Institute for Mathematics and its Applications

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IMA NEWSLETTER # 248

March 1–31, 1997

See the Winter, Summer and Fall 1996 IMA Update for a full description of the 1996–97 program on Mathematics in High-Performance Computing.

News and Notes

IMA Workshop:

Computational Radiology and Imaging: Therapy and Diagnostics

March 17–21, 1997
Organizers: Christoph Borgers (Tufts / Univ. of Michigan) and Frank Natterer (Univ. of Münster, Germany)

Special IMA Workshop:

Structured Adaptive Mesh Refinement Grid Methods

March 12–13, 1997
Organizers: Scott B. Baden (UCSD), Nikos P. Chrisochoides (Cornell University), Dennis Gannon (Indiana University) and Mike Norman (NCSA, UIUC)

Sponsored by the Department of Energy
and the National Science Foundation

SIAM Conference in Minneapolis

The Eighth SIAM Conference on Parallel Processing for Scientific Computing will take place at Hyatt Regency Hotel, 1300 Nicollet Mall, Minneapolis March 14–17, 1997. A number of IMA visitors will participate. Further information is available on the world-wide web at

`http://www.siam.org/meetings/pp97/pp97home.htm`

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Improved IMA Home Page

The IMA has substantially improved its home page on the World-Wide Web, accessible through netscape or other web-reading applications at

`http://www.ima.umn.edu`.

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

`webmaster@ima.umn.edu`.

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

Schedule for March 1–31, 1997

Monday, March 3

Computer Science Colloquium in room 108 Mech. Eng.

2:30 pm	**Godfried Toussaint** McGill University	On Removing Non-Degeneracy Assumptions in Computational Geometry

Abstract: Existing methods for removing degeneracies in computational geometry can be classified as either approximation or perturbation methods. These methods give the implementer two rather unsatisfactory choices: find an approximate solution to the original problem given, or find an exact solution to an approximation of the original problem. We address an alternative approach that has received little attention in the computational geometry literature. Often a typical computational geometry paper will make a non-degeneracy assumption that can in fact be removed (without perturbing the input) by a global rigid transformation of the input. Once the solution is obtained on the transformed non-degenerate input, it can be transformed back trivially to yield the solution to the original problem. In these situations, by applying suitable pre- and post- processing steps to an algorithm, we obtain the exact solution to the original problem using the algorithm that assumes a non-degenerate input, even when that input is in fact degenerate.

We consider several non-degeneracy assumptions that are typically made in the literature, propose algorithms for performing the pre- and post- processing steps that remove these degeneracies, analyze their complexity and, for some of these problems, give lower bounds on their worst-case complexity. The assumptions considered here include:
(1) no two points in the plane have the same x-coordinate,
(2) no two points in space lie on a vertical line,
(3) no two points in space have the same x-coordinate,
(4) no three points in space lie on a vertical plane, and

(5) no two line segments lie on a vertical plane.

Incorporating our algorithms with those in the literature that make these non-degeneracy assumptions, allows those algorithms to work even when the degeneracies are present, albeit at the cost of increased complexity.

We propose low-degree polynomial-time solutions for the decision, computation and optimization versions of all these problems. For the optimization version of problem (5) we give an $O(n^4)$ time algorithm, reducing the previous best running time of $O(n^6 logn)$.

This is joint work with Francisco Gomez and Suneeta Ramaswami.

Tuesday, March 4

IMA Postdoc Seminar

2:30 pm **Petter Bjørstad** University of Bergen/IMA — An Overview of Domain Decomposition Algorithms

Abstract: This talk will discuss domain decomposition algorithms and briefly touch upon a convergence theory. The talk will be targeted at non-specialists with a general background in numerical analysis.

Organizer: Serguei Maliassov

NOTE: The Postdoc Seminar is organized by the IMA postdoctoral members, but all interested IMA participants are very welcome to attend. The Seminar meets in Vincent Hall 570.

Wednesday, March 5

Thursday, March 6

Friday, March 7

Monday, March 10

Tuesday, March 11

IMA Postdoc Seminar

2:30 pm **Susanne Brenner** Univ. of South Carolina/IMA — Nonconforming Finite Elements

Abstract: Nonconforming finite elements appear in (among others) the application of finite element methods to fourth order problems and problems involving an incompressibility condition. In this talk we will discuss the usefulness of these elements and present some efficient methods for solving the resulting discretized equations.

Organizer: Serguei Maliassov

NOTE: The Postdoc Seminar is organized by the IMA postdoctoral members, but all interested IMA participants are very welcome to attend. The Seminar meets in Vincent Hall 570.

