

# INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

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## IMA UPDATE

### Winter 1998

This is one of a series of quarterly notices concerning the activities of the Institute for Mathematics and its Applications.

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PARTICIPATING INSTITUTIONS: Centre National de la Recherche Scientifique, Consiglio Nazionale delle Ricerche, Georgia Institute of Technology, Indiana University, Iowa State University, Kent State University, Michigan State University, Northern Illinois University, Ohio State University, Pennsylvania State University, Purdue University, Seoul National University (RIM - GARC), Texas A&M University, University of Chicago, University of Cincinnati, University of Houston, University of Illinois (Urbana), University of Iowa, University of Kentucky, University of Manitoba, University of Maryland, University of Michigan, University of Minnesota, University of Notre Dame, University of Pittsburgh, University of Southern California, University of Wisconsin, Wayne State University.

PARTICIPATING CORPORATIONS: Bellcore, Eastman Kodak, EPRI, Ford, Fujitsu, General Motors, Honeywell, IBM, Lockheed Martin, Lucent Technologies, Motorola, Siemens, 3M.

## I. NEWS AND NOTES

### a. Lucent Technologies Joins IMA as Participating Corporation

Lucent Technologies of Murray Hill, New Jersey joined the IMA in January, 1998 as a Participating Corporation. The IMA Participating Corporation program aims at broadening relations between university and industry mathematical scientists and identifying new mathematical research areas of interest to industry.

### b. Four new members elected to IMA Board of Governors

At its recent meeting, the IMA Board of Governors elected four distinguished mathematical scientists as new members, who have agreed to serve on the board for three years beginning January 1, 1998. They are **Lynne Billard** of the University of Georgia, **Jennifer Chayes** of Microsoft, **James Keener** of the University of Utah, and **Paul Rabinowitz** of the University of Wisconsin.

Retiring members are Mary Ellen Bock (Purdue University), David Levermore (University of Arizona), James McKenna (Bellcore) and Alan Perelson (Los Alamos National Laboratory).

Continuing Board members are David H. Bailey (NASA Ames Research Center), Rob Calderbank (AT&T Labs), Rosemary Chang (Silicon Graphics, Incorporated), John Polking (Rice University), William Pulleyblank (chair)(IBM Watson Research Center), Ridgway Scott (University of Houston), Al Taylor (University of Michigan) and James Turner (Arizona State University).

### c. Board of Governors Selects Topic for 2000 – 2001: Multi-Media

The Board of Governors approved a proposal to devote the year September 2000 – June 2001 to the topic, **Mathematics in Multi-Media**. The organizing committee consists of Michael Barnsley (Iterated, Inc.), Rosemary Chang (Silicon Graphics, Inc.), Tony Derosé (Pixar, Inc.), Stu Geman (Brown University), Peter Olver (University of Minnesota), Roni Rosenfeld (Carnegie-Mellon University), Larry Schumaker (Vanderbilt University) and Ahmed Tewfik (University of Minnesota).

The proposal outlines workshops on Image Processing; Image Analysis; Mathematical Foundations of Speech Processing; Mathematical Foundations of Language Modeling; Compression, Communication and Retrieval; Computer Security, Copyright and Privacy Protection; Geometric Design; and Computer Graphics. All workshops are tentative. A primary goal of these workshops is to educate and interest mathematicians in the mathematical and scientific problems that arise in these dynamic and challenging areas of science and technology.

The IMA continually asks members of the mathematical sciences community for ideas for topics of future programs, from one week as part of a longer program, to a ten-month Annual Program. See the accompanying flyer.

### d. IMA Reorganization

The IMA Board of Governors has approved reorganization of the senior management of the IMA, initiated by the new IMA Director, **Willard Miller**. **Fadil Santosa** has been appointed to the new position of **Associate Director for Industrial Programs**. **Robert Gulliver** has announced his resignation as Associate Director, effective this March, and **Frederic Dulles** has been appointed to the new position of **Associate Program Director**. Dr. Dulles will assume part of Dr. Gulliver's responsibilities, the others passing to Dr. Miller. Dr. Santosa's responsibilities will free up time from the Director's position.

#### **e. New Scientific Program Advisory Committee**

This new committee will assist Miller in developing ideas for annual and Summer programs. Members will be **Avner Friedman** (chair) of the University of Minnesota, **Mac Hyman** of Los Alamos National Laboratories, **George Papanicolaou** of Stanford University and **William Pulleyblank** of IBM T. J. Watson Research Center. Friedman was Director of the IMA from 1987–97, and Pulleyblank is currently chair of the IMA Board of Governors.

