INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

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IMA NEWSLETTER # 332

1–30 June 2004

2003–2004 Program

PROBABILITY AND STATISTICS IN COMPLEX SYSTEMS

See http://www.ima.umn.edu/complex/ for a full description of the 2003–2004 program on Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering

IMA schedules are subject to revision, particularly during workshops. See http://www.ima.umn.edu/~seminar/sched and http://www.ima.umn.edu/newsltrs/ for the latest scheduling information.

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PART I: NEWS AND NOTES

IMA New Directions

The next New Directions program will start next month. The goal of the program is to provide mid-career scientists with an opportunity to broaden their work in an interdisciplinary way.

The program will begin with a Short Course on Computational Topology, to be held 6–16 July. The course will be taught by Herbert Edelsbrunner and John L. Harer, both of Duke University.

The program will continue in the fall with the arrival of our New Directions Visiting Professors: Zhi-Qiang Wang (Utah State University) will be at the IMA in the fall and Shi Jin (University of Wisconsin) in the spring. Baisheng Yan (Michigan State University) will attend the full year. All three will spend their time at the IMA immersed in the annual thematic program on “Mathematics of Materials and Macromolecules: Multiple Scales, Disorder, and Singularities”.

PARTICIPATING INSTITUTIONS: Consiglio Nazionale delle Ricerche (CNR), Georgia Institute of Technology, Indiana University, Iowa State University, Kent State University, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Michigan State University, Mississippi State University, Northern Illinois University, Ohio State University, Pennsylvania State University, Purdue University, Rice University, Sandia National Laboratories, Seoul National University (BK21 Math-SNU), Seoul National University (SRCCS), Texas A&M University, University of Chicago, University of Cincinnati, University of Delaware, University of Houston, University of Illinois (Urbana), University of Iowa, University of Kentucky, University of Maryland, University of Michigan, University of Minnesota, University of Notre Dame, University of Pittsburgh, University of Wisconsin, University of Wyoming, Wayne State University.

PARTICIPATING CORPORATIONS: Boeing, ExxonMobil, Ford, General Electric Company, General Motors, Honeywell, IBM, Lockheed Martin, Lucent, Motorola, Schlumberger, Siemens, Telcordia Technologies, 3M.

Version of July 6, 2004

New IMA Postdocs

Six new IMA postdoctoral members, selected from over 100 applicants, will arrive in September 2004: Brian DiDonna (University of Chicago, Physics), Sookyung Joo (Purdue University, Mathematics), Richard Kollár (University of Maryland, Mathematics), Matthias Kurzke (University of Leipzig, Mathematics), Frédéric Legoll (École nationale des Ponts & Chaussées, Applied Mathematics) and Xiantao Li (University of Wisconsin, Mathematics). Welcome!

IMA Summer Program:

n-Categories: Foundations and Applications

7-18 June 2004
Organizers: J. Peter May (University of Chicago),
John Baez (University of California at Riverside)

See http://www.ima.umn.edu/categories/

IMA Participating Institution Summer Program for Graduate Students:

Coding and Cryptography

8-26 June 2004 at the University of Notre Dame
Lecturers: G. David Forney, Jr. (Massachusetts Institute of Technology),
James L. Massey (ETH Zurich),
Michael E. O'Sullivan (San Diego State University),
Vera Pless (University of Illinois at Chicago),
Joachim Rosenthal (University of Notre Dame),
Andreas Stein (University of Illinois at Urbana-Champaign)

http://www.ima.umn.edu/PI/2004summergrad.html

IMA "Hot Topics" Workshop:

Adaptive Sensing and Multimode Data Inversion

27-30 June 2004
Organizers: Lawrence Carin (Duke University),
George Papanicolaou (Stanford University),
Fadil Santosa (University of Minnesota),
Michael Vogelius (Rutgers University),

See http://www.ima.umn.edu/hot-topics/2004/W6.27-30.2004.html

IMA Website

Comments or suggestions concerning the IMA website 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.

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PART II: Schedule for 1–30 JUNE 2004

Tuesday, June 1

The 10:30 IMA break will be in Lind Hall 400.

Wednesday, June 2

The 10:30 IMA break will be in Lind Hall 400.

BROWN BAG SEMINAR, Lind Hall 409:

12:00	**Jun Zhao** IMA	Overlapping Schwarz Methods for Maxwell Equations

The IMA Brown Bag Seminar is organized by
Tim Garoni and Tamon Stephen.