Special IMA Workshop:

Structured Adaptive Mesh Refinement Grid Methods

March 12–13, 1997

Organizers: Scott B. Baden (UCSD), Nikos P. Chrisochoides (Cornell University), Dennis Gannon (Indiana University) and Mike Norman (NCSA, UIUC)

Sponsored by the Department of Energy
and the National Science Foundation

Structured Adaptive Mesh Refinement (SAMR) methods are playing an increasing role in tackling difficult scientific applications, including compressible flows, cosmology, and electronic structures arising in local spin-density calculations. Providing adequate software support for SAMR codes is challenging even on sequential implementations. In parallel implementations, program complexity increases qualitatively due to computation and communication requirements that are dynamic, data-dependent, and irregular.

This workshop will bring together experts in applications, numerical methods, and software development from academia, national labs, and industry. The goal of the workshop is to identify common ground in the application and implementation of SAMR, as well as issues requiring specialization. The specific objectives of the workshop are: (i) to improve the general understanding of the application of SAMR to practical problems, (ii) to identify issues critical to efficient and effective implementation on high-performance computers, (iii) to stimulate the development of a community code repository for software including benchmarks to assist in the evaluation of software and compiler technologies.

Workshop themes include:

- Error estimation,
- Projection and interpolation operations,
- Implicit vs. explicit solvers,
- Linear and nonlinear PDE solvers,
- Dynamic memory management and load balancing,
- Compilers, languages and libraries, and
- Performance analysis and visualization.

Wednesday, March 12

Talks today are in the Seminar Room, Vincent Hall 570

8:15 am	**Registration and Coffee**	IMA Lounge, Vincent Hall 502
8:45 am	**Welcome and Orientation**	A. Friedman, R. Gulliver, S. Baden
9:00–9:45	**Marsha Berger** Courant Institute, NYU	AMR: Roadblocks and Building Blocks
9:45–10:30	**David Keyes** Old Dominion U. & ICASE/NASA	Accommodating Adaptivity in Structured vs. Unstructured Grids

10:30 am	**Coffee Break**	IMA Lounge, Vincent Hall 502
10:45–11:15	**John A. Trangenstein** Duke University	Adaptive Mesh Refinement for Multi-Scale Problems
11:15–11:45	**Chris Myers** Cornell Theory Center	The Dynamics of Localized Coherent Structures and The Role of Adaptive Software in Multi-scale Modeling
11:45–12:15	**Scott Kohn** Univ. of Calif. San Diego	Software Abstractions and Computational Issues in Parallel Structured Adaptive Mesh Methods for Electronic Structure Calculations

Joint work with John Weare, Elizabeth Ong and Scott B. Baden

1:30–2:00	**Manish Parashar** University of Texas at Austin	Systems Engineering Issues in the Implementation of an Infrastructure for Parallel Structured Adaptive Meshes

Joint work with J. C. Browne

2:00–2:30	**Keshav Pingali** Univ. of Notre Dame	Compiler support for parallel structured adaptive mesh refinement codes

Joint work with Nikos Chrisochoides and Induprakas Kodukula

2:30–3:00	**John Michalakes** Argonne National Lab.	RLS: A Parallel Runtime System Library for Atmospheric Models with Nesting
3:00 pm	**Coffee Break**	IMA Lounge, Vincent Hall 502
3:15–3:45	**Henry Neeman** Illinois/NCSA	HAMR: the Hierarchical Adaptive Mesh Refinement System

Joint work with Michael L. Norman

3:45–4:15	**Daniel Quinlan** Los Alamos National Lab.	AMR++: And Object-Oriented C++ Library for the Development of Serial and Parallel Adaptive Mesh Refinement Applications
4:15–5:00	**Discussions**	
6:30 pm	**Workshop Dinner** Radisson Hotel	Alumni Room, second floor

Reception at 6:00 in the Alumni Room, dinner at 6:30.

Thursday, March 13

Talks today are in Lecture Hall EE/CS 3-180

8:30 am	**Coffee**	IMA Lounge, Vincent Hall 502

9:00–9:30	**M. Pernice** University of Utah	Progress, Results and Experience in Developing and Adaptive Solver for Steady-State Turbulent Reacting Flows in Industrial Boilers and Furnaces

Joint work with M. Bockelie, D. Swensen, and P. Smith

9:30–10:00	**Phil Colella** Univ. of Calif. Berkeley and LBNL	Adaptive Mesh Refinement for Sharp Fronts and Irregular Geometries
10:00–10:30	**James Quirk** Caltech	AMRITA: Adaptive Mesh Refinement by Numbers
10:30 am	**Coffee Break**	IMA Lounge, Vincent Hall 502
10:45–11:15	**Matthew W. Choptuik** Univ. of Texas at Austin	Experience with AMR and Numerical Relativity
11:15–11:45	**Mike Norman** NCSA	Static and Adaptive Hierarchical Mesh Simulations in Astrophysics
11:45–12:15	**Greg L. Bryan** MIT	A Hybrid AMR Application for Cosmology and Astrophysics