#### **f. New Computational Programs and Resources Advisory Committee**

Another new committee will advise Miller as to how the computational aspects of current and upcoming IMA programs can be strengthened, and on the establishment and maintenance of appropriate facilities, personnel and software. Members will be **Mitchell Luskin** of the University of Minnesota, **Douglas Arnold** of Penn State University, **George Cybenko** of Dartmouth College, **Leslie Greengard** of the Courant Institute of Mathematical Sciences at NYU, and **Jorge Moré** of Argonne National Laboratories.

#### **g. Expanded Programs and Improved IMA Home Page**

See the accompanying letter regarding the expanding programs and services of the IMA, which motivated Miller to carry out the reorganization outlined above. Many of the new services are accessible through the IMA home page on the World-Wide Web. For example, recent Industrial Problems talks are summarized and abstracted at

[http://www.ima.umn.edu/industrial/97\\_98/](http://www.ima.umn.edu/industrial/97_98/).

Formerly, the Industrial Problems talks were first made available to the public many months later in the hard-copy IMA Volumes (volumes # 16, 24, 31, 38, 49, 57, 67, 83, 88 and 100, available through Springer-Verlag.)

The IMA home page is continually under construction. We invite comments or suggestions, which may be addressed to

[webmaster@ima.umn.edu](mailto:webmaster@ima.umn.edu).

In particular, we appreciate any information about World-Wide Web links appropriate to current and upcoming IMA programs.

#### **h. Workshop on NSF's KDI Initiative March 7, 1998.**

The NSF has just announced a new activity, Knowledge and Distributed Intelligence (KDI), that builds on recent advances in computation and communications to make new thrusts in three focal areas: Knowledge Networking (KN), Learning and Intelligent Systems (LIS) and New Computational Challenges (NCC). Mathematical scientists can participate at several levels; see <http://www.nsf.gov/kdi> for further details. KDI Proposals to the NSF are due May 8, 1998, with letters of intent by April 1 (!).

The IMA will put on a workshop from 10 a.m. to 5 p.m. on Saturday, March 7, 1998. The purpose of the workshop is to inform mathematical scientists about the funding opportunities presented by KDI and, in particular, the mathematical research areas that are of greatest interest. Proposal preparation issues and issues of interdisciplinary collaboration will also be addressed. No funding can be provided. IMA Participating Institutions can use IMA funds under their control to send faculty to the workshop. For updated information, see

<http://www.ima.umn.edu/announce.html>.

To confirm participation, contact

[ima-staff@ima.umn.edu](mailto:ima-staff@ima.umn.edu).

**i. New workshop: Dynamical Systems Techniques in Oceanography— Chaotic Advection in Ocean Mesoscale Structures, May 7–9, 1998.**

This workshop will bring together researchers from both applied dynamics and oceanography. The aim is to develop and extend a close working relationship between both groups. The workshop will give an opportunity to share the recent advances in the different fields as well as provide a forum for setting an agenda for future activity. See the enclosed flyer for a detailed description of the workshop and a partial participant list.

The organizer for this workshop is Chris Jones (Brown). The workshop is sponsored by the Office of Naval Research.

**j. New workshop: Continuum Mechanics and Non-Linear Partial Differential Equations, June 8–12, 1998.**

The list of confirmed participants for this workshop includes S. Antman (Maryland), J. Ball (Oxford), K. Bhattacharya (Caltech), B. Dacorogna (Lausanne), C. Dafermos (Brown), W. E (Courant), J. Ericksen, M. Esteban (Paris Dauphine), G. Friesecke (Oxford), P. Holmes (Princeton), D. Kinderlehrer (CMU), I. Kukavica (USC), M. Luskin (Minnesota), J. Marsden (Caltech), F. Murat (Paris 6), F. Otto (UCSB), Z. Xin (Courant) and L. C. Young. Organizers for this workshop are Richard James (University of Minnesota), Stefan Müller (Max-Planck Institut, Leipzig) and Vladimír Šverák (University of Minnesota). The workshop is sponsored by the Max-Planck Gesellschaft.

