATURDAY MORNING, OCTOBER 17

7:30/Ballroom Foyer

Registration opens

8:30/Ballroom 1&2

IP7/Chair: William L. Kath, Northwestern University

Dynamical Systems Problems for the Superconducting Super Collider

Beam dynamics at the super-collider presents a challenging class of theoretical problems in dynamical systems. The central issue to understand is particle stability for roughly 10^8 revolutions around the 87 Km machine. A basic model is the single particle dynamics governed by a one-revolution 6D sympletic map composed of the 10,000 magnetic elements, or one of several Hamiltonian flow approximations to this map. Other effects are included perturbatively. Thus mathematically it is important to understand the stability of this map, the stability of its approximate flows and the effect of perturbations.

The speaker will review the status of stability investigations and the associated slow particle loss problem, discuss ensemble evolution and perturbative effects such as synchroton radiation (based on the Lorentz-Dirac Equation) and noise in the RF cavity. The latter involves a stochastic theory of adiabatic invariants and weak convergence techniques.

James A. Ellison
Department of Mathematics and Statistics
University of New Mexico, Albuquerque and SSCL, Waxahachie, TX

9:30/Golden Cliff Room

Coffee

10:00 AM - 12:00 PM

CONCURRENT SESSIONS

MS15/Magpie Room

Invariant Manifolds

In the study of dynamical systems, the theory of invariant manifolds has proven to be a fundamental and useful idea. In this minisymposium, the speakers will discuss center manifolds for reaction-diffusion equations with time delays, the existence of invariant tori for Hamiltonian systems and applications of invariant manifolds in mathematical physics.

Organizer: Kening Lu
Brigham Young University

10:00 **Stable Manifolds and Nonlinear PDEs**
Russell Johnson, Università di Firenze, Italy and University of Southern California, Yingfei Yi, Georgia Institute of Technology and Xing-Bin Pan, Zhenjiang University, People's Republic of China

10:30 **Centre Manifolds for Reaction Diffusion Equations with Time Delays**
Joseph W.-H. So, University of Alberta, Canada

11:00 **The Existence of Invariant Tori for a Class of Hamiltonian System**
Zhihong Xia, Georgia Institute of Technology

11:30 **Invariant Helical Subspaces for the 3-D Navier-Stokes Equations**
Sidney Leibovich, Cornell University; Alex Mahalov, Arizona State University; and *Edriss Titi,* University of California, Irvine and Cornell University

MS16/Ballroom 1&2

Nonlinear Optics and Hamiltonian Systems

Hamiltonian and conservative systems arise frequently in nonlinear optics, due to the low intrinsic loss rates which can be achieved in optical systems (e.g., in optical fibers). The use of dynamical systems techniques has led to new insights into the behavior occurring in such applications. This minisymposium will be comprised of presentations that illustrate how these techniques (including Hamiltonian and integrable systems methods, stability and bifurcation theory, and stochastic processes) are currently being utilized to study the dynamics of light in nonlinear optical systems.

Organizer: William L. Kath
Northwestern University

10:00 **Class B Laser Oscillations**
Thomas Erneux, Northwestern University

10:30 **Soliton Robustness and Hamiltonian Deformations in Optical Fibers**
Curtis Menyuk, University of Maryland, Baltimore County

11:00 **An Unstable Modulation Theory and Optical Oscillations**
David Muraki, Princeton University

11:30 **Polarization Decorrelation in Randomly Birefringent Nonlinear Optical Fibers**
Tetsuji Ueda, Los Alamos National Laboratory

MS17/Wasatch Room

The Dynamics for Patterns in Excitable Media

The speakers in this minisymposium will present recent results in the analytical, numerical, and experimental investigation of waves in two and three dimensional excitable media.

Organizer: James P. Keener
University of Utah

10:00 **Defects, Spirals and Fibrillation**
E. Meron, University of Arizona

10:30 **Scroll Waves in Excitable Media**
John J. Tyson, Virginia Polytechnic Institute and State University

11:00 **Behavior of Vortex Filaments in Three-Dimensional Excitable Media: Results of Some Numerical Simulations**
Chris Henze, University of Arizona

11:30 **Dynamics of Organizing Centers in Excitable Chemical and Biological Media**
Arkady M. Pertsov and Jose Jalife, State University of New York Health Sciences Center, and Michael Vinson, Syracuse University

MS18/Maybird Room
(This session will run until 12:30 PM.)

Dynamics of Mechanical Systems

The speakers in the minisymposium will concentrate on various aspects of geometrical methods in mechanics. *(Note: The following talk titles are tentative).*

Organizer: Mark Levi
Rensselaer Polytechnic Institute

10:00 **Some Homoclinic Phenomena in Slowly Varying Hamiltonian Systems**
Tasso Kaper, Brown University

10:30 **The Resonance Phenomena in Hamiltonian Systems**
Gregor Kovacic, Rensselaer Polytechnic Institute

11:00 **An Overview of Random Behavior in Celestial Mechanics**
Richard Moeckel, University of Minnesota

11:30 **Ergodic Behavior in Mechanics of Colliding Particles**
Maciej Wojtkowski, University of Arizona, Tuscon

12:00 **Geometrical Ideas in Mechanics of Flexible Space Structures**
Mark Levi, Organizer

CP16/Superior A Room

Control of Dynamical Systems

Chair: Bijoy Kumar Ghosh, Washington University

10:00 **Analysis of a Method for Tracking Unstable Orbits in Experiments**
Ira B. Schwartz, and *Ioana Triandaf,* Naval Research Laboratory, Washington, DC

10:20 **A Perspective Systems Approach to Problems in Computer Vision**
Bijoy Kumar Ghosh, Washington University

10:40 **Using the Butterfly Effect to Direct Orbits to Targets in Chaotic Systems**
Troy Shinbrot, University of Maryland, College Park

11:00 **Model-based Control of Nonlinear Systems**
Joseph L. Breeden and Norman H. Packard, University of Illinois, Urbana

11:20 **PD High-Gain Natural Tracking Control of Time-Invariant Systems Described by IO Vector Differential Equations**
William Pratt Mounfield, Jr., Louisiana State University, Baton Rouge and Ljubomir T. Grujic, University of Belgrade, Yugoslavia

11:40 **Dynamics and Control of a Flexible Beam**
Eric H.K. Fung, Hong Kong Polytechnic, Hong Kong

CP17/Superior B Room

Fluids 1

Chair: David Wollkind, Washington State University

10:00 **Bifurcation Analysis of Turbulent Mixing Effects in the Chlorite-Iodide Reaction**
Rodney O. Fox and Gholam Erjaee, Kansas State University

10:20 **Roads to Turbulence in Dissipative Dynamical Systems: Amplitude Modulation as a New Road**
Slobodan R. Sipcic and Alan Russo, Boston University

10:40 **A Nonlinear Stability Analysis of a Unified Aerosol Model for Thin Layer Rayleigh-Benard Convection**
David J. Wollkind, Washington State University

11:00 **Flow-induced Liquid Crystallization and Pattern Formation in Suspensions**
Andrew J. Szeri, University of California, Irvine

11:20 **Navier-Stokes Equations**
G. Adomian, Athens, GA

11:40 **Chaotic Behavior of Convective Motions in the Solar Atmosphere**
A. Hanslmeier, Universität Graz, Austria and A. Nesis, Kiepenheuer Institüt für Sonnenphysik, Germany

SATURDAY AFTERNOON, OCTOBER 17

12:00
Lunch

1:30/Ballroom 1&2
IP8/Chair: Paul Fife, University of Utah

Bifurcations and Traveling Waves in a Delayed Partial Differential Equation

The speaker will discuss cell population dynamics in which there is simultaneous proliferation and maturation. The mathematical model is a nonlinear first order partial differential equation for the cell density in which there is retardation in both temporal and maturation variables, and depends on three parameters. For strictly positive initial functions, there are three homogeneous solutions of biological importance: a trivial solution, a positive stationary solution, and a time periodic solution. For zero initial conditions, there are a number of different solution types depending on the theory parameters: the trivial solution, a spatially inhomogeneous stationary solution, a spatially homogeneous singular solution, a traveling wave solution, slow traveling waves and slow traveling chaotic waves. The speaker will delineate the regions of parameter space in which these solutions exist and are locally stable, and present some numerical results.

Michael C. Mackey
Departments of Physiology, Physics and Mathematics and Centre for Nonlinear Dynamics in Physiology and Medicine
McGill University, Canada

2:30 PM - 4:30 PM

CONCURRENT SESSIONS

MS19/Ballrom 1&2

Dynamics of Infinite-Dimensional Problems

The speakers in this minisymposium will discuss existence of global attractors for locally damped wave equations, connections with stabilization and complete controllability and applications in thin domains. They will also discuss lower and upper semicontinuity of attractors for continuous and discrete flows, structural stability of flows, effects of shape of domain on dynamics in PDEs, existence of rotating waves on a thin annulus, and convergence to equilibrium solutions.