Joint work with Michael L. Norman

1:15–1:45	**Piyush Mehrotra** ICASE/NASA	AMR using HPF
1:45–2:15	**Tomasz Haupt** NPAC, Syracuse University	Data-Parallel Implementations of AMR
2:15–2:45	**Dinshaw S. Balsara** NCSA	Parallel Object-Oriented Adaptive Mesh Refinement for Hyperbolic Systems

Joint work with Daniel J. Quinlan

2:45 pm	**Coffee Break**	IMA Lounge, Vincent Hall 502
3:00–4:30	**Round-Table Discussions** Dennis Gannon, leader	Software Issues

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Friday, March 14

IMA Industrial Postdocs Seminar

The seminar will meet from 1:00 am – 4:30 pm today in Vincent Hall 570. The format of the seminar is:

1. Presentation of projects and problems from industry (Honeywell, Lockheed Martin and Kodak) on which the industrial postdocs are working.

2. Informal suggestions and discussion among the participants.

The seminar is directed by Avner Friedman and Walter Littman. Visitors who plan to attend are requested to inform Dr. Friedman.

NOTE March 14–17, 1997:
Eighth SIAM Conference on Parallel Processing for Scientific Computing will take place at Hyatt Regency Hotel, 1300 Nicollet Mall, Minneapolis

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IMA Workshop:

Computational Radiology and Imaging: Therapy and Diagnostics

March 17–21, 1997
Organizers: Christoph Borgers (Tufts / Univ. of Michigan) and
Frank Natterer (Univ. of Münster, Germany)

Radiation is used in medicine for both diagnostics (for instance, tomography) and therapy (for instance, radiation treatment of cancer). These applications lead to hard computational and mathematical problems. From a mathematical point of view, many of these are related to differential or integro-differential equations. As an example, Boltzmann transport equations underlie the modeling of optical tomography and radiotherapy planning. Typically, inverse problems are the ones of ultimate interest, but even the forward problems are often quite difficult computationally.

The workshop brings together Applied Mathematicians, Numerical Analysts, Nuclear Engineers, and Medical Physicists working on different aspects of these and related problems, including subjects such as X-ray tomography and magnetic resonance imaging. One of the main purposes of the workshop is to improve communication between different groups of researchers working on different aspects of the same problems, sometimes without even knowing about each other's existence. There will therefore be a substantial number of expository talks aimed at non-specialists.

Monday, March 17

Talks today are in Lecture Hall EE/CS 3-180

8:45 am	**Registration and Coffee**	Reception Room EE/CS 3-176
9:15 am	**Welcome and Orientation**	A. Friedman, R. Gulliver, F. Natterer
9:30 am	**Harrison H. Barrett** University of Arizona	Scattered Radiation in Emission Computed Tomography: Accurate Modeling and Optimum Utilization

Abstract: Emission computed tomography is an important medical imaging modality in which a radioactive tracer is used to probe anatomical structures or physiological function. The tracer emits gamma rays, which then interact witht he tissues of the body primarily by photoelectric absorption and inelastic Compton scattering. Some of the gamma rays escape the body, pass through a collimator or pinhole aperture and are detected by a device called a gamma-ray camera. This device makes a relatively inaccurate estimate of the position and energy of each gamma ray that strikes it. The objective is to make many such measurements and deduce the three-dimensional distribution of the tracer.

In this talk, we shall discuss some of the analytical and numerical problems that arise in emission tomograpy. We shall present rapid numerical means of modeling the forward problem, an approach to the inverse problem

based on a Neumann series, a method for assessing the image quality that can be obtained from a particular data set and a way of optimizing the system for maximum image quality.

This is joint work with Eric Clarkson, Brandon Gallas, Bo Huang, Timothy White, and Anne Clough.

10:30 am	**Coffee Break**	Reception Room EE/CS 3-176
11:00 am	**S.R. Arridge** University College London	Image reconstruction in optical tomography

Abstract: Optical Tomography is a new medical imaging modality that is at the threshold of realisation. A large amount of clinical work has shown the very real benefits that such a method could provide. At the same time a considerable effort has been put into theoretical studies of its probable success. At present there exist gaps between these two realms. In this paper, the underlying basis for the image reconstruction process is reviewed, and examples are presented that show the realistic resolution, contrast and specificity that may be expected. In particular we discuss problems of acquistion time, computational efficiency and reconstruction artefacts. We suggest in particular that both time-resolved, and intensity-modulated systems can reconstruct variations in both optical absorption and scattering, but that unmodulated, non-time-resolved systems are prone to severe artefact. Furthermore, classical back-projection style reconstructions are insufficient and iterative methods are required.