**k. Conference honoring Avner Friedman, May 1–3, 1998.**

In celebration of Avner Friedman's sixty-fifth birthday, the School of Mathematics of the University of Minnesota will put on a conference on **Pure, Applied and Industrial Mathematics: Strength through Connections**. The conference will be held May 1–3, 1998.

The list of confirmed speakers includes Luis A. Caffarelli (University of Texas), Peter Castro (Kodak), Emmanuele DiBenedetto (Northwestern), Wendell H. Fleming (Brown), James G. Glimm (Stony Brook), Walter Littman (Minnesota), Hillary Ockendon (Oxford), John Ockendon (Oxford) and Juan J. L. Velázquez (Madrid Complutense). The web page

<http://www.math.umn.edu/arb/FriedmanConference.html> has a registration form and further information. Friedman was IMA Director from 1987–97.

## I. Participating Institution Conference: “A Workshop on Superconductivity,” May 18–20, 1998 at Purdue University

Beginning with the work of G. Bednorz and A. Muller in 1985, the discovery of materials that retain superconducting properties at temperatures above the boiling point of nitrogen has resulted in a resurgence of interest in superconductivity. It has also sparked, as never before, the involvement of mathematicians in the modeling, analysis, and computation of superconducting phenomena. At the same time, it is also evident that there remain many questions to whose answers mathematicians can make significant contributions.

The goals of the conference at Purdue University are, first, to review the state of the art in all mathematical aspects of superconductivity; second, to hear about recent theoretical and experimental developments coming from the physics and materials science communities; and, third, to catalog the important outstanding theoretical and practical problems.

In order to meet these goals, conference participants will include physicists, materials scientists, and all flavors of mathematicians. The topics that will be discussed at the conference include: vortex dynamics, thermal fluctuations, anisotropies and inhomogeneities, layered superconductors, macroscale modeling, critical current, pinning, computational methods, analytical techniques, vortex liquids and glass states, vortex lattice structure, thin films and surface superconductivity.

The following people have agreed to speak:

I. Aronson	M. McElfresh	H. Brezis	Y. Morita	L. N. Bulaevskii
J. Peterson	S. J. Chapman	L. Prigozhin	J. R. Clem	G. Richardson
Q. Du	J. Rubinstein	P. Gray	P. Sternberg	A. Gurevich
B. Stoth	R. Jerrard	D. Stroud	H. Kaper	P. Takáč
	V. Kogan		J. X. Xin	

The Organizing Committee consists of P. Bauman, M. Gunzburger and D. Phillips. If you have questions, please contact: Patricia Bauman, e-mail [bauman@math.purdue.edu](mailto:bauman@math.purdue.edu).

The conference is being supported by the IMA, the Midwest Superconductivity Consortium (MISCON), and the Department of Mathematics at Purdue.

The IMA is also supporting the Workshop as follows. Mathematicians from the Participating Institutions of the IMA are eligible to receive IMA/PI funding, where available, to come to the Workshop. Application to use IMA/PI funds for the workshop should be made directly to the mathematician’s own department chair.

## m. Conference on Operator Theory at Winnipeg, October 7-11, 1998.

The **International Conference on Operator Theory and its Applications to Scientific and Industrial Problems** will be held October 7-11, 1998 in Winnipeg, Canada. This conference is a sequel to one held by IIMS in 1994. Its scope is considerably broader and includes theory and applications. The topics include: Functional models and characteristic functions of linear operators, operators in spaces with indefinite inner product, Schroedinger operators, spectral and scattering theory, infinite matrices and projection methods, interpolation of rational matrix functions, Hankel operators, operator theory and control theory, wave propagation and scattering, mathematical physics and fluid mechanics, signal and image processing, inverse problems, biomathematics and financial mathematics.

Organizers are P. N. Shivakumar (Manitoba, Canada), A. G. Ramm (KSU, USA) and A. Strauss (Ulyanovsk, Russia). For further information see <http://www.iims.umanitoba.ca> or contact P. N. Shivakumar (e-mail: [inmath@umanitoba.ca](mailto:inmath@umanitoba.ca), Tel: 204 474 6724, Fax: 204 474 7602).

## n. Weekly IMA Seminar List Available by List Server

The IMA is happy to offer its e-mail mailing list service. The mailing list “weekly” is a distribution each Thursday of the next week’s schedule of IMA seminars and events. If you wish to subscribe, simply send an e-mail message to [imalists@ima.umn.edu](mailto:imalists@ima.umn.edu) whose first line is of the form

subscribe weekly

If your preferred e-mail address is different from the one from which you are sending the request, the first line should be

subscribe weekly you@e.mail.address

The subject line and the rest of the message are ignored. Questions or problems should be sent to

owner-weekly@ima.umn.edu.