Thursday, June 3

The 10:30 IMA break will be in Lind Hall 400.

Friday, June 4

The 10:30 IMA break will be in Lind Hall 400.

Monday, June 7

IMA Summer Program:

n-Categories: Foundations and Applications

7–18 June 2004
Organizers: J. Peter May (University of Chicago),
John Baez (University of California at Riverside)

See http://www.ima.umn.edu/categories/

This summer program is about an area of mathematics which is very new and of great current interest. It concerns iterative structures that appear naturally in a wide variety of contexts.

Eilenberg and MacLane introduced categories, functors, and natural transformations in a landmark 1945 paper. The language they introduced transformed modern mathematics. In fact, a very great deal of mathematics since then would quite literally have been unthinkable without that language. Their focus was not on categories and functors, but on natural transformations, which are maps between functors. Implicitly, they were introducing the 2-category "Cat" of categories, functors, and natural transformations.

Higher category theory concerns higher level notions of naturality, which can be expressed as maps between natural transformations, maps between such maps. Just as the original definitions of Eilenberg and MacLane gave a way of thinking about categorical structures and analogies between such structures in different fields, higher category theory promises to allow serious thinking about and study of higher categorical structures that appear in a variety of specific fields. The need for such a language has become apparent, almost simultaneously, in mathematical physics, algebraic geometry, computer science, logic, and, of course, category theory. Such a language and a relevant body of results is already implicit throughout algebraic topology. In all of these areas, higher categorical structures are there in nature, and one needs a coherent way of thinking about them.

In contrast to the introduction of categories, functors, and natural transformations, which could successfully be carried out by two authors in one paper, the development of higher category theory is technically very difficult mathematics. Our central goal is to end up with a coherent theory that is field independent. We hope to develop a clear language of higher category theory that, like the original language of categories, functors, and natural transformations, can be accepted, understood, and worked with by mathematicians in general, whether algebraic geometers, logicians, algebraic topologists, mathematical physicists, or theoretical computer scientists.

We have in mind many general surveys and open-ended discussions. As a general rule, we are following an old suggestion to have particular definitions of (weak) n-categories presented by people other than their creators. Following the lead of experience with the geometric Langlands seminar at Chicago, and other "Russian style" seminars elsewhere, we plan long late afternoon and evening sessions. We are in process of working out logistics for dinners at these seminars. (Going out for dinner is civilized, but fattening and not very productive.) Early afternoons are working time.

SUMMER PROGRAM FIRST WEEK

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30-9:00	**Coffee and Registration**	Reception Room EE/CS 3-176
9:00–9:15	**Douglas N. Arnold, Scot Adams, and Organizers**	Welcome and Introduction
9:15–10:45	**John Baez** University of California at Riverside	Why n-Categories?
10:45–11:15	**Coffee Break**	Reception Room EE/CS 3-176
11:15–12:15	**John Baez** University of California at Riverside	What n-Categories Should Be Like
2:00–2:10	**Group Photo**	
2:10	**Reception**	Lind Hall 400

4:00–8:00	**Thomas Leinster** University of Glasgow	Survey and Taxonomy

Tuesday, June 8

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00-10:30	**André Joyal** Université du Québec à Montréal **J. Peter May** University of Chicago **Timothy Porter** University of Wales, Bangor	Weak Categories
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Michael Batanin** Macquarie University	A_∞ Operad Definition
4:00–8:00	**Thomas Leinster** University of Glasgow **Eugenia Cheng** University of Cambridge	Multicategories and Related Definitions

Abstract: *1. General*

In these talks I intend to give a brief overview and then let the pace be set by the audience. I won't be producing detailed notes because the details will depend heavily on what the audience wants at the time. However, general notes can be found in *Higher-Dimensional Categories: an illustrated guidebook*, Chapters 2, 3 and 4. This is available from

http://www.dpmms.cam.ac.uk/∼elgc2/guidebook

2. Multicategories and related definitions

Tom Leinster will begin with an introduction to generalised multicategories and operads. I will then explain related definitions that use the notion of algebraic structure on underlying data consisting of "globular" cells. These definitions are expressed in the form: "An ω-category is an algebra for a certain monad/operad". I will explain the various components of the definition as necessary — I envisage this including magmas, contractions and the construction of the initial operads in question, possibly globular sets and probably not monads and algebras. (A crash course on monads and algebras can be found in the *Guide Book*, Section 2.4. I will be happy to talk about it informally beforehand if anyone needs it.)