2:00 pm	**Robert Y. Levine** MIT	The application of the x-ray transform to 3D conformal radiotherapy with dynamic multileaf collimators

Abstract: It is shown that for γ-ray ($> 1MeV$) therapy the delivered dose can be approximated by the dual attenuated x-ray transform of the filtered beam profiles. The implied treatment geometry is appropriate for the new multileaf collimators. The number of intensity-modulated beams required for conformal radiotherapy is examined using the mathematics of tomographic reconstruction. For a 2D tomotherapy geometry the sampling requirement is at most $(2\pi r_{max} W_{max} + 5/2)$ beams, where r_{max} and W_{max} are the maximum spatial extent and frequency, respectively, of the radiation dose. We generalize this "Bow Tie" solution to 3D, suggesting a sufficient beam number given by $(\Delta\omega/2\pi W_{max})(2\pi r_{max} W_{max} + 5/2)^2$, where $\Delta\omega$ is the frequency resolution of the beam front modulation delivered by the multilear collimator. The matrix inversion implicit in this bound suggests a beam selection criteria. The beam angles should be chosen such that the SVD inversion to beam profiles is non-singular for the entire configuration. The direct function metric among beam profiles provides another criteria for choosing beam angles. By maximizing the overlap between the sampled and continuous beam profile functions, the intensity (in the ρ-metric) is derived and displayed relative to the 3D data set for a ranking of beam orientations.

The formalism above is applied to the derivation and evaluation of radiotherapy plans for brain and prostate tumors based on real patient data from the UMASS Medical School and Massachusetts General Hospital. Dose-volume histograms are examined for evidence of beam number thresholds in conformal treatments.

4:00 pm	**IMA Tea (and more!)**	Vincent Hall 502 (The IMA Lounge)

A variety of appetizers and beverages will be served.

Tuesday, March 18

Talks today are in Lecture Hall EE/CS 3-180

9:15 am	**Coffee**	Reception Room EE/CS 3-176
9:30 am	**Gabor Herman** Univ. of Pennsylvania	Some Computational Issues in Medical Imaging

Abstract: Some solutions to medical imaging problems are computationally extremely intensive. Examples are the use of image modeling Gibbs priors for the restoration or reconstruction of images and fully three dimensional

image reconstruction as practiced in Positron Emission Tomography and in Electron Microscopy. In this talk we describe the nature of these problems and discuss some of the approaches that have been taken to reduce the computational load required for solving them.

10:30 am	**Coffee Break**	Reception Room EE/CS 3-176
11:00 am	**D.S. Anikonov** Acad. Sci. Vladivostok, Russia	Tomography through the Transport Equation

Abstract: The transport equation is considered as a mathematical model of passage of the radiation through a medium. The report deals with the inverse problems of the transport equation. These problems consist in determination of the coefficients of the transport equation or their partial characterization provided the intensity of the radiation on the boundary of a given body is known.

Another derection of the investigation is the comparison of various mathematical models used in tomography. For example the models based on the transport equation and the diffusion approximation are considered.

2:00 pm	**Christopher R. Johnson** University of Utah	Bioelectric Field Imaging Problems: Modeling, Computation, and Visualization

Abstract: Computational bioelectric field problems often require a researcher to apply diverse skills in confronting problems involving very large data sets, three-dimensional complex geometries, large-scale computing, hefty amounts of numerical analysis, and visualization. In this talk, I will present an overview of these distinct, but interrelated aspects of large scale bioelectric field imaging problems, focusing on inverse problems in cardiology and neuroscience.

3:30–4:00	**Peter Maass** Univ. of Potsdam, Germany	Nonlinear Inverse Problems and Emission Tomography

Abstract: Mathematical results on the convergence of standard regularization methods (Tikh onov, iteration methods) for nonlinear inverse problems can only be obtained under strong assumptions on the underlying operator. The aim of this talk is to discuss the applicability of these methods for emission tomography.

Wednesday, March 19

Talks today are in Lecture Hall EE/CS 3-180

9:15 am	**Coffee**	Reception Room EE/CS 3-176
9:30 am	**Lawrence Shepp** Rutgers Univ. and AT&T Bell Labs	New Inverse Problems and Applications of Old Ones

Abstract: A discussion of discrete tomography, refraction tomography, and functional magnetic resonance imaging and related pure math problems.