The current week's updated seminar list may also be obtained via `finger seminar@ima.umn.edu`.

## II. IMA CALENDAR

### 1. EMERGING APPLICATIONS OF DYNAMICAL SYSTEMS, September 1997–June 1998

#### Fall 1997: Numerical Analysis of Dynamical Systems

**September 4–9:** Tutorial on **Numerical Methods for Bifurcation Problems**

**September 15–19:** Workshop on **Numerical Methods for Bifurcation Problems**

**September 29–October 3:** Workshop on **Large-Scale Dynamical Systems**

**October 23–24:** Tutorial on **Multiple-Time-Scale Dynamical Systems**

**October 27–31:** Workshop on **Multiple-Time-Scale Dynamical Systems**

**November 17–21:** Workshop on **Dynamics of Algorithms**

#### Winter 1998: Dynamics in Physiology and Chemistry

**January 14–23:** Workshop on **Computational Neuroscience**

**February 5–6:** Tutorial on **Calcium Dynamics in Cells**

**February 9–13:** Workshop on **Calcium Dynamics in Cells**

**March 7:** Workshop on **Knowledge and Distributed Intelligence in the Information Age**

**March 9–14:** Workshop on **Cardiac Dynamics**

#### Spring 1998: Symmetry and Pattern Formation

**April 23:** IMA Spring Lecture by Ian Stewart on **Life's Other Secret**

**April 27–May 1:** Workshop on **Nonlinear Identification and Control**

**May 1–3:** Conference on **Pure, Applied and Industrial Mathematics: Strength through Connections.**

**May 7–9:** Workshop on **Dynamical Systems Techniques in Oceanography: Chaotic Advection in Ocean Mesoscale Structures**

**May 11–15:** Workshop on **Pattern Formation in Continuous and Coupled Systems**

**June 1–5:** Workshop on **Animal Locomotion and Robotics**

**June 8–12:** Special Workshop on **Continuum Mechanics and Non-Linear Partial Differential Equations**

### 2. CODING AND CRYPTOGRAPHY, July 6–18, 1998

See below for details of topics and participants.

### 3. MATHEMATICS IN BIOLOGY, September 1998–June 1999

#### Fall 1998: Theoretical Problems in Developmental Biology and Immunology

**September 2–4:** Tutorial on **Mathematical and Computational Issues in Pattern Formation**

**September 7–11:** Workshop on **Pattern Formation and Morphogenesis: The Basic Process**

**September 14–18:** Workshop on **Pattern Formation and Morphogenesis: Model Systems**

**October 7–8:** Tutorial on **Immunology, Cell Signaling, the Physiology of the Immune System & the Dynamics of the Immune Response**

**October 12–16:** Workshop on **Immune System Modeling & Cell Signaling**

**October 19–23:** Period of Concentration on **Forging an Appropriate Immune Response as a Problem in Distributed Artificial Intelligence**