I will also briefly discuss points of comparison between these three related definitions, if there is time.

3. Opetopic definitions

My aim in this talk will be to convey the idea of the opetopic definitions while avoiding as much of the technical detail as possible. Experience has shown that this is highly expedient for those wishing to get a feel for the theory without necessarily wanting to calculate with it. I will explain the ideas behind the theory and the various components of the definition: opetopes, opetopic sets, niches, and universal cells. I will show how to recover a classical bicategory from an opetopic 2-category as this tends to help shed a great deal of light on the various components of the definition. If there is time I will discuss various notions of strictness and points of comparison with other definitions.

Note that for the benefit of overall understanding I will aim to avoid talking in detail about: the use of multicategories in the iterative construction of opetopes, the different technical approaches to this construction, and the construction of

morphisms of opetopes. I will be happy to talk about this in an informal session another day if anyone is keen to hear these details.

Wednesday, June 9

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**J. Peter May** University of Chicago	Model Categories
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Clemens Berger** University of Nice	Cellular Definitions

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BROWN BAG SEMINAR, Lind Hall 409:

12:00	**Gerard Awanou** IMA	Shortfall Risk Minimization in the Presence of Inside Information

Abstract: The safest criterion for eliminating completely the risk associated with a risky position is the superhedging one but it may require too much initial capital. In a market with inside information, it makes sense to ask how much one can lower the initial cost and what risk it involves. We discuss strategies for risk minimization in this context using a discrete model of stock fluctuations.

The IMA Brown Bag Seminar is organized by
Tim Garoni and Tamon Stephen.

4:00–8:00	**Eugenia Cheng** University of Cambridge	Opetopic Definitions

Abstract: Same as the abstract for the 4-8 pm talk on Tuesday 8 June.

Thursday, June 10

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**André Joyal** Université du Québec à Montréal	Perspective

10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Nick Gurski** University of Chicago **Thomas Leinster** University of Glasgow	Simplicial Definition
4:00–8:00	**Larry Breen** Universite Paris 13	n-stacks & n-gerbes: Homotopy Theory

Friday, June 11

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**David Neil Corfield** Oxford University	Philosophy
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Bertrand Toen** Universite Paul Sabatier	Segalic Definition
4:00–6:00	**Bertrand Toen** Universite Paul Sabatier	n-stacks & n-gerbes: Algebraic Geometry

Monday, June 14

SUMMER PROGRAM SECOND WEEK

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**Zbigniew Fiedorowicz** Ohio State University	n-Fold Categories
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Stefan Forcey** Virginia Tech	Higher Enrichment
4:00–8:00	**moderator**	Comparisons

Tuesday, June 15

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**Michael Makkai** University do Algarve	Perspectives
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Mark Weber** University of Ottawa	Higher Monads
4:00–8:00	**moderator**	Comparisons

Wednesday, June 16

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**Michael Batanin** Macquarie University	Perspectives
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Joachim Kock** Université du Québec à Montréal	Topological Quantum Field Theory Primer
4:00–8:00	**Marco Mackaay** University do Algarve **John Baez** University of California at Riverside	Topological Quantum Field Theory and Quantum Gravity

Thursday, June 17

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**Ross Street** Macquarie University	Perspectives

Abstract: Much Australian work on categories is part of, or relevant to, the development of higher categories and their theory. In this talk, I hope to describe some of the origins and achievements of our efforts that they might perchance serve as a guide to the development of aspects of higher-dimensional work.

10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Stephen Lack** University of Western Sydney	Higher Model Categories
4:00–8:00	**John Power** University of Edinburgh **Philippe Gaucher** Université Paris 7 Denis-Diderot **Lisbeth Fajstrup** Aalborg University **Eric Goubault** Commissariat l'Energie Atomique	Computer Science: Programming Languages and Concurrency

Friday, June 18

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30–9:00	**Coffee**	Reception Room EE/CS 3-176
9:00–10:30	**Martin Hyland** Cambridge University	Perspectives
10:30–11:00	**Coffee Break**	Reception Room EE/CS 3-176
11:00–12:00	**Alissa Crans** University of California at Riverside	Higher Linear Algebra
2:00–4:00	**Tutti**	Problems and Directions

Monday, June 21

The 3:00 IMA break will be in Lind Hall 400.

Tuesday, June 22

The 10:30 IMA break will be in Lind Hall 400.