10:30 am	**Coffee Break**	Reception Room EE/CS 3-176
11:00 am	**Weldon A. Lodwick** Univ. of Colorado at Denver	Inverse Radiation Treatment Planning— Theoretical and Implementational Issues

Abstract: This project deals with radiation therapy of cancer tumors — the mathematical models and development of computer systems to do the two-dimensional problem. Results will be presented for several ways to do this, both on phantoms and actual patient CT's. Preliminary work will be described on the three-dimensional problem.

2:00 pm	**Michael V. Klibanov** Univ. North Carolina at Charlotte	A novel approach to numerical methods in diffuse and acoustical imaging

Abstract: In the past several years researchers have become increasingly more interested in effective numerical methods for image reconstruction which would deal with highly scattered radiation, as opposed to the conventional techniques of computed tomography. A major practical attraction of such methods lies in a number of important applications which range from the early female breast cancer diagnosis and underwater mine search (*i.e.* diffuse imaging) to the "classical" inverse problems in geophysics (*i.e.* acoustical imaging).

These methods are expected to work with n-dimensional ($n = 2, 3$), rather than with 1-dimensional Inverse Scattering Problems (ISP). Obviously, the multi-dimensionality is a major obstacle in the development of such algorithms.

In this talk, we will present a novel approach to this challenging problem derived recently by ourselves [1,2]. We call this procedure "Carleman's Weight Method" (CWM). CWM works with ISPs for both hyperbolic and parabolic equations which model perfectly acoustical and diffuse imaging respectively. One of the attractive features of CWM is that rigorous global convergence results are proven.

Also, we will present our numerical resutls for a locally convergent version of CWM (i.e. Newton's Method) which deals with diffuse image reconstruction. It should be pointed out that these results were obtained for two ranges of parameters which perfectly model the situation of both an early breast cancer diagnosis and underwater mine search using ultrafast laser pulse propagation. Our computational experience shows a good potential of CWM. In particular, its computational complexity is of order several magnitudes less than that of many competing algorithms.

This is joint work with Thomas R. Lucas and Robert M. Frank.

References

1. M.V. Klibanov and O.V. Ioussoupova, SIAM J. Math Anal., **26** (1995), 147–179.
2. S. Gutman, M.V. Klibanov, and A.V. Tikhonavov, IMA J. Appl. Math., (1996).

Thursday, March 20

Talks today are in Lecture Hall EE/CS 3-180

9:15 am	**Coffee**	Reception Room EE/CS 3-176
9:30 am	**David L. Colton** Univ. of Delaware	Mathematical Problems in Microwave Medical Imaging

Abstract: In recent years there has been an increased interest in the use of microwaves in medical imaging,particularly for the detection of cancerous tumors.This method is based on the fact that cancerous tumors have a significantly different index of refraction.Hence,the mathematical problem is basically an inverse scattering problem for electromagnetic waves.We will present a method for determining the support of tumors in the body which is suitable for microwave imaging and leads to the problem of solving an improperly posed Fredholm integral equation of the first kind.We note that the validity of this integral equation is unrestricted,i.e. no physical approximations have been made in its derivation.The investigation of this equation leads to the study of a new class of boundary value problems for elliptic equations called interior transmission problems.Numerical examples using synthethic data will be given showing the potential practicality of our method.

10:30 am	**Coffee Break**	Reception Room EE/CS 3-176
11:00 am	**Gunnar Sparr** Institute of Technology Lund	Vector Field Tomography

Abstract: Computerized tomography usually aims at the reconstruction of some scalar density function from

data collected along lines. Analogous problems for reconstruction of vector fields have recently been studied by several authors, motivated by different applications. An overview of this work will be given in the talk.

In many situations, e.g. time of flight and Doppler measurements on flows, the integral of the component of the flow vector along lines can be measured. However, from this information, it is only possible to compute the curl of the vector field. The remaining part of the field, the divergence, can in principle be determined from analogous information about the normal of the vector field, a kind of data which however is difficult to acquire in practice. Using apriori-information about the field, e.g. that it is bound to 'vessels', where it has a parabolic velocity profile, uniqueness can be achieved, without using the normal components.

It is natural to consider also generalized transforms, modeling exponential decay along the lines of measurement. Also in this case it is possible to formulate reconstruction methods.

A problem of a different nature, much more difficult, containing also non-linear, combinatorial ingredients, is reconstruction in the case when the distribution of the vector field components along lines are known, i.e. 'velocity spectra'. This situation occurs naturally in connection with ultrasound Doppler measurements. Some results about this problem will be discussed, using a parametrization that also turns out to be useful in scalar tomography.