Organizer: Shui-Nee Chow
Georgia Institute of Technology

2:30 **Limits of Semigroups Depending on Parameters**
Jack K. Hale, Georgia Institute of Technology

3:30 **Attractors for Locally Damped Hyperbolic Equations**
Genevieve Raugel, Université Paris-Sud, France

MS20/Magpie Room

Nonlinear Optics

Nonlinear optics is a highly diversified research field, strongly driven by the needs of modern technology. It offers the applied mathematician a marvelously rich and varied set of mathematical challenges. Perhaps best known are the problems of soliton propagation in optical fibers and the chaotic dynamics of a single-mode homogeneously broadened ring laser. However, optics offer much more to the applied mathematician.

The theme of this minisymposium is localized nonlinear structures and spontaneous pattern formation in passive and active nonlinear optical systems. Where appropriate, analogies will be made with other physical systems such as convection of fluids. The goal is to introduce problems of great current interest which are just entering the nonlinear optics mainstream. Emphasis will be placed on nonlinear pde's which arise either as initial or initial/boundary value problems. The role of imposed or nonlinearly induced spatial gratings on an optical wavelength scale, when optical waves counterpropagate in a nonlinear medium will be highlighted.

Organizer: Jerome V. Moloney
University of Arizona

2:30 **Instabilities of Counterpropagating Light Waves in Kerr and Brillouin Media**
Colin J. McKinstrie, University of Rochester

3:00 **Dynamics of Light Pulses in Periodic Structures**
Alejandro Aceves, University of New Mexico

3:30 **Spontaneous Pattern Formation in Wide Gain Section Lasers**
Jerome V. Moloney, Organizer

4:00 **Localized States in Fluid Convection and Multi-Photon Lasers**
James A Powell, Utah State University

MS21/Wasatch Room

Neural Networks

Many scientists are now studying how the brain works and how ideas about biological intelligence can be used to solve difficult technological problems, notably problems concerning autonomous adaptive behavior in response to a nonstationary world. Neural network models are typically defined by nonlinear dynamical systems of high dimension which include multiple spatial and temporal scales. They embody many new computational ideas for solving problems in image processing, speech and language understanding, pattern recognition, nonstationary prediction, adaptive control, statistical estimation, and hypothesis testing.

The speakers in this minisymposium will describe recent results about models of learning, pattern recognition, prediction, and control.

Organizer: Stephen Grossberg
Boston University

2:30 **Saturation of Outputs for Positive Feedback Networks at High Gain**
Morris W. Hirsch, University of California, Berkeley

3:10 **Learning, Pattern Recognition, and Prediction by Self-Organizing Neural Networks**
Gail A. Carpenter, Boston University and *Stephen Grossberg*, Organizer

3:50 **Neural Networks in Control Systems**
Kumpati S. Narendra, Yale University

CP18/Maybird Room

Computational Dynamical Systems 1

Chair: Debra Lewis, University of California, Santa Cruz

2:30 **Bifurcations from Symmetric Relative Equilibria**
Debra Lewis, University of California, Santa Cruz

2:50 **Conley Decomposition for Fixed Bounds on Pseudo-Orbit Deviations from True Orbits**
Douglas E. Norton, Villanova University

3:10 **An Extended System with Determined Auxiliary Vectors for Locating Simple Bifurcation Points**
Yun-Qiu Shen, Western Washington University

3:30 **Computer Generation of Symmetric Patterns**
David Kwok-wai Chung, City Polytechnic of Hong Kong, Hong Kong

CP19/Superior A Room

Physical Applications 1

Chair: Celso Grebogi, University of Maryland, College Park

2:30 **Algebraic Decay and Phase-Space Metamorphoses in Microwave Ionization of Hydrogen Rydberg Atoms**
Ying-Cheng Lai and Celso Grebogi, University of Maryland, College Park; Reinhold Blumel, University of Delaware; and Mingzhou Ding, Florida Atlantic University

2:50 **Hamiltonian Dynamical Analysis of A Basic Two-Wave Interaction in Plasma Physics**
Mark Buchanan and John J. Dorning, University of Virginia

3:10 **Tori and Chaos in a Nonlinear Dynamo Model for Solar Activity**
Ulrike Feudel, Max-Planck-Gesellschaft an der Universität Potsdam, Germany

3:30 **Thermodynamics of Dissipative Systems**
Victor Berdichevsky, Georgia Institute of Technology

3:50 **Permanence of Stochasticity Thresholds in KAM Systems**
A. Scotti and F. Zanzucchi, Università di Parma, Italy

4:10 **Control of Turbulence and Transport in the Small Tokamak TBR--1**
Ibere Luiz Caldas, Maria Vittoria A.P. Heller, Raul M. Castro, Ruy P. da Silva, Zoezer A. Brasilio, University of Sao Paulo, Brasil

CP20/Superior B Room

Fluids 2

Chair: To be announced

2:30 **Pattern Selection in Rotating Raleigh-Bénard Convection in a Finite Cylinder**
H.F. Goldstein and E. Knobloch, University of California, Berkeley; I. Mercader and M. Net, Universidad Politecnica de Catalunya, Spain

2:50 **Three-Dimensional Oscillations of a Fluid Conveying Tube with Discrete Symmetries**
Alois Steindl and Hans Troger, Technical University Vienna, Austria

3:10 **Solitons on a Vortex Filament with Axial Flow**
Kimiaki Konno, Nihon University, Japan and Yoshi H. Ichikawa, National Institute for Fusion Science, Japan

3:30 **A Package for Determining Pattern Selection in Convecting Systems**
Thomas Clune, University of California, Berkeley

3:50 **Lyapunov Exponents for Hydromagnetic Convection**
Jurgen Kurths, Max-Planck-Gesellschaft an der Universität Potsdam, Germany

4:10 **Atmosphere-Ocean Models with Quasiperiodic or Stochastic Forcing**
John Brindley, University of Leeds, United Kingdom and Albert Barcilon, Florida State University

4:30/Golden Cliff Room

Coffee

5:00/Ballroom 1&2

IP9/Chair: James Keener, University of Utah

Chaos and Fractals in Physiology and Medicine

Healthy systems in physiology and medicine are remarkable for their structural and dynamical complexity. The concept of fractal growth and form offers novel approaches to understanding morphogenesis from the level of the gene to the organism. Scale-invariance and long-range power law correlations, markers of phenomena having a self-similar or fractal origin, are also features of healthy physiological processes, such as regulation of the heartbeat. The complex variability exhibited by such systems and its relation to deterministic chaos is under active investigation. Perturbation of healthy systems by diseases, drug toxicity or aging most often leads to a loss of complexity or shorter-range correlations. Nonlinear dynamics provides new ways of quantifying both healthy variability and the pathologic loss of complexity, and is providing new methods of bedside monitoring, including the prevention of sudden cardiac death.

Ary L. Goldberger
Harvard Medical School and
Beth Israel Hospital, Boston

SATURDAY EVENING, OCTOBER 17

7:30-9:30/Golden Cliff Room and Ballroom Foyer

Poster Session

Complimentary Beer/Soda/Chips

Simulation of Sustained Reaction-Diffusion Oscillations on a Massively Parallel Computer
William A. Hogan, MasPar Computer Corporation, Sunnyvale, CA and Robert F. Stetson, Florida Atlantic University

Amplitude Expansions for Instabilities in Populations of Globally-Coupled Oscillators
John David Crawford, University of Pittsburgh and Steven Strogatz, Massachusetts Institute of Technology

A Fractal Model of Diffusion in Extracellular Space (ECS) of the CNS
Thomas A. Sipes and Martin P. Paulus, University of California, San Diego

Assessing Complexity in Biological Data Sets
Martin P. Paulus, University of California, San Diego

A Slightly Nonlinear Stability Model for Driven, Dissipative Magnetohydrodynamic Systems
Wilbur F. Pierce IV, University of Washington

Bifurcation Structures of Minimal ODEs from Weighted Sobolev Projections of PDEs
Emily Stone and Michael Kirby, Colorado State University

Effect of Actuator Positions on the Performance of Ground Vehicle Systems
Faleh Al-Sulaiman and *Sadaruz Zaman,* King Fahd University of Petroleum and Minerals, Saudi Arabia

On the Characterization of Turbulence as Spatio-Temporal Chaos
Jerry F. Magnan and P.K. Jay Kumar, Florida State University

On the Fractal Nature of Human Heart Rate Variability and the Effect of Sympathetic Blockade
Yoshiharu Yamamoto and Richard L. Hughson, University of Waterloo, Canada