Wednesday, June 23

The 10:30 IMA break will be in Lind Hall 400.

Thursday, June 24

The 10:30 IMA break will be in Lind Hall 400.

Friday, June 25

The 10:30 IMA break will be in Lind Hall 400.

Sunday, June 27

IMA "Hot Topics" Workshop:

Adaptive Sensing and Multimode Data Inversion

27–30 June 2004
Organizers: Lawrence Carin (Duke University),
George Papanicolaou (Stanford University),
Fadil Santosa (University of Minnesota),
Michael Vogelius (Rutgers University),

See http://www.ima.umn.edu/hot-topics/2004/W6.27-30.2004.html

There has been much progress in the development of theory and effective methods for solving inverse problems for acoustics, electromagnetic waves, and elastic waves. However, most of the progress has been made in situations where the measurement setup is "static," that is, it does not adaptively change as the probing proceeds. Moreover, very little work has been done in situations where the measurements are truly multimodal.

The research in adaptive sensing and multimode data inversion is only beginning. Adaptive sensing starts out by probing the unknown with a set initial pattern, but the pattern then adaptively changes in response to the information acquired. An example of such a system is the distinguishability method in electrical impedance imaging. Multimode data leverages information available through different physical probes and sensors, and can potentially contain much more information than data coming from a single modality. An important example of the need for multimode data inversion is in detection of unexploded ordinance/anti-personnel mines.

The purpose of this workshop is to gather researchers who work in electromagnetic, acoustic and elastic inverse problems as well as pioneers in the area of adaptive sensing and multimode inversion to address computational, theoretical, and practical challenges of dealing with adaptivity and multimode inversion. Invited talks will address recent development in inverse problems, forward modeling for single and multi-modality, adaptive methods, optimal experimental design, and in new approaches to inversion of multimode data.

On Sunday, all talks are in Lind Hall 305 unless otherwise noted.

8:30–9:15	**Coffee and Registration**	Reception Room Lind Hall 400
9:15–9:30	**Douglas N. Arnold, Fadil Santosa, and Organizers**	Welcome and Introduction; Lind Hall 305
9:30–10:00	**George C. Papanicolaou** Stanford University	Adaptive Multiresolution Interferometry

Abstract: Interferometric array imaging in a cluttered environment works well only if the residual space-time coherence of the array data is taken into consideration appropriately. Is there a way to account for coherence effects in an optimal way? We will examine this question by using the adaptive local cosine transform. We will review briefly adaptive multiresolution methods and we will discuss how they can be used in imaging. We will also show results of numerical simulations.

10:00–10:30	**Lawrence Carin** Duke University	Semi-Supervised and Adaptive Multi-Aspect Sensing of General Targets

Abstract: In design of statistical inversion algorithms, one typically assumes access to a set of labeled training data, represented by observed data and associated labels (a given label denotes the target/clutter type). A supervised algorithm is trained entirely on the labeled data. In practice the amount of available labeled training data is quite small, and this data does not account for environmental changes the sensor may encounter. By contrast, one typically has access to a large quantity of unlabeled data, with this changing as the environment changes. A semi-supervised classifier utilizes the labeled data and unlabeled data (i.e., all available data) to build an inversion algorithm. By utilizing the unlabeled data in the classifier design, the algorithm naturally accounts for changes in the properties of the environment, as seen by the sensor. We investigate a semi-supervised statistical inversion algorithm, employing a hidden Markov model (HMM), thereby accounting for multi-aspect sensing. In addition, the semi-supervised algorithm employs active sensing, wherein the inversion and sensing missions are combined. In this context the algorithm determines which new data would be most informative, if it were measured by the sensor. The active-sensing algorithm also defines those unlabeled signatures that would be most informative to classifier design if the associated labels were acquired. In this talk we summarize the underlying algorithmic developments, and show example results for measured underwater-acoustic scattering data.

Joint work with Shihao Ji.

10:30–11:00	**Coffee Break**	Reception Room Lind Hall 400

11:00–11:30	**Karl J. Langenberg** University of Kassel	Electromagnetic and Elastic Wave Scattering and Imaging for Multi-Mode Non-Destructive Testing

Abstract: Non-destructive testing of concrete is a safety relevant task in civil engineering. Therefore, particular attention must be given to a quantitative analysis of measured data, and a combination of different wave modes, i.e., electromagnetic and elastic waves, is often required. A typical problem is the location of metallic tendon ducts in concrete below the metallic reinforcement grid and their subsequent check against corrosion; to achieve this goal the physical scattering properties of electromagnetic and elastic waves may be exploited to complement each other.