**November 9–13:** Workshop on **Dynamics and Control of AIDS**

**Winter 1999:** **Mathematical Problems in Physiology**

**January 4–8:** Workshop on **Cell Adhesion and Motility**

**January 25–29:** Workshop on **Computational Modeling in Biological Fluid Dynamics**

**February 8–12:** Workshop on **Membrane Transport and Renal Physiology**

**February 13:** Tutorial on **Hormones**

**February 15–19:** Workshop on **Endocrinology: Mechanism of Hormone Secretion and Control**

**March 5:** Tutorial on **Audition**

**March 8–12:** Workshop on **Audition**

**Spring 1999:** **Dynamic Models of Ecosystems and Epidemics**

**April 19–23:** Workshop on **Local Interaction and Global Phenomena in Vegetation and other Systems**

**May 13–14:** Tutorial on **Introduction to Epidemiology & Immunology**

**May 17–21:** Workshop on **Mathematical Approaches for Emerging and Reemerging Infectious Diseases**

**June 7–11:** Workshop on **From Individual to Aggregation: Modeling Animal Grouping**

#### **4. REACTIVE FLOWS & TRANSPORT PHENOMENA, September 1999–June 2000**

**Fall 1999:** **Combustion**

**Winter 2000:** **Natural Resources and Environment**

**Spring 2000:** **Multiscale and Transition Regimes**

#### **5. MATHEMATICS IN MULTIMEDIA, September 2000–June 2001**

**Fall 2000:** **Vision, Speech and Language**

**Winter 2001:** **Compression, Communication and Retrieval**

**Spring 2001:** **Geometric Design and Computer Graphics**

**Summer Program:**  
**III. CODING AND CRYPTOGRAPHY**

July 6–18, 1998

Organizers: Ian Blake (Hewlett-Packard)  
Rob Calderbank (AT&T Laboratories)  
Andrew Odlyzko (AT&T Laboratories) and  
Vera Pless (University of Illinois, Chicago)

The aim of this two-week Summer program is to bring together mathematicians, computer scientists, and electrical engineers involved in two disciplines, coding and cryptography, so that the techniques from one area can be applied to problems in the other area. One major goal will be to utilize knowledge from coding to construct good cryptographic schemes.

Both coding theory and cryptography originated with the seminal work of Claude Shannon in 1948. During and before World War II, the main applications of cryptography were military. With the spread of computers and electronic communications after the war, the use of cryptographic schemes for passwords, banking transactions and various aspects of computer security proliferated. So did the uses of error-correcting codes in radio based communication systems, satellite communications and for high fidelity on CD's. These uses and the evolving mathematical theory of codes generated much mathematical activity.

**Week 1:** July 6–10, 1998.

**A. Codes, Design, and Cryptography**

This part of the program will concentrate on finite geometries, designs, secret sharing schemes, schemes to detect deception and authentication, secret broadcasting schemes, and the construction of cryptographic schemes related to discrete objects. Both finite geometries and more generally combinatorial designs have been used in the analysis and construction of error correcting codes and secret sharing schemes. These uses will be explored to see if they can be utilized in other areas.

**Week 2:** July 13–18, 1998.

**B. Coding, Complexity and Cryptography**

This part of the program will concentrate on codes for cryptographic schemes; a study of combinatorial and algebraic properties of different codes (are certain specific codes good codes for cryptographic purposes), complexity of decoding and decrypting algorithms, and how decoding of codes affects decrypting of cryptographic schemes.

**C. Sequences**

The complexity of sequences is of interest in random number generation, decoding cyclic codes, and cryptography also.

**CONFIRMED SUMMER PROGRAM VISITORS: July 6–18, 1988** (as of 2/5)

**Summer Program: Coding and Cryptography**

ASSMUS, EDWARD	Lehigh University	JUL 5 – 18
ATKIN, OLIVER	Univ. of Illinois–Chicago (Mathematics, Statistics & CS)	JUL 12 – 18
BARG, ALEXANDER	AT&T Bell Laboratories	JUL 12 – 18
BIERBRAUER, JUERGEN	Michigan Technological Univ. (Math Sciences)	JUL 5 – 10
BLAKE, IAN	Hewlett Packard	JUL 5 – 18
BLAKLEY, G. R.	Texas A & M Univ. (Mathematics)	JUL 5 – 18
CALDERBANK, ROBERT	AT&T Labs	JUL 5 – 10
CHAN, AGNES	Northeastern Univ. (Computer Science)	JUL 12 – 18
CHARPIN, PASCALÉ	INRIA, France	JUL 5 – 18
DESMEDT, YVO	Univ. of Wisconsin–Milwaukee (Electrical Engineering & Comp)	JUL 5 – 18
FENG, GUI-LIANG	Univ. of Southwestern Louisiana (Ctr Adv Computer Studies)	JUL 12 – 18
GABIDULIN, ERNST	Moscow Institute of Physics and Technology	JUL 5 – 18
GARRETT, PAUL	Univ. of Minnesota (Math)	JUL 6 – 18
HELLESETH, TOR	Univ. of Bergen (Informatics)	JUL 5 – 18
HOFFMAN, JOHN	Secure Computing Corporation	JUL 5 – 18
IMAI, HIDEKI	Univ. of Tokyo (Inst Industrial Science)	JUL 12 – 18
JOHANSSON, THOMAS	Univ. of Lund (Technology)	JUL 5 – 18
KABATIANSKI, GRIGORI	Institute for Problems of Information Techn.	JUL 5 – 18
KLAPPER, ANDREW	Univ. of Kentucky (Computer Science)	JUL 12 – 18
KLOVE, TORLIEV	Univ. of Bergen (Informatics)	JUL 5 – 18
KUMAR, VIJAY	Univ. of Southern California (Communication Sciences)	JUL 12 – 18
LEONARD, DOUG	Auburn Univ. (Discrete & Statistical Sc)	JUL 5 – 18
LEVENSTEIN, VLADIMIR	Keldysh Institute for Applied Mathematics	JUL 5 – 18
MAGLIVERAS, SPYROS	Univ. of Nebraska (Computer Science & Eng)	JUL 5 – 18
MARTIN, WILLIAM J.	Univ. of Winnipeg (Math and Statistics)	JUL 5 – 18
NIEDERREITER, HARALD	Austrian Academy of Science (Information Processing)	JUL 12 – 18
PHELPS, KEVIN	Auburn Univ. (Discrete and Statistical)	JUL 5 – 18
PLESS, VERA	Univ. of Illinois–Chicago (Mathematics, Statistics & CS)	JUL 5 – 18
SCHNEIER, BRUCE	Counterpane Systems	JUL 6 – 18
SENDRIER, NICOLAS	INRIA-Rocquencourt (Project CODES)	JUL 5 – 18
SIMMONS, GUS	Sandia National Labs	JUL 5 – 10
SIMONIS, JURIAAN	T. U. Delft (Technical Math and Informatics)	JUL 5 – 18
SLOANE, NEIL	A T. & T. Research Labs	JUL 5 – 10
VAN LINT, JACOBUS	Technical Univ. of Eindhoven	JUL 5 – 10
WILSON, RICHARD	California Inst. of Technology (Mathematics)	JUL 5 – 10
ZEMOR, GILLES	ENTS, Paris (Network Dept.)	JUL 5 – 18
ZINOVIEV, VICTOR	Russian Academy of Sciences (Problems of Info. Transmission)	JUL 5 – 18