Parasympathetic Blockade Reduces Dynamic Complexity of Heart Rate Variability
Yoshio Nakamura, Waseda University, Japan; Yoshiharu Yamamoto, University of Waterloo, Canada; Hiroshi Sato, Machiko Yamamoto and Kazuzo Kato, The Cardiovascular Institute, Japan

Silnikov-Hopf Birfucation
Philip Hirschberg and E. Knobloch, University of California, Berkeley

Scaling in an Electroencephalogram
John E. Erdei and Elaine M. Brunsman, University of Dayton and Albert F. Badeau, Armstrong Laboratory, Wright Patterson Air Force Base

A Lax Pair for the Three-Wave Interaction of Four Waves
Filipe J. Romeiras, Instituto Superior Tecnico, Portugal

Hemapoietic Models with Delays
Joseph M. Mahaffy, San Diego State University

On Nonlinear Normal Modes: Geometrical Concepts and Computational Techniques
Jose Manoel Balthazar, Universidade Estadual Paulista, Brasil and Mario Francisco Mucheroni, Universidade Sao Paulo, Brasil

An Investigation of Transverse Effects in the Dynamics of Solid State Laser Systems
Lila F. Roberts, Georgia Southern University

Evolution of 2-D Instabilities in Circular Shear Layers
Keith Bergeron and E.A. Coutsias, University of New Mexico, Albuquerque and J.P. Lynov, Riso National Laboratory, Denmark

Arnold Sausages for the Sawtooth Circle Map
David J. Uherka, University of North Dakota, Grand Forks and David K. Campbell, Los Alamos National Laboratory

A Study of an Algorithm Using a Posteriori Error for Adaptive IIR Filters
Guoliang Zeng, Arizona State University

Lie Symmetries for Three-Dimensional Models
Ildeu de Castro Moreira and Maria Antonieta de Almeida, Universidade Federal do Rio de Janeiro, Brasil

Numerical Study of Separatrix Breaking of Adiabatic Invariants
A.R. Champneys, University of Bath, United Kingdom and P.G. Hjorth, The Technical University of Denmark, Denmark

Helicity in Hamiltonian Dynamical Systems
P.G. Hjorth, The Technical University of Denmark, Denmark; and M.E. Glinsky, Lawrence Livermore National Laboratory, Livermore CA

Bifurcations and Stability of Motions of One Mechanical System
Tatiana A. Dobrinskaya, North-Western Polytechnical Institute of St. Petersburg, Russia

Fractal Structures on the Viscous Fluid Surface
Sergei A. Chivilikhin, "Quarz" Corporation, St. Petersburg, Russia

Classification of Heteroclinic Ω-Explosion
Kazuyuki Aihara, and *Shin Kiriki,* Tokyo Denki University, Japan

On the Dynamics of Some Endomorphisms of the Plane
Indur Mandhyan, Philips Laboratories, Briarcliff Manor, NY

Nonlinear Oscillation and Chaos in Backward Four Wave Mixing
J. Li and C.J. McKinstrie, Laboratory for Laser Energetics, Rochester, NY

Invariant Manifolds in Homogeneous Chemical Kinetics
Simon J. Fraser,and Marc R. Roussel, University of Toronto, Canada

Chaotic Behavior in a "Prey-Predator" Model
Gregori Markman, Rostov State University, Russia

Motion of Energy Eigenvalue Levels
W.-H. Steeb, Rand Afrikaans University, South Africa

Minimum Energy Optimal Control for Linear Time-invariant Discrete-time Systems
Ala Al-Humadi, Embry-Riddle Aeronautical University

SUNDAY MORNING, OCTOBER 18

7:30

Buses leave for Salt Lake City tour and Mormon Temple

Cliff Lodge

SUNDAY AFTERNOON, OCTOBER 18

12:00

Buses return from tour

12:00/Ballroom Foyer

Registration opens

12:30-3:00

MS22/Ballroom 1&2

Inertial Manifolds and Low Dimensional Dynamics of PDEs (Part 1 of 2)

The spatiotemporal complexity of the dynamic behavior of nonlinear PDEs (and the physical systems they model) is often found to be low-dimensional, and can thus, in principle, be described by "small" sets of ODEs. Large classes of physical systems, ranging from combustion to transitional flows to nonlinear optics, fall under this category in realistic parameter regimes. Theory and computation have come together in an attempt to establish and then exploit the low-dimensional nature of the dynamics for modeling, simulation and control purposes.

The speakers in this minisymposium will present methods, algorithms and examples of this model reduction approach to spatiotemporal dynamics. They will discuss rigorous and "experimental" approaches: the theory of Inertial Manifolds, implementations of Approximate Inertial Manifolds, the Karhunen-Loeve expansion, and their interplay with modern scientific computing. The speakers will stress applications and illustrations using relevant physical models.

Organizers: Yannis Kevrekidis, Princeton University, and Edriss S. Titi, University of California, Irvine

12:30 **Title to be announced**
George Sell, University of Minnesota

1:00 **The Meaning of Different Length Scales in Turbulent Flows**
John D. Gibbon, Imperial College, United Kingdom

1:30 **On Wavelet Projections of an Evolution Equation**
Philip Holmes, Cornell University

2:00 **Dynamical Systems Reduction Approaches**
Nadine Aubry and Wenyu Lian, Levich Institute, City College of the City University of New York

2:30 **Low and Not so Low Dynamical Models**
Lawrence Sirovich, Brown University

1:00 PM - 3:00 PM

CONCURRENT SESSIONS

MS23/Magpie Room

Application of Dynamical Systems to Information Theory

Ideas originating in Shannon's work in information theory have arisen somewhat independently in a mathematical discipline called topological dynamics. On one hand, Shannon devised notions of entropy and channel capacity to determine the amount of information that can be transmitted through a channel. However, the question remains as how to actually do it. On the other hand, the notion of topological entropy, which turns out to be a generalization of noiseless channel capacity, was introduced to topological dynamics as an isomorphism invariant. The resulting isomorphism theory can be applied to construct finite state automata which can essentially achieve maximum channel capacity. In this mini-symposium we discuss these developments.

Organizer: Roy L. Adler
IBM Thomas J. Watson Research Center

1:00 **Application of Symbolic Dynamics to Data Storage and Transmission**
Roy L. Adler, Organizer

2:00 **Overview of the Isomorphism Theory of Symbolic Dynamics**
Jonathon Ashley, IBM Almaden Research Center

MS24/Wasatch Room

Computer Techniques for the Numerical Study of Dynamical Systems

Numerical studies are fundamental to advancement in dynamics. The speakers will address three main current research areas in which computer experiments play a major role.

Organizer: Celso Grebogi
University of Maryland, College Park

1:00 **Higher Dimensional Targeting**
Eric Kostelich, Arizona State University

1:40 **Noise Reduction for Signals from Nonlinear Systems**
Timothy Sauer, George Mason University

2:20 **When Trajectories of Higher Dimensional Systems Cannot be Shadowed**
James A. Yorke, University of Maryland, College Park

MS25/Maybird Room

Bursting Oscillations in Biological Systems

Bursting oscillations arise in a variety of biological systems including models for electrical activity in pancreatic β cells. These oscillations consist of slow alternations between a silent phase of near steady state behavior and an active phase of rapid spike-like oscillations. Numerous models have been developed to test different hypotheses for the biophysical mechanisms that underlie the bursting behavior. Methods currently being used to analyze these models include recent geometric methods from the theory of dynamical systems and singular perturbation techniques. The speakers in this minisymposium will discuss models for several bursting systems and their analysis.