To locate metallic objects embedded in concrete we apply diffraction tomographic imaging schemes either in reflection or transmission. Applications to synthetic data obtained with a Finite Difference Time Domain code reveals the resolution of the respective algorithms with the reinforcement grid size as a parameter; yet the application to experimental Ground Penetrating Radar data still exhibits a better performance on synthetic data.

Grouting holes in the tendon duct are perfect targets for elastic waves because they act as scattering voids. Yet for the ultrasonic frequency regime under concern, concrete is a very heterogeneous propagation medium. Therefore, detailed investigations were performed with the numerical EFIT code (Elastodynamic Finite Integration Technique) to understand elastic wave scattering in concrete; this is demonstrated with wave propagation movies. We confirm on synthetic as well as on experimental data that diffraction tomographic imaging techniques can be equally applied to ultrasonic data even in a highly random scattering environment.

11:30–12:00	**David Isaacson** Rensselaer Polytechnic Institute	Adaptive Current Tomography

Abstract: We explain how current patterns can be chosen adaptively in order to yield the largest "distinguishability" of different states of a body. Examples from monitoring heart and lung function , breast cancer detection, geophysical sensing, and crack detection in pipes will be shown that illustrate the theory.

12:00–2:00	**Lunch Break**	

2:00–2:30	**Liliana Borcea** Rice University	Coherent Interferometric Array Imaging in Clutter, Part I Theory

Abstract: We describe a new coherent interferometric approach to imaging small or extended sources hidden in clutter,

via passive arrays of transducers. The uncertainty in the index of refraction in clutter is modeled as a random process and the imaging method is based on the asymptotic stochastic analysis of wave propagation in random media, in regimes with strong multipath. To achieve stable results, our method uses cross-correlations of nearby traces recorded at the array, the interferograms. We also exploit the existence of a frequency coherence band in order to achieve good resolution of the images. Naturally, the spatial and frequency coherence of the data at the array depend on the random medium and, as we show here, they quantify explicitly the resolution of the images. The efficiency and robustness of the proposed method in clutter will be illustrated with several numerical results.

2:30–3:00	**Chrysoula Tsogka** Stanford University	Coherent interferometric Array Imaging in Clutter, Part II Numerical Results

Abstract: We describe a new coherent interferometric approach to imaging small or extended sources hidden in clutter, via passive arrays of transducers. The uncertainty in the index of refraction in clutter is modeled as a random process and the imaging method is based on the asymptotic stochastic analysis of wave propagation in random media, in regimes with strong multipath. To achieve stable results, our method uses cross-correlations of nearby traces recorded at the array, the interferograms. We also exploit the existence of a frequency coherence band in order to achieve good resolution of the images. Naturally, the spatial and frequency coherence of the data at the array depend on the random medium and, as we show here, they quantify explicitly the resolution of the images. The efficiency and robustness of the proposed method in clutter will be illustrated with several numerical results.

3:00–3:30	**Coffee Break**	Reception Room Lind Hall 400
3:30–4:15	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.

Monday, June 28

All talks are in Rapson Hall 100 unless otherwise noted.

9:00–9:30	**Coffee**	Just outside Rapson Hall 100
9:30–10:00	**Michael S. Vogelius** The State University of New Jersey	Effective Imaging of Small Inhomogeneities

Abstract: I shall give a review of the perturbation formulae (generalized Born Approximations) and the direct numerical reconstruction algorithms (of a linear samling nature) that are at the center of a very effective method to accurately image small inhomogeneities using electromagnetic measurements.

10:00–10:30	**Fernando Reitich** University of Minnesota	A New High-Order High-Frequency Integral Equation Method - for the Solution of Wave Scattering Problems

Abstract: The effort and interest in the design of improved algorithms for computational electromagnetics and acoustics applications has consistently grown over the last twenty years as these simulations have become relevant in an increasing number of fields and have been facilitated by remarkable developments in computing resources. Still, current state-of-the-art algorithms are limited by the competing demands of accuracy, which typically requires an increasing number of degrees of freedom to resolve on the scale of a wavelength, and efficiency, which favors coarse discretizations. In this talk we will present a new strategy for the solution of the integral equations of electromagnetic and acoustic scattering that successfully deals with these requirements by avoiding the need to discretize on the scale of the wavelength at high-frequencies, while retaining error-controllability and high-order convergence characteristics. The approach is based the derivation of an appropriate ansatz for the phase of the (unknown) currents, on explicit treatment of shadow boundaries, and on localized high-order integration around critical points. [This is joint work with O. Bruno & C. Geuzaine (Caltech)].