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**IV. THE IMA VOLUMES IN MATHEMATICS  
AND ITS APPLICATIONS**

The IMA Volumes are available from Springer–Verlag. These volumes can be obtained by calling the toll-free number 1–800–SPRINGER or by writing:

attn: Book Fulfillment Department  
Springer-Verlag  
44 Hartz Way  
Secaucus, NJ 07094

Volume 104: Essays on Mathematical Robotics

John Baillieul, Shankar S. Sastry, and Hector J. Sussmann

The chapters in this book present an excellent exposition of recent developments in both robotics and nonlinear control centering around (i) “hyper-redundancy”, (ii) highly oscillatory inputs, (iii) optimal control, (iv) exterior differential systems, and (v) the use of generic loops. The principal topics covered in the book are:

1. Adaptive control for a class of nonlinear systems (Chapter 1),
2. Event-based motion planning (Chapter 2),
3. Nonlinear control synthesis and path planning in robotics—with special emphasis on nonholonomic and ‘hyper-redundant’ robotic systems (Chapters 3–5),
4. Control design and stabilization of driftless affine control systems (of the type arising in the kinematic control of nonholonomic robotic systems) (Chapters 6–7),
5. Control design methods for Hamiltonian systems (Chapters 8–9), and
6. Exterior differential systems (Chapter 10). This chapter contains a detailed introduction to the use of exterior differential methods, including the Goursat and extended Goursat normal forms and their application to path planning for nonholonomic systems.

**Forthcoming Volumes:**

1996 Summer Programs:

Emerging Applications of Number Theory

1996–1997: *Mathematics in High Performance Computing*

Algorithms for Parallel Processing

Evolutionary Algorithms

The Mathematics of Information Coding, Extraction and Distribution

Molecular Structure: Dynamics, Geometry and Topology

Structured Adaptive Mesh Refinement Grid Methods

Computational Radiology and Imaging: Therapy and Diagnostics

Mathematical and Computational Issues in Drug Design

Grid Generation and Adaptive Algorithms

Parallel Solution of Partial Differential Equations

1997 Summer Program: Statistics in the Health Sciences

Week 1: Genetics, July 7–11

Week 2: Imaging, July 14–18

Week 3: Diagnosis and Prediction, July 21–25

Weeks 4 & 5: Design & Analysis of Clinical Trials, July 28–Aug. 8

Week 6: Statistics and Epidemiology: Environment and Health, August 18–22

1997–1998: *Emerging Applications of Dynamical Systems*

Numerical Methods for Bifurcation Problems