Applications can be found in ultrasonic imaging in medicine, flow imaging in non-destructive testing, and in photoelasticity. Results of some experiments and simulations of ultrasound Doppler measurements will be reported.

2:00 pm	**Rolf Clack** University of Utah	Some Recent Results in Cone-Beam Tomography

Abstract: A cone-beam projection of some object is a collection of ray-sums through the object, where all the rays converge on a single "vertex point" in space. Usually this vertex point is outside the object, and it is often assumed that from each vertex point, every non-zero ray-sum through the object is available. If some of these ray-sums are not available, the cone-beam projection is called a truncated projection.

Several algorithms are available to reconstruct the object from its cone-beam projections, under the assumptions that the vertex point travels along a suitable path in space and that no projection is truncated. There has been progress recently on algorithms that relax these assumptions. Effective algorithms for handling certain kinds of truncated data will be discussed, and an algorithm that is able to reconstruct from a discrete, unordered set of vertex points (but with no truncated projections) will be presented.

Images obtained from these algorithms will be presented for the cases of computer-simulated data, and for data taken from a large-area CT scanner.

6:00 pm	**Workshop Dinner** Radisson Hotel	Alumni Room, second floor

Reception at 6:00 in the Alumni Room, dinner at 6:30.

Friday, March 21

Talks today are in Lecture Hall EE/CS 3-180

9:15 am	**Coffee**	Reception Room EE/CS 3-176
9:30 am	**Willi Jäger** University of Heidelberg	To be announced
10:30 am	**Coffee Break**	Reception Room EE/CS 3-176
11:00 am	**David Isaacson** Rensselaer Polytechnic Institute	Electrical Impedance Imaging

Abstract: It will be explained how attempts to improve the diagnosis and treatment of heart disease and breast

cancer have lead to inverse problems for Maxwell's equations.

Some of these problems arise in the design of electrical impedance imaging systems. These systems apply electrical currents to the surface of a body. They measure and record the voltages that result on the surface. From these measurements a reconstruction and display of the electrical conductivity and permittivity inside the body is made.

It will be explained how the spectral properties of the Dirichlet to Neumann operator influence the design of these systems.

Images and movies from the ACT3 system will also be shown.

2:00 pm **Yair Censor**
University of Haifa

On the Fully Discretized Model for the Inverse Problem in Radiation Therapy Treatment Planning

Abstract: The forward problem of radiation therapy treatment planning (RTTP)–commonly called dose calculation– involves the use of empirical look-up tables and complex formulae. In order to represent it with a closed-form mathematical formula several simplifying assumptions need to be made on the model. Even then transform inversion is not readily available.

The fully discretized approach to RTTP [1, 2] allows us to maintain the forward calculations in their utmost accurate form and use special-purpose iterative mathematical optimization algorithms for the inversion. Some of these algorithms are either parallelizable or parallel already in their mathematical formulations, [3].

The ray-intensities solution obtained in such a way needs to be appropriately translated to treatment machine parameters. We review this approach, point out some of its weaknesses and compare it with other solution methods of the inverse problem in RTTP.

References

[1] Y. Censor, M.D. Altschuler, and W.D. Powlis, "On the use of Cimmino's simultaneous projections method for computing a solution of the inverse problem in radiation therapy treatment planning", Inverse Problems, 4:607-623, 1988.
[2] W.D. Powlis, M.D. Altschuler, Y. Censor, and E.L. Buhle, Jr., "Semi- automatic radiotherapy treatment planning with a mathematical model to satisfy treatment goals", International Journal Radiation Oncology Biology Physics, 16:271-276, 1989.
[3] Y. Censor and S.A. Zenios, Parallel Optimization : Theory, Algorithms, and Applications, A volume in the series: Numerical Mathematics and Scientific Computation, Oxford University Press, New York, 1997.

Monday, March 24

Tuesday, March 25

IMA Postdoc Seminar

2:30 pm **To be announced**

Organizer: Qing Nie

NOTE: The Postdoc Seminar is organized by the IMA postdoctoral members, but all interested IMA participants are very welcome to attend. The Seminar meets in Vincent Hall 570.

Wednesday, March 26

Thursday, March 27

Friday, March 28

A University of Minnesota holiday. IMA offices will be closed.