Organizer: David H. Terman
Ohio State University, Columbus, and John Rinzel,
National Institutes of Health

1:00 **Bursting Oscillations and Slow Passage Through Bifurcation Points**
Thomas Erneux, Northwestern University and Lisa Holden, Kalamazoo College

1:30 **Plateau Fractions for Models of Pancreatic β Cells**
Robert Miura, University of British Columbia, Canada

2:00 **Complex Oscillations in Insulin-Secreting Cells: On Beyond Bursting**
Arthur Sherman, National Institutes of Health

2:30 **Bursting Oscillations and Homoclinic Orbits to a Chaotic Saddle**
Xing-Jing Wang, University of Chicago

CP21/Superior A Room

Physical Applications 2

Chair: Stephen B. Margolis, Sandia National Laboratories, Livermore, CA

1:00 **A Dynamical Systems Approach to the Stability of Geophysical Features**
Sue Ellen Haupt, University of Colorado, Boulder

1:20 **Nonlinear Dynamics of Complex Two-Phase-Flow Systems: Heat Exchangers and Nuclear Reactors**
Rizwan-uddin and John J. Dorning, University of Virginia

1:40 **Some Connections Between Localization in Plasticity and in Combustion**
T.J. Burns, National Institute of Standards and Technology

2:00 **Quasiperiodicity and Chaos in a Dynamical System of Amplitude Equations Describing Gasless Combustion**
Stephen B. Margolis, Sandia National Laboratories, Livermore, CA

2:20 **Multi-Dimensional Acoustic Analysis of A Solid Propellant Rocket Motor**
Mohammad Farshchi and Mehdi Golafshani, Sharif University of Technology, Iran

2:40 **One-Dimensional Flow Analysis of a Solid Propellant Rocket Motor**
Mehdi Golafshani and Mohammad Farshchi, Sharif University of Technology, Iran

CP22/Superior B Room

Homoclinic Orbits and Chaos 2

Chair: Edgar Knobloch, University of California, Berkeley

1:00 **Horseshoe Maps with Sinks Near Homoclinic Tangencies**
Thomas L. Richards, University of North Dakota, Grand Forks

1:20 **An Analogue to the Birkhoff-Smale Homoclinic Theorem for Snapback Repellers of Entire Mappings**
Franz Rothe, University of North Carolina, Charlotte

1:40 **Transition to Chaotic Travelling Waves via a New Type of Global Bifurcation**
Edgar Knobloch, University of California, Berkeley and D.R. Moore, Imperial College, United Kingdom

2:00 **A Novel Homoclinic Bifurcation in a Hamiltonian System**
Alan R. Champneys, Alastair Spence and John F. Toland, University of Bath, United Kingdom

2:20 **Infinitely Many Sinks for a Singular Map**
David T. Closky, College of Mount St. Joseph

2:40 **Dynamical Behaviors in Kolmogrov Models**
Fude Cheng, Hubei Normal Institute, People's Republic of China

3:00/Golden Cliff Room

Coffee

3:30/Ballroom 1&2

IP10/Chair: James Yorke, University of Maryland, College Park

Stationary and Turbulent Patterns in a Reaction-Diffusion System

Experiments have been conducted on a quasi-two-dimensional open chemical reactor that can be maintained indefinitely in well-defined nonequilibrium states by feeding fresh chemicals from reservoirs. Bifurcations from a uniform (nonpatterned) state to different patterns (hexagons, stripes, and a mixed state) were observed as a function of different control parameters. A further change in bifurcation parameter led to a supercritical transition from a hexagonal pattern to "chemical turbulence", which is marked by a continuous motion of the pattern within a domain and of the grain boundaries between domains. The transition from hexagons to turbulence was accompanied by a large increase in the defects in the pattern, which suggests that this is an example of defect-mediated turbulence. The speaker will discuss these results and their implications

Harry L. Swinney
Center for Nonlinear Dynamics
University of Texas, Austin

4:30/Ballroom 1&2

IP11/Chair: E. Norman Dancer, Brigham Young University

Symmetric Chaos

Typically, dynamical systems with symmetry exhibit kinds of bifurcation that are different from those observed in systems without symmetry. For example, bifurcation of steady states and periodic solutions often leads to high multiplicity of such states and the breaking of symmetry. From this perspective, one expects the complexity of dynamics to increase and the amount of symmetry of an asymptotic state to decrease as parameters are varied. What is less well known is that once the dynamics of symmetric systems is chaotic, there is a trend towards the increase in symmetry of asymptotic states through collisions of conjugate attractors. This increased symmetry can be observed in systems of differential equations using time averages.

The speaker will present an overview of recent joint work with Michael Dellnitz, Mike Field and Ian Melbourne on symmetry increasing bifurcations and will discuss a number of examples from the iteration of symmetric maps to the dynamics of reaction diffusion equations.

Martin Golubitsky
Department of Mathematics
University of Houston

SUNDAY EVENING, OCTOBER 18

7:30 PM - 9:30 PM

CONCURRENT SESSIONS

MS26/Ballroom 1&2

Inertial Manifolds and Low Dimensional Dynamics of PDEs (Part 2 of 2)

(For Description, See MS 22, page 14)

Organizers: Yannis Kevrekidis, Princeton University, and Edriss S. Titi, University of California, Irvine

7:30 **Numerical Schemes Based on the Algebraic Approximation of the Attractors**
Ciprian Foias, Indiana University, Bloomington

8:00 **Inertial Sets and Exponential Attractors for Navier-Stokes Flows**
Basil Nicolaenko and Alp Eden, Arizona State University; Ciprian Foias, and Roger Temam, Indiana University, Bloomington

8:30 **Spatiotemporal Behavior of Approximate Inertial Forms for the 2-D Navier-Stokes Equation**
Michael S. Jolly, Indiana University, Bloomington

9:00 **Numerical Study of Dynamics and Symmetry Breaking in the Wake of a Circular Cylinder**
Dwight Barkley, Princeton University

MS27/Magpie Room

Signal Processing and Chaos (Part 1 of 2)

Nonlinear dynamics research has introduced several new data processing techniques as well as techniques for the study of novel behavior in dynamical systems (e.g. chaos). Several of these techniques have been developed to the point that they have application to signal processing, especially as applied to chaotic signals. The speakers will present a full spectrum of applications from software techniques for signal processing to full hardware implementation of dynamical behaviors that would be useful in communications and control.

Organizer: Louis M. Pecora, Naval Research Laboratory, Washington, DC

7:30 **Processing Filtered Chaotic Signals**
Steve Isabelle, Massachusetts Institute of Technology

8:00 **Modeling Chaotic Systems with Hidden Markov Models**
Cory Meyers, Lockheed/Sanders, Nashua, NH

8:30 **Determining Robust Dynamical Maps From Observed Time Series**
Reginald Brown, University of California, San Diego

9:00 **Determining Minimum Embedding Dimension and Local Dimension**
Matthew Kennell, University of California, San Diego

MS28/Wasatch Room

Qualitative Results for Partial Differential Equations

This minisymposium focuses on qualitative results on solutions of nonlinear partial differential equations relevant in applications. On the one side there are detailed results concerning particular solutions of the Cahn-Hilliard equation. On the other side, assertions of a general character on the asymptotics for continuous-time and discrete-time infinite-dimensional dynamical systems stemming from parabolic and elliptic equations are given. Of particular interest is the fact that in all these considerations a wide range of mathematical tools, from a-priori estimates to general principles in functional analysis, are used.

Organizers: E. Norman Dancer and Peter Hess, Brigham Young University

7:30 **Nucleating Solutions for the Cahn-Hilliard Equation in Higher Space Dimension**
Giorgio Fusco, University of Rome II, Italy

8:00 **Equilibrium and Dynamics of Bubbles for the Cahn-Hilliard Equation**
Nicholas D. Alikakos, University of Tennessee and University of Crete, Greece

8:30 **Large-Time Behavior of Monotone Discrete-Time Dynamical Systems**
Peter Takac, Vanderbilt University

9:00 **Structural Stability of Global Attractors for Partial Differential Equations of Dissipative Type**
XuYan Chen, Georgia Institute of Technology

MS29/Maybird Room

The Numerical Treatment of PDEs with Symmetry

Partial differential equations frequently possess symmetry which is related to the geometry of the spatial domain, the type of boundary conditions or the algebraic structure of the equation itself. Also they may show spatio-temporally complex processes, for instance a chaotic behavior. Recently Galerkin approximations based on proper orthogonal decompositions (PODs) of solutions have successfully been used in PDEs with symmetry in order to analyze this type of behavior numerically. We will essentially focus on two aspects: Modifications of the POD itself and how to make use of it in the numerical investigation concerning the interaction of dynamics and symmetry.

Organizer: Michael Dellnitz, Universität Hamburg, Germany

7:30 **From Partial Differential Equations to Minimal Dynamical Systems**
Michael Kirby, Colorado State University, Fort Collins

8:00 **Detecting Symmetry Creation in PDEs**
Ernest Barany, University of Houston, *Michael Dellnitz*, Organizer, and Martin Golubitsky, University of Houston

8:30 **The Use of Symmetries in Dynamical Systems**
Nadine Aubry and Zhen-Su Cao, City College of the City University of New York and Ricardo Lima, City College of the City University of New York and Centre National de la Recherche Scientifique, France

9:00 **Non-Linear Extensions to the POD and Systems with Symmetry**
Gal Berkooz, Cornell University

CP23/Superior B Room

Biological Applications 1

Chair: John Dorning, University of Virginia

7:30 **Physical Modelling of the Human Circulatory System for Cardiovascular Device Testing**
M. Keith Sharp, University of Utah

7:50 **Dynamics of the Calcium Subsystem in Cardiac Cells**
Anthony Varghese, University of Minnesota, Minneapolis; Raimond L. Winslow, Johns Hopkins University; and James E. Holte, University of Minnesota, Minneapolis

8:10 **A Simple ODE Model for the Nonlinear Dynamics of the Heart Sinus Node**
John J. Dorning and *Rizwan-uddin*, University of Virginia