10:30–11:00	**Coffee Break**	Just outside Rapson Hall 100

11:00–11:30	**Alfred O. Hero III** University of Michigan	Non-Myopic Strategies Adaptive Multi-Modal Sensor Management for Target Tracking and Acquisition

Abstract: Myopic approaches for scheduling multi-modality sensors are computationally simpler than optimal non-myopic strategies but can have significantly poorer performance. This performance loss translates into a longer time to detection of targets, less efficient use of resources, and higher tracking errors for multiple target tracking and acquisition applications. We will illustrate the causes underlying myopic performance degradation and present a hybrid reinforcement-learning and particle-filtering framework for improving performance.

Joint work with C. Kreucher and D. Blatt.

11:30–12:00	**Margaret Cheney** Rensselaer Polytechnic Institute	Optimal Measurements, Time-Reversal, and Frequency Tuning

Abstract: We consider the problem of obtaining information about an inaccessible half-space from acoustic or electromagnetic measurements made in the accessible half-space. If the measurements are of limited precision, some scatterers will be undetectable because their scattered fields are below the precision of the measuring instrument. How can we make optimal measurements? In other words, what incident fields should we apply that will result in the biggest measurements?

There are many ways to formulate this question, depending on the measuring instruments. In this paper we consider a formulation involving wave-splitting in the accessible half-space: what downgoing wave will result in an upgoing wave of greatest energy? This formulation is most natural for far-field problems.

A closely related question arises in the case when we have a guess about the configuration of the inaccessible half-space. What measurements should we make to determine whether our guess is accurate? In this case we compare the scattered field to the field computed from the guessed configuration. Again we look for the incident field that results in the greatest energy difference.

We show that the optimal incident field can be found by an iterative process involving time reversal "mirrors." For band-limited incident fields and compactly supported scatterers, in general this iterative process converges to a time-harmonic field at the frequency that gives the most scattering. In other words, the time-reversal process "tunes" automatically to the best frequency.

12:00–2:00	**Lunch Break**	

2:00–2:30	**Bart Truyen** Vrije Universiteit Brussel (VUB)	The Residual Least Squares Method, a New Variational Approach to Electrical Impedance Tomography Part I. Problem Formulation, Solution Method, and Properties

Abstract: Electrical Impedance Tomography (EIT), which is concerned with the reconstruction of a spatially varying conductivity distribution inside a bounded domain from partial knowledge of the Neumann-to-Dirichlet or Dirichlet-to-Neumann map, is a notoriously difficult to solve inverse problem, due to its nonlinear and severely ill-posed nature. Despite its theoretical limitations and often disappointing performance, output least squares (OLS) based reconstruction methods continue to play a prominent role in most practical applications of EIT. Recently, we suggested a new variational method, which, unlike OLS, is guaranteed to deliver solutions that satisfy both the associated Thompson and Dirichlet variational principles, irrespective of any additional smoothness assumptions on the conductivity distribution.

In the first part of this presentation, we will introduce the variational formulation, establish its convergence properties, and elucidate how its discretization gives rise to a conventional subspace approximation problem. Whereas the OLS method can be regarded as minimizing a certain error norm, solutions are recovered here as the minimizers of a closely related residual norm problem arising directly from the governing differential equations. This key difference is found to have a profound effect on the numerical properties of the proposed method. The derivation of a nonlinear conjugate gradient based solution scheme is shown to lead to a sequence of structured sparse matrix problems, the conditioning of which appears to be far more favorable than typically observed in OLS iterations.

In the second part of this presentation, we identify the sparsity structure in the discretized problem formulation as the distinguishing feature underlying the superior computational efficiency and robustness of our variational method. In particular, it will be illustrate how multi-frontal QR factorization and displacement rank concepts combine with the conjugate gradient scheme, to yield a nonlinear solution method that requires significantly less computations than OLS, while restricting the iterations to a confined subspace of valid solutions. When tested on a set of numerical experiments, the results are found to confirm the anticipated computational savings.