Monday, March 31

CURRENT IMA PARTICIPANTS

POSTDOCTORAL MEMBERS FOR 1996–97 PROGRAM YEAR

NAME	PREVIOUS INSTITUTION
GOBBERT, MATTHIAS	Arizona State University
LOTOTSKY, SERGEY	University of Southern California
MALIASSOV, SERGUEI	Texas A&M University
NGUYEN, BRIAN	University of Michigan
NIE, QING	Ohio State University
SARKAR, SANHITA	University of Minnesota
SUCHOMEL, BRIAN	University of Wyoming
YANG, DAOQI	Wayne State University

POSTDOCTORAL MEMBERSHIPS IN INDUSTRIAL MATHEMATICS FOR 1996–97

NAME	PREVIOUS INSTITUTION	INDUSTRIAL AFFILIATION
CHAWLA, SANJAY	University of Tennessee	Honeywell
KOURITZIN, MICHAEL	Carleton University	Lockheed Martin
LOPEZ, GILBERTO	Northwestern University	Eastman Kodak
WANG, LEI	University of Washington	Honeywell

VISITORS IN RESIDENCE (as of 2/13)

AARSVOLD, JOHN	University of Michigan	MAR 17 - 21
ANIKONOV, DIMITRI	Far Eastern Branch Russian Acad. Sci.	MAR 16 - 21
ARRIDGE, S. R.	University College London	MAR 16 - 21
AXELSSON, C.	Linkoping University	MAR 1 - 31
AXELSSON, O.	Toernooiveld 1	MAR 17 - 21
BADEN, SCOTT	Univ. of California-San Diego	MAR 11 - 16
BARNSLEY, MICHAEL	Iterated Systems Incorporated	MAR 2 - 3
BARRETT, HARRISON H.	University of Arizona	MAR 15 - 22
BAUMAN, SARA	University of Wisconsin-Madison	MAR 11 - 13
BERENSTEIN, CARLOS A.	University of Maryland	MAR 16 - 21
BERGER, MARSHA J.	NYU-Courant Institute	MAR 11 - 13
BEYLKIN, GREGORY	University of Colorado	MAR 16 - 21
BJORSTAD, PETTER	University of Bergen	SEP 1 - JUN 30
BONDARENKO, A	University of Novosibirsk	MAR 1 - 31
BORGERS, CHRISTOPH	Tufts University	MAR 15 - 21
BRENNER, SUSANNE	University of South Carolina	JAN 13 - JUN 30
BROWNE, J.C.	University of Texas, Austin	MAR 11 - 13
CENSOR, YAIR	University of Haifa	MAR 16 - 22
CHANG, ROSEMARY	Silicon Graphics Computer Systems	MAR 1 - 3
CHENEY, MARGARET	Rensselaer Polytechnic Institute	JAN 1 - JUN 30
CHOPTUIK, MATTHEW	University of Texas- Austin	MAR 11 - 13
CHRISOCHOIDES, NIKOS	Cornell University	MAR 11 - 13