8:30 **A Transplanted Human Heart as a Deterministic Nonlinear Dynamical System**
David F. Scollan, John J. Dorning, Rizwan-uddin and J. Randall Moorman, University of Virginia

8:50 **A Coupled Oscillator Model for the Dynamics of a Transplanted Human Heart**
John J. Dorning, Rizwan-uddin, David F. Scollan and J. Randall Moorman, University of Virginia

9:10 **Investigations on a Model of Neuronal Bursting**
T.I. Toth, University of Wales College of Cardiff, United Kingdom

CP24/Superior A Room

Physical Applications 3

Chair: M.S. El Naschie, Cornell University

7:30 **Some Applications of Peano Dynamics in Classical and Quantum Mechanics**
M.S. El Naschie, Cornell University

7:50 **Dealing with Multiple Objectives in an Econometric Model**
H.A. Eiselt, University of New Brunswick, Canada and C.-L. Sandblom, Technical University of Nova Scotia, Canada

8:10 **Chaotic Phenomena in Communication Networks**
Ashok Erramilli and Leonard Forys, Bell Communications Research, Red Bank, NJ

8:30 **Physically Realizable Polynomial Systems**
Anatoly P. Torokhty, St. Petersburg Institute of Transportation Engineering, Russia

8:50 **Stable and Unstable Quasiperiodic Oscillations in Robot Dynamics with Delay**
Gabor Stepan, Technical University of Budapest, Hungary and G. Haller, California Institute of Technology

9:10 **Dynamics of Flexible Manipulators**
Ali Meghdari and Mani Ghassempouri, Sharif University of Technology, Iran

MONDAY MORNING, OCTOBER 19

8:00/Ballroom Foyer

Registration opens

8:30/Ballroom 1&2

IP12/Chair: Darryl D. Holm, Los Alamos National Laboratory

Stability, Instability and Bifurcation by the Energy-Momentum Method

The energy momentum method and especially its block diagonalization properties has proven very effective for stability analysis of mechanical systems, including fluids and plasmas. However, when a bifurcation and symmetry change occurs, the method requires modification. The speaker will present a blowing up, or regularization procedure for such cases. He will illustrate the procedure with the double spherical pendulum in which one sees non-generic eigenvalue movement and discuss the role of small dissipation, which can be stabilizing or destabilizing.

Jerrold E. Marsden
Department of Mathematics
University of California, Berkeley

9:30/Golden Cliff Room

Coffee

10:00/Ballroom Foyer

Registration desk closes

10:00 AM - 12:00 PM

CONCURRENT SESSIONS

MS30/Magpie Room

New Methods of Embedding and Analysis for Noisy Chaotic Data

Time series produced in an experiment where an underlying low-dimensional dynamical system governs the output will be contaminated with noise. Moreover, complex systems sometimes can be described approximately by low-dimensional models. Indeed it may be that some very irregular data seen in field observations or in biological systems, are reasonably represented as low-dimensional, but noisy chaos.

The speakers in this minisymposium will present some new mathematical methods of scalar time series embedding, geometric noise reduction, and chaotic data analysis being developed to uncover and analyze experimental and field data produced by such systems.

Organizer: Robert Cawley
Naval Surface Warfare Center,
Silver Spring, MD

10:00 **Attractor Reconstruction**
James A. Yorke, University of Maryland, College Park

10:30 **System Reconstruction Using Embedding Techniques**
Timothy D. Sauer, George Mason University

11:00 **Geometric Noise Reduction**
Guan-Hsong Hsu, University of Missouri, Columbia

11:30 **Analysis of Experimental Data**
Robert Cawley, Organizer, Guan-Hsong Hsu, University of Missouri, Columbia, and Liming W. Salvino, Naval Surface Warfare Center, Silver Spring, MD

MS31/Wasatch Room

Applications of Dynamical Systems Methods in Nonlinear Optics

Comprehensive numerical simulations and theoretical investigations have recently been progressing toward better understanding of laser-matter interaction in optical fibers and resonant cavities. Laser-matter interaction dynamics involves very short time scales at which a Hamilton description is often applicable. The speakers in this minisymposium will discuss some of the mathematical and computatioinal approaches for treating coherent optical pulses at such short time scales in dynamical systems models of nonlinear optics. The minisymposium will acquaint the audience with some of the ideas and methods being employed for understanding laser-matter interaction in optical fibers and resonant cavities, by using dynamical systems models. The minisymposium is intended to complement the other dynamical systems discussions.

Mathematical and theoretical issues in laser-matter interaction will be addressed from a strongly physical motivation. The expected role of Hamiltonian dynamics, and its computability and measurability in this application will be discussed from a dynamical systems viewpoint.

Organizer: Darryl D. Holm
Los Alamos National Laboratory

10:00 **Enhancement of Optical Bistability by Periodic Layering**
Roberto Camassa, Los Alamos National Laboratory

10:30 **Mode Dynamics in Nonlinear Optical Fibers**
Alejandro Aceves, University of New Mexico, Albuquerque

11:00 **Perturbation Effects on the Dynamics of a Mode and Two Sidebands in an Optical Fiber**
Gregor Kovacic, Rensselaer Polytechnic Institute

11:30 **Homoclinic Chaos due to Competition among Degenerate Modes in a Ring-Cavity Laser**
Darryl D. Holm, Organizer

MS32/Maybird Room

Chaotic Transport for Hamiltonian Systems

Understanding the statistical properties of maps arising from Hamiltonian flows is of importance in many applications, e.g. particle confinement in accelerators and plasma devices, chemical reaction rates, and fluid mixing. Recent advances have led to a new picture of transport processes in two dimensions. Successes of the theory include results on universality of onset of transport, long time correlation decay and a-priori estimates of transport rates.

Application to higher dimensions has proved more difficult. Some progress has made for the nearly separable case but the general theory remains to be constructed. The speakers will discuss some of the successes and the work that remains to be done.

Organizer: James D. Meiss
University of Colorado, Boulder

10:00 **Chaotic Transport in Symplectic Maps**
James D. Meiss, Organizer

10:30 **Transport in Two and Four Dimensions**
Robert W. Easton, University of Colorado, Boulder

11:00 **The Birkhoff Signature: Identification and Applications**
Vered Rom-Kedar, University of Chicago and The Weizmann Institute of Science, Israel

11:30 **Phase Space Structure Near Resonant Equilibria of 3 Degree-of-freedom Hamiltonian Systems**
Stephen R. Wiggins, California Institute of Technology

MS33/Ballroom 1&2

Signal Processing and Chaos (Part 2 of 2)

(For Description see MS 27, page 16)

Organizer: Louis M. Pecora
Naval Research Laboratory,
Washington, DC

10:00 **Attractor Reconstruction, Data Filtering, and Ill-Posed Problems**
Louis M. Pecora, Organizer

10:30 **Building Synchronizing Chaotic Circuits**
Thomas Carroll, Naval Research Laboratory, Washington, DC

11:00 **Using Strange Attractors**
Hal Fredericksen, Naval Postgraduate School

11:30 **Tracking Unstable Periodic Orbits in Experiments: A New Continuation Method**
Ira B. Schwartz, Naval Research Laboratory, Washington, DC

CP25/Superior A Room

Computational Dynamical Systems 2

Chair: Donald L. Hitzl, Lockheed Research Laboratory, Palo Alto, CA

10:00 **Transient Perturbations Prior to Instability in Periodically Excited Oscillators**
Lawrence Virgin, Phil Bayly and Kevin Murphy, Duke University

10:20 **Numerical Experiments in Noise Reduction and Attractor Restoration**
Donald L. Hitzl and Legesse Senbetu, Lockheed Research Laboratory, Palo Alto, CA

10:40 **Thermodynamics of Duffing's Oscillator**
Akif Ozbek and Victor Berdichevsky, Georgia Institute of Technology

11:00 **General Theory of Higher-order Decomposition of Symplectic Integrators**
Masuo Suzuki, University of Tokyo, Japan

CP26/Superior B Room

Biological Applications 2

Chair: Jack Dockery, Montana State University

10:00 **Modifications to a Model of Chaotic Dopamine Neurodynamics**
E. Jeffrey Sale, A. Douglas Will, Jeffrey M. Tosk and Stephen H. Price, Loma Linda University Medical Center

10:20 **Block Copolymers and the Visual Cortex: the Striped Pattern**
Monica Bahiana, Federal University of Rio de Janeiro, Brasil

10:40 **Analysis of a Double Porosity Bioreactor Model**
Jack Dockery and Curt Vogel, Montana State University

11:00 **Some New Observations on the Classical Logistic Equation with Heredity**
S. Roy Choudhury, University of Central Florida and Jay I. Frankel, Florida Institute of Technology

11:20 **Planting and Harvesting for Pioneer-Climax Models**
James F. Selgrade, North Carolina State University

11:40 **On the Bifurcation of Positive Solutions Arising in Population Genetics**
Nickolaos Stavrakakis, National Technical University, Greece

12:00 Conference Adjourns

BY CAR

From the Airport

Snowbird is located 29 miles (40 minutes) from Salt Lake City International Airport.

Take Interstate 80 east to Interstate 215 south. Interstate 215 swings east toward the Wasatch Mountains. Exit at 6200 South Street making a right turn at the light. Follow this road up the hill to Wasatch Blvd. and on toward Little Cottonwood Canyon, following the signs to Snowbird and Alta.

From Downtown Salt Lake City

Snowbird is 25 miles (30 minutes) from downtown Salt Lake City.

Take Interstate 15 south to Interstate 215 east and exit at 6200 South Street. Make a right turn at the light. Follow this road up the hill to Wasatch Blvd. and on toward Little Cottonwood Canyon, following the signs to Snowbird and Alta.

PUBLIC TRANSPORTATION FROM THE AIRPORT

Canyon Transportation Inc. is a shuttle service that transports passengers between the airport and Snowbird. YOU MUST MAKE RESERVATIONS IN ADVANCE. You can do this by either filling out the transportation form in the back of this brochure, calling Canyon direct at 1-800-255-1841 or making your transportation reservations with Snowbird's Central Reservations Office when making your lodging reservations. If you are making a reservation by phone, please be sure to include the date of arrival, your last name, the airline you are using, the flight number, time of arrival and the lodge that you are staying in at Snowbird. If you are using the registration card, mail to: Canyon Transportation, P.O. Box 1762, Sandy, Utah 84091.

Once you arrive at the airport, proceed to the ground transportation desk (Canyon Transportation Inc.) located in the baggage claim area of the airport. The cost of the shuttle service is $14.00 per person each way with a minimum of 2 people in a van. If you are arriving late or leaving early, and there are no other passengers, the cost to you would be $28.00 because you must pay the minimum of 2 passenger ($14 x 2 min.). You do not have to pay in advance when making your reservation. All payments are made at the time you confirm your reservation at the Ground Transportation Desk at the airport. Canyon Transportation accepts American Express, VISA and Mastercard as forms of payment for services. Snowbird is approximately 29 miles (40 minutes) from the airport. Canyon Transportation Inc. hours of operation are as follows:

Salt Lake City Airport to Snowbird	9:00 AM - 9:00 PM daily
Snowbird to Salt Lake City	7:00 AM - 7:00 PM daily

You must confirm your reservation for departure from Snowbird to the airport with Canyon Transportation 24 hours prior to your scheduled departure.

The average one way cost of a cab to or from Snowbird is approximately $50.00.

CAR RENTAL

Dollar Rent A Car has been selected as the official car rental agency for the SIAM Conference on Dynamical System. The following rates will apply to cars rented at the airport:

Type of Car	Daily Rate	Weekly Rate
Compact	$32.00	$160.00
Intermediate	$33.00	$165.00
Standard	$33.00	$165.00
Luxury	$41.00	$225.00

CAR RENTAL RESERVATIONS

You can make a reservation for car rental by calling (toll free):

800-800-4000
from points in the United States and
800-421-6868
from points in Canada

From points outside the United States and Canada, send your reservation by fax to:

213-641-1111
Attn: Karen Bell
c/o Dollar Rent A Car

Make sure to give the SIAM account code **CCSIA1**, and mention that you are attending the SIAM Conference on Dynamical Systems, October 15-22, 1992, at Snowbird, Utah.

Please make your car rental reservations in advance as on-site availability cannot be guaranteed.

CONDITIONS FOR CAR RENTAL

1. Rates are valid from October 8 - 22, 1992, inclusive. Cars are available at the airport location and should be picked up and dropped off at the same location.
2. You must be 21 years of age and have a valid U.S. or International Driver's License.
3. You must have one of the following credit cards to rent a car: American Express, MasterCard, VISA or Diner's Club.
4. The prices quoted do not include refueling services, tax optional collision and loss damage waiver (LDC and CDW), and optional personal accident insurance.
5. Dollar Rent A Car offers free unlimited mileage with every rental.
6. Daily rates apply to 1-4 day rentals, weekly rates apply to 5-7 day rentals.

CANYON TRANSPORTATION
RESERVATIONS
P.O. Box 1762
Sandy, Utah 84091

I am attending the SIAM Conference on Dynamical Systems at Snowbird Resort and Conference Center and am requesting a reservation for shuttle pick up based on the following information:

Name _____ (FIRST MIDDLE LAST)

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

The airline I will be using is _____ Flight # _____

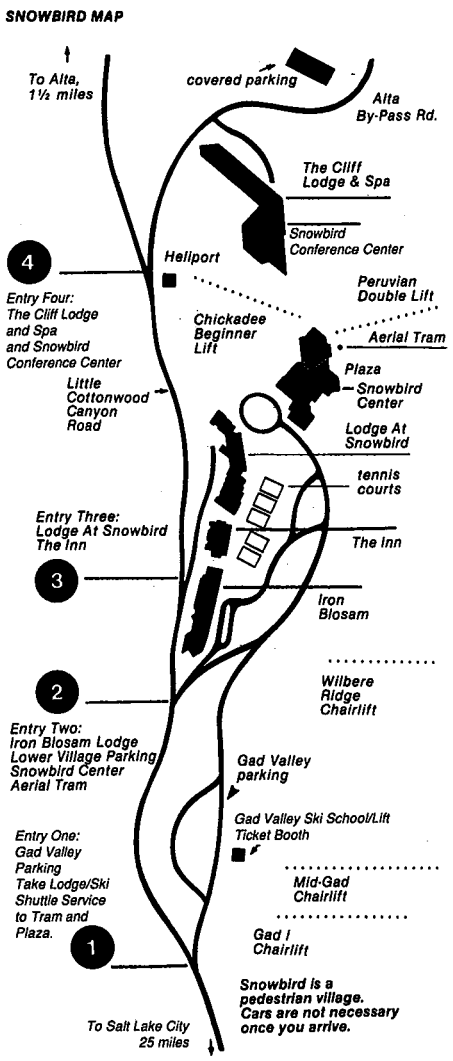
Arrival Date _____ Arrival Time _____ Departure Date _____ Departure Time _____ Departure Flight # _____

I will be staying at the ❑ Cliff Lodge ❑ Lodge/Inn

I will pay for my reservation at the time that I check in at the Canyon Transportation Desk located in the baggage claim area of the airport. I understand the fare to be a maximum of $28.00 if there is only one person in the van and $14.00 if there is more than one person.

Detach form and mail to: CANYON TRANSPORTATION, Reservations, P.O. Box 1762, Sandy, Utah 84091

SNOWBIRD MAP



HOTEL INFORMATION

Snowbird Resort and Conference Center
Snowbird, Utah 84092-6019
Telephone: (801)742-2222
Fax: (801)742-3204

SIAM is holding a block of rooms at Snowbird on a first come first served basis at the following discounted rates until September 21, 1992:

Cliff Lodge	$60.00 Single or Double
Lodge/Inn	$63.00 Studio Efficiency
Dormitory rooms	$21.00 per person (4 in a room)

There is a 9.25% occupancy tax that will be added to your room rate.

These rooms are being held for our exclusive use until September 21, 1992, after this date reservations will depend on availability and the above rates may not be in effect. We urge you to make your reservations as soon as possible. You may do so by telephoning (800)453-3000, or filling out and returning the attached Hotel Reservation Form found on the inside back page of this brochure. You must mention that you are attending the SIAM Conference on Dynamical Systems in order to receive the discounted room rates. A deposit in the amount of one night's room rate is required when making a reservation.

Cliff Lodge Rooms: Set up like a full service modern hotel with outdoor swimming pool, hot tubs, health spa and two queen beds.

Lodge/Inn Studio/Efficiencies: Rustic living room with kitchen facilities, fireplace (in most) and walkout balconies. These rooms do not have separate bedroom.

Sofa beds are located in the living room of the studios and wall beds in the efficiencies. There is a limited number of these rooms available.

Dormitory Rooms: DUE TO THE LIMITED NUMBER OF ROOMS AVAILABLE, YOU MUST BE A STUDENT IN ORDER TO RESERVE THESE ROOMS. Rooms are located in the Cliff Lodge and there are 5 rooms available with 4 people per room. These are non-smoking rooms. There is a private bathroom in each room. Common areas located at end of the hall are equipped with televisions and pool tables. When registering for a room please be sure to mention your gender. You will be asked to show your student I.D. before checking into rooms.

If your first choice in rooms is not available, a reservation will then be made for you in the Cliff Lodge.

Cancellations: To obtain a refund of a deposit, reservations must be cancelled before 4:00 PM and at least 48 hours prior to scheduled arrival date.