CINZORI, AARON	Michigan State University	MAR 15 - 21
CLACK, R.	Unversity of Utah	MAR 1 - 29
COCKBURN, BERNARDO	University of Minnesota	SEP 1 - AUG 31
COLELLA, PHIL	University of California	MAR 11 - 13
COLTON, DAVID L.	University of Delaware	MAR 15 - 21
CULLUM, JANE	IBM TJ Watson Research Center	MAR 11 - 17
DEROSE, TONY	Pixar	MAR 2 - 3
DESBAT, LAURENT	Université Joseph Fourier	MAR 1 - 31
FESSLER, JEFF	University of Michigan	MAR 16 - 22
FINCH, DAVID	Oregon State University	MAR 15 - 21
FRIEDMAN, AVNER	Institute for Mathematics	SEP 1 - AUG 31
GANNON, DENNIS	Indiana University	MAR 11 - 13
GEMAN, STUART	Brown University	MAR 2 - 3
GREGERSON, EUGENE A.	Lincoln Laboratories	MAR 16 - 21
GRUNBAUM, ALBERTO F.	University of California	MAR 16 - 21
GULLIVER, ROBERT	Institute for Mathematics	SEP 1 - AUG 31
GUNTER, DONALD LEE	Rush-Pres. St. Luke's Medical Center	MAR 17 - 21
HANSEN, HENRIETTE	University of Bergen	FEB 3 - MAR 6
HAUPT, TOMASZ	NPAC Syracuse University	MAR 11 - 13
HEJHAL, DENNIS	University of Minnesota	SEP 1 - AUG 31
HERMAN, GABOR T.	University of Pennsylvania	MAR 16 - 21
HORNUNG, RICHARD	Lawrence Livermore National Lab	MAR 11 - 13
HU, WEI	University of Kentucky	MAR 15 - 21
ISAACSON, DAVID	Rensselaer Polytechnic Institute	MAR 16 - 21
JÄGER, WILLI	Universität Heidelberg	MAR 16 - 21
JOHNSON, CHRIS	University of Utah	MAR 16 - 21
KANEKO, AKIRA	University of Tokyo	MAR 1 - 30
KEYES, DAVID E.	NASA	MAR 11 - 13
KLEINMAN, RALPH	University of Delaware	FEB 1 - MAR 31
KLIBANOV, MICHAEL	Univ. North Carolina at Charlotte	MAR 16 - 21
KODUKULA, INDUPRAKAS	University of Notre Dame	MAR 11 - 13
KOHN, SCOTT	Univ. of California- San Diego	MAR 11 - 13
KRUZIK, MARTIN	Czech Academy of Sciences	SEP 1 - JUN 30
LADYZHETS, VLADIMIR S.	Florida International University	MAR 15 - 23
LAMM, PATRICIA	Michigan State University	MAR 16 - 21
LEVINE, ROBERT Y.	Lincoln Laboratories	MAR 16 - 21
LEWITT, R. M.	University of Pennsylvania	MAR 15 - 21
LIANG, JIE	University of Illinois at Urbana	JUN 29 - 30
LITTMAN, WALTER	University of Minnesota	SEP 1 - AUG 31
LODWICK, WELDON	University of Colorado - Denver	MAR 16 - 21
LOUIS, ALFRED K.	Universität des Saarlandes	MAR 16 - 21
LOWENGRUB, JOHN	University of Minnesota	SEP 1 - AUG 31
LUSKIN, MITCHELL	University of Minnesota	SEP 1 - AUG 31
MAASS, PETER	Universitat Potsdam	MAR 10 - 22
MAIR, BERNARD	University of Florida	MAR 16 - 21
MEAKIN, ROBERT	Ames Research Center	MAR 11 - 13
MEHROTRA, PIYUSH	ICASE/NASA	MAR 11 - 13
MICHALAKES, JOHN	Argonne National Laboratory	MAR 11 - 13
MYERS, CHRISTOPHER	Cornell Theory Center	MAR 11 - 13
NATTERER, FRANK	Universität Münster	FEB 16 - MAR 31
NEEMAN, HENRY	Univ. of Illinois Urbana-Champaign	MAR 11 - 15
NORMAN, MIKE	NCSA, UIUC	MAR 11 - 15
OLVER, PETER	University of Minnesota	MAR 2 - 3
PAPIEZ, L. S.	Indiana University Medical Center	MAR 15 - 21
PARASHAR, MANISH	University of Texas- Austin	MAR 11 - 13
PATCH, SARAH	Stanford University	MAR 16 - 21

PEITGEN, HEINZ-OTTO	Universität Bremen	MAR 16 - 21
PERNICE, M.	University of Utah	MAR 11 - 13
PINGALI, KESHAV	University of Notre Dame	MAR 11 - 13
PROHL, ANDREAS	Universität Heidelberg	SEP 1 - JUN 30
QUINLAN, DANIEL	Los Almos National Laboratory	MAR 11 - 13
QUINTO, ERIC T.	Tufts University	MAR 17 - 21
RACKNER, BARRY	Minnesota Supercomputer Center	SEP 1 - AUG 31
RAHMAN, MOHAMMAD	University of Bergen	MAR 11 - JUN 20
ROSENAU, PHILLIP	Tel Aviv University	MAR 10 - 19
ROSENFELD, RONI	Carnegie-Mellon University	MAR 2 - 3
SCHUMAKER, LARRY	Vanderbilt University	MAR 2 - 3
SCOFIELD, TOM	Michigan State University	MAR 16 - 21
SCOTT, RIDGWAY	University of Houston	MAR 1 - 31
SELL, GEORGE	University of Minnesota	SEP 1 - AUG 31
SHEPP, LAWRENCE	AT&T Bell Labs/Rutgers Univ.	MAR 16 - 21
SKEEL, ROBERT	University of Illinois - Urbana	MAR 13 - 17
SPARR, GUNNAR	Institute of Technology Lund	MAR 8 - 23
STENGER, FRANK	The University of Utah	MAR 16 - 21
SVERAK, VLADIMIR	University of Minnesota	SEP 1 - AUG 31
TEWFIK, AHMED	University of Minnesota	MAR 2 - 3
TRANGENSTEIN, JOHN	Duke University	MAR 11 - 13
UDUPA, J. K.	University of Pennsylvania	MAR 15 - 19
VON DER MOSEL, HEIKO	Universität Bonn, Germany	FEB 4 - MAR 4
WALNUT, D.F.	George Mason University	MAR 7 - 25
WUEBBELING, F.	Universität Münster	MAR 1 - 31
YABUSAKI, STEVE	Pacific Northwest National Lab	MAR 11 - 17