Arrivals and Departures: To check in at Snowbird you should report to either the Cliff Lodge or the Lodge/Inn depending on the room you have reserved. The technical sessions will be held in the Cliff Lodge. Check-in at either location is 4:00 PM and check out is 11:00 AM.

Facilities: Each lodge is equipped with saunas and at least one all-season swimming pool. The Cliff Spa occupies the 9th and 10th floors of the Cliff Lodge and offers numerous services: massages, aerobics and weight room. Spa facilities are available to guests 16 years of age and older. A children's pool is available on Level B. A wide variety of shops and boutiques are available in the Snowbird Center and the Cliff Lodge. There are five tennis courts at Snowbird. Court time is $8.00 per hour. Hotel guests receive their first hour of court time per day at $4.00. For those who enjoy hiking, maps of the Snowbird area are available at the Activities Center. Guides are available by appointment. Mountain bikes are available for rental. Bring a lunch and pedal along at 8,000 feet. Helmets and water bottles are included with your rental.

Parking: There is complimentary valet parking available at the Cliff Lodge.

Restaurants: The Mexican Keyhole serves breakfast, lunch and traditional Mexican dinners and drinks. Elegant dining can be found in the Aerie, a glass enclosed rooftop restaurant with views of the mountains on all sides. There are also a variety of other restaurants and lounges located in the Snowbird Village.

Weather: The average temperature at Snowbird for October ranges between 30 and 50 degrees.

SIAM Conferences, Meetings, Symposia, Tutorials, and Workshops

Sponsored by the Society for Industrial and Applied Mathematics

1992

September 17-19 1992
SIAM Conference on Control and Its Applications
Radisson Hotel Metrodome, University of Minnesota, Minneapolis, MN

Sponsored by SIAM Activity Group on Control and Systems Theory

Organizers: Kevin Grasse, University of Oklahoma, Norman; Andre Manitius, George Mason University; and Eduardo Sontag, Rutgers University

September 21-23 1992
SIAM Workshop on Evolution of Phase Boundaries and Microstructure
Xerox Training Center
Leesburg, VA

Organizer: Robert V. Kohn, Courant Institute of Mathematical Science, NYU

October 15-19, 1992
SIAM Conference on Applications of Dynamical Systems
Snowbird Conference Center
Snowbird, UT

Sponsored by SIAM Activity Group on Dynamical Systems

Organizers: Peter W. Bates, Brigham Young University, and Christopher K.R.T. Jones, Brown University

1993

January 25-27, 1993
Fourth ACM-SIAM Symposium on Discrete Algorithms (SODA)
Omni Austin Hotel, Austin, TX

Abstract deadline: 7/14/92

Organizer: Vijaya Ramachandran, University of Texas, Austin

March 21-24, 1993
Sixth SIAM Conference on Parallel Processing for Scientific Computing
Marriott Hotel, Norfolk, VA

Sponsored by SIAM Activity Group on Supercomputing

Abstract deadline: 9/14/92

Organizer: Richard F. Sincovec, Oak Ridge National Laboratory

April 19-21, 1993
SIAM Conference on Mathematical and Computational Issues in the Geosciences
Hyatt Regency Hotel, Houston, TX
Sponsored by SIAM Activity Group on Geosciences

Abstract deadline: 10/5/92

Organizer: James Glimm, State University of New York at Stony Brook

June 7-10, 1993
SIAM Conference on Mathematical and Numerical Aspects of Wave Propagation Phenomena
University of Delaware, Newark, DE

Abstract deadline: 11/13/92

Organizer: Ralph Kleinman, University of Delaware

July 12-16, 1993
SIAM Annual Meeting
Wyndham Franklin Plaza Hotel
Philadelphia, PA

Abstract deadline: 1/15/93

August 4-6, 1993
SIAM Conference on Simulation and Computational Probability
Cathedral Hill Hotel
San Francisco, CA

Abstract deadline: 1/22/93

Organizer: Peter W. Glynn, Stanford University

August 16-19, 1993
Third SIAM Conference on Linear Algebra in Signals, Systems and Control
University of Washington, Seattle, WA

Abstract deadline: 1/29/93

Organizers: Biswa N. Datta, Northern Illinois University and John G. Lewis, Boeing Computer Services, Inc.

October 25-29, 1993
Third SIAM Conference on Geometric Design
Seattle, WA (tentative)

Sponsored by SIAM Activity Group on Geometric Design

Abstract deadline: 3/22/93

Organizers: Robert E. Barnhill, Arizona State University, and Rosemary E. Chang, Silicon Graphics Computer Systems

July 25 - 29, 1994
SIAM Annual Meeting
Sheraton Harbor Island, San Diego, Ca

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FOR MORE INFORMATION, PLEASE CONTACT:

SIAM Conference Coordinator
3600 University City Science Center
Philadelphia, PA 19104-2688
Phone: (215)382-9800 / Fax: (215)386-7999 / E-mail: meetings@siam.org

05/92

SPRINGER FOR DYNAMICAL SYSTEMS

A.J. LICHTENBERG, M.A. LIEBERMAN both of University of California, Berkeley, CA

REGULAR AND CHAOTIC DYNAMICS

Second Edition

Treats nonlinear dynamics in both Hamiltonian and dissipative systems emphasizing the mechanics for generating chaotic motion, methods of calculating the transitions from regular to chaotic motion, and the dynamical and statistical properties of the dynamics when it is chaotic. The book is intended as a self-consistent treatment of the subject at the graduate level and as a reference for scientists. The new edition is greatly expanded and brings the subject matter up to date.

1992/APP. 656 PP., 140 ILLUS./HARDCOVER/$59.95
ISBN 0-387-97745-7
APPLIED MATHEMATICAL SCIENCES, VOLUME 38

S. WIGGINS, California Institute of Technology, Pasadena, CA

CHAOTIC TRANSPORT IN DYNAMICAL SYSTEMS

Many issues related to the behavior of nonlinear dynamical systems can be naturally expressed as "phase space transport problems". **Chaotic Transport in Dynamical Systems** develops this point of view with examples from fluid mechanics, celestial mechanics, the dynamics of bubbles, and presents them in the context of two dimensional maps. This theory is then applied to convective mixing and transport in fluid flows. Includes the most complete discussion available of the geometrical structure of the phase space of Hamiltonian systems.

1992/301 PP., 116 ILLUS./HARDCOVER/$39.95
ISBN 0-387-97522-5
INTERDISCIPLINARY APPLIED MATHEMATICS, VOLUME 2

L.M. PERKO, Northern Arizona University, Flagstaff, AZ

DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS

This systematic study introduces students to the qualitative and geometric theory of ordinary differential equations and serves as a reference book for mathematicians doing research on dynamical systems. Although the main topic of the book is the local and global behavior of nonlinear systems, a thorough treatment of linear systems is given in the beginning of the text. Covers all of the material necessary for a clear understanding of the qualitative behavior of dynamical systems.

1991/403 PP., 177 ILLUS./HARDCOVER/$39.00
ISBN 0-387-97443-1
TEXTS IN APPLIED MATHEMATICS, VOLUME 7

J.K. HALE, Georgia Institute of Technology, Atlanta, GA and **H. KOÇAK**, University of Miami, Coral Gables, FL

DYNAMICS AND BIFURCATIONS

This comprehensive textbook is designed to take undergraduate and beginning graduate students of mathematics, science, and engineering from the rudimentary beginnings to the exciting frontiers of dynamical systems and their applications. It is a masterful exposition of the foundations of ordinary differential and difference equations from the contemporary viewpoint of dynamical systems and bifurcations. The authors implement a fresh approach to mathematical narration. Fundamental ideas are explained in simple settings, the ramifications of theorems are explored for specific equations, and the subject is related in the guise of a mathematical epic. With its insightful and engaging style, as well as its numerous computer-drawn illustrations, this unique book will simply captivate the attention of students and instructors alike.

1992/568 PP., 314 ILLUS./HARDCOVER/$49.00
ISBN 0-387-97141-6
TEXTS IN APPLIED MATHEMATICS, VOLUME 3

J. HUBBARD and **B. WEST**, Cornell University, Ithaca, NY

MACMATH

A Dynamical Systems Software Package for the Macintosh

An updated collection of twelve interactive graphics programs for the Macintosh computer addressing differential equations and iteration. The MacMath programs encourage experimentation and vastly increase the number of examples to which a student may be quickly exposed. They are also ideal for exploring applications of differential equations and iteration which, roughly speaking, form the interface between mathematics and the real world. MacMath permits easy investigation of various models, particularly in showing the effects of a change in parameters on ultimate behavior of the system.

1992/168 PP., 164 ILLUS. PLUS DISKETTE/SOFTCOVER
$49.95/ISBN 0-387-97416-4

C.K.R.T. JONES, Brown University, Providence, RI; **U. KIRCHGRABER**, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland; **H.O. WALTHER**, University of Munich, Germany (Managing Editors)

DYNAMICS REPORTED

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Dynamics Reported is a series of books dedicated to the exposition of the mathematics of dynamical systems. Makes the recent research accessible to advanced students and beginning researchers, and enables mathematicians to stay up-to-date with the work being done in neighboring fields. There is an emphasis on examples and explanations, but theorems appear with their proofs. The focus is on the analytic approach to dynamical systems, emphasizing the origins of the subject in the theory of differential equations. Written in a style that is best described as expository, **Dynamics Reported** provides an excellent foundation for seminars on dynamical systems.

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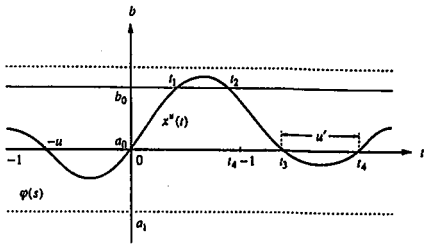
ISBN 0-387-54193-4



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5/92 REFERENCE #: S241

The registration desk will be located in the Cliff Lodge lobby in front of Ballroom 1&2. The registration desk will be open as listed below:

Wednesday, October 14	6:00 PM - 8:00 PM
Thursday, October 15	7:45 AM - 4:30 PM
Friday, October 16	7:30 AM - 4:30 PM
Saturday, October 17	7:30 AM - 4:30 PM
Sunday, October 18	12:00 PM - 4:30 PM
Monday, October 19	8:00 AM -10:00 AM

GET-TOGETHERS

SIAM Welcoming Reception
Wednesday, October 14, 1992
6:30 PM - 8:30 PM
Golden Cliff Room
(Level B of Cliff Lodge)
Cash Bar and mini hors d'oeuvres.

Business Meeting
SIAM Activity Group on Dynamical Systems
Friday, October 16, 1992
8:00 PM - 9:00 PM
Ballroom 1&2
Anyone interested in the activity group is welcome to attend.

Poster Session
Saturday, October 17, 1992
7:30 PM - 9:30 PM
Golden Cliff Room
(Level B of Cliff Lodge)
Come and talk with your colleagues and enjoy complimentary beer, sodas and chips.

Trip to Salt Lake City and Mormon Temple (Tabernacle Choir)
Sunday, October 18, 1992
7:30 AM - 12:00 Noon
Board buses in front of Cliff Lodge at 7:45 AM. You will enjoy a continental breakfast while a guide offers a description of Little Cottonwood Canyon. This canyon played a significant part in the settling of the Salt Lake Valley. Today, the canyon is home to a gigantic genealogical records vault which is carved in the granite walls that line the canyon. Little Cottonwood is also home to two major ski resorts. Once in Salt Lake, which is an hour's drive from Snowbird, you will stop at Historic Temple Square for the live radio broadcast of the Mormon Tabernacle Choir. Following the broadcast, you will visit the Capitol and Beehive House, city founder Brigham Young's home. You will be served refreshments on your trip back to Snowbird. Cost $25.00

Please complete the Advance Registration Form on the inside back cover and return it with your payment to SIAM in the enclosed envelope. We urge attendees to register in advance as the registration fees are lower for advance registrants. Your advance registration form and payment must arrive at the SIAM office by October 2nd. Attendees whose registration is received at SIAM after October 2nd will be required to pay the difference between Advance and On-site registration fees at the conference.

Registration Fees:

	SIAG/DS	SIAM Member	Non Member	Student
Advance	$120	$125	$155	$25
On-site	$150	$155	$185	$25

Non-SIAM Members

Non-member registrants are encouraged to join SIAM in order to obtain the member rate for conference registration and enjoy all the other benefits of SIAM membership.

There will be no prorated fees. *No refunds will be issued once the meeting has started.*

Advance fee expires on October 2, 1992. Payments postmarked after October 2 will be on-site fee.

On-site registration starts October 14. If your payment has not reached the SIAM office by October 14, you will be asked to register and remit the on-site fee. Should your payment arrive in the SIAM office after October 14, that payment will not be processed; checks will be returned and credit card information destroyed.

Telephone Messages

The telephone number of the Snowbird Resort and Conference Center is 801-742-2222. Snowbird will either connect you with the SIAM registration desk or with the attendees guest room where you can leave a message.

Credit Cards

SIAM accepts VISA, MasterCard and American Express for the payment of registration fees, special events, membership and book orders. When you complete the Advance Registration Form, please be certain to indicate the type of credit card, the account number and the expiration date.

SIAM Corporate Members

Non-member attendees who are employed by the following institutions are entitled to the SIAM member rate.

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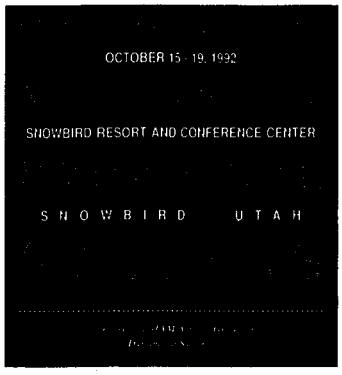


HOTEL RESERVATION FORM

Please Send Me a Confirmation Notice

Name _____ Day-Time Phone _____

Address _____

City _____ State _____ Zip _____

Arrival Date _____ Arrival Time _____

Departure Date _____ Departure Time _____

Please reserve a ❑ **Cliff Lodge Room** $60.00
❑ Single ❑ Double
❑ **Lodge/Inn Studio or Efficiency** $63.00 *(first come first served basis)*
❑ **Dormitory Room in Cliff Lodge** $21.00 *(first come first served basis for students only)*
❑ Female ❑ Male

I choose to pay by: ❑ AMEX ❑ VISA ❑ MC ❑ Check ❑ Diners Club ❑ Discover

Credit Card Number _____ Expiration Date _____ Deposit $ _____

Signature _____

If you list your credit card number, please enclose this card in an envelope and mail to: Snowbird Central Reservations: Snowbird Resort and Conference Center, Snowbird, Utah 84092-6019.

Specially discounted rooms are being held for our exclusive use until September 21, 1992. After that date, reservations will depend on availability. Your reservation is not confirmed until acknowledged in writing by the hotel or verified by phone. When making reservations by phone, be certain to identify yourself as an attendee at the SIAM Conference on Dynamical Systems. Telephone (800) 453-3000. A deposit in the amount of the first night's room rate is required in order to make your reservation.

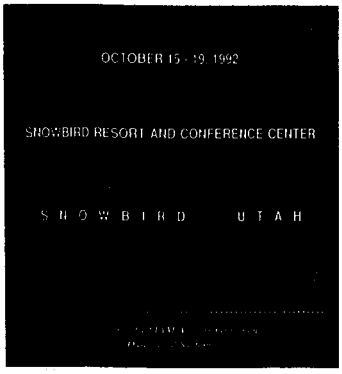
ADVANCE REGISTRATION FORM

In order to qualify for the advance registration fees, your registration form and payment must reach the SIAM office by October 2, 1992. If we receive your registration after October 2, the difference between the advance and on-site fee will be charged to your credit card or requested from you at the conference.

Registration Fees:

	*SIAG/DS	SIAM Member	Non Member	Student
Advance	$120	$125	$155	$25
On-site	$150	$155	$185	$25
Conference fee	$ ____	$ ____	$ ____	$ ____
Tour/Choir $25	$ ____	$ ____	$ ____	$ ____
TOTAL	$ ____	$ ____	$ ____	$ ____

**Members of SIAM Activity Group on Dynamical Systems.*



Please complete this card and print legibly.

Name _____

Organization _____

Department _____

Office Address _____

City _____ State _____ Zip _____

Telephone No.Office: _____ Home: _____

Fax No. _____ E-mail Address _____

Home Address _____

City _____ State _____ Zip _____

Please update my SIAM records to reflect one of the above addresses. Use my ❑ Office ❑ Home **(PLEASE CHECK ONE)**

For SIAM members, please note that in the future, all membership materials and correspondence will be mailed to the address selected above if different from your current membership address.

Local address in Snowbird _____

NAME BADGE

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Name: _____ Affiliation: _____

I wish to pay by ❑ AMEX ❑ VISA ❑ MC ❑ Check

Credit Card No. _____ Expiration Date _____

Signature _____

Detach form and enclose it with payment in the envelope provided (domestic mail only) and mail to SIAM, 3600 University City Science Center, Philadelphia, PA 19104-2688. Telephone: 215-382-9800; FAX: 215-386-7999; E-mail: meetings@siam.org

From _____

_____

_____

TO: Snowbird Central Reservations
Snowbird Resort and Conference Center
Snowbird, Utah 84092-6019

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