2:30–3:00	**Parcival Bourgeois** Vrije Universiteit Brussel (VUB)	The Residual Least Squares Method, a New Variational Approach to Electrical Impedance Tomography Part II. Computational considerations

Abstract: Electrical Impedance Tomography (EIT), which is concerned with the reconstruction of a spatially varying conductivity distribution inside a bounded domain from partial knowledge of the Neumann-to-Dirichlet or Dirichlet-to-Neumann map, is a notoriously difficult to solve inverse problem, due to its nonlinear and severely ill-posed nature. Despite its theoretical limitations and often disappointing performance, output least squares (OLS) based reconstruction methods continue to play a prominent role in most practical applications of EIT. Recently, we suggested a new variational method, which, unlike OLS, is guaranteed to deliver solutions that satisfy both the associated Thompson and Dirichlet variational principles, irrespective of any additional smoothness assumptions on the conductivity distribution.

In the first part of this presentation, we will introduce the variational formulation, establish its convergence properties, and elucidate how its discretization gives rise to a conventional subspace approximation problem. Whereas the OLS method can be regarded as minimizing a certain error norm, solutions are recovered here as the minimizers of a closely related residual norm problem arising directly from the governing differential equations. This key difference is found to have a profound effect on the numerical properties of the proposed method. The derivation of a nonlinear conjugate gradient based solution scheme is shown to lead to a sequence of structured sparse matrix problems, the conditioning of which appears to be far more favorable than typically observed in OLS iterations.

In the second part of this presentation, we identify the sparsity structure in the discretized problem formulation as the distinguishing feature underlying the superior computational efficiency and robustness of our variational method. In particular, it will be illustrate how multi-frontal QR factorization and displacement rank concepts combine with the conjugate gradient scheme, to yield a nonlinear solution method that requires significantly less computations than OLS, while restricting the iterations to a confined subspace of valid solutions. When tested on a set of numerical experiments, the results are found to confirm the anticipated computational savings.

3:00–3:30	**Coffee Break**	Just outside Rapson Hall 100
3:30–4:15	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
4:15	**IMA Tea and more (with POSTER SESSION)**	400 Lind Hall
poster	**David Castanon** Boston University	Multimodal Data Fusion for Atherosclerotic Plaque Imaging

Abstract: In many subsurface sensing problems, single sensor information quality is poor. In these cases, the solution of inverse problems in each modality can be ill-conditioned and lead to artifacts that make it hard to co-register and fuse the data. We present a joint inversion framework for fusing and estimating images from multimodal data directly as a single inverse problem based on shared boundary structure. The approach is based on generalizations of the Mumford-Shah variational approach to image enhancement, to account for simultaneous registration and inversion. The approach is demonstrated with examples for imaging of vulnerable atherosclerotic plaque with MRI and CT modalities.

Joint work with Robert Weisenseel and Clem Karl.

poster	**Leslie M. Collins** Duke University	Uncertainty Mitigation Using Adaptive Multi-Modality Processing
poster	**Joaquim Fortuny Guasch** DG Joint Research Centre	Retrieval of Biophysical Parameters Using Polarimetric Interferometry Techniques: Theory and Experimental Results
poster	**Bojan Guzina** University of Minnesota	A Linear Sampling Method for Near-Field Inverse Problems in Elastodynamics; joint with Ivan Chikichev (University of Minnesota) and Marc Bonnet (Ecole Polytechnique, Palaiseau, France)
poster	**Bojan Guzina** University of Minnesota	A Linear Sampling Method for Near-Field Inverse Problems in Elastodynamics; joint withSylvain Nintcheu (Oakridge National Lab) and and Andrew Madyarov (University of Minnesota)
poster	**Alfred O. Hero III** University of Michigan	Analysis of a Multistatic Adaptive Target Illumination and Detection Approach (MATILDA) to Time Reversal Imaging

Abstract: An iterative physical time reversal method using an array of antennas or transducers is presented for imaging random media. The Cramer-Rao bound (CRB) is used to explore the imaging performance advantages of this method, which we call MATILDA, as compared to conventional techniques that do not exploit time reversal retrofocusing. The analysis is performed under a narrowband far-field approximation to the scatter medium. Our principal conclusions are: 1) for a calibrated array (known antenna positions) use of time reversal results in a significant reduction of variance of estimates of scatter cross-section in the far-field; 2) for an uncalibrated array (unknown sensor positions) variance reduction can still be achieved if statistically efficient estimates (estimates attaining the CRB) of the sensor positions can be implemented; 3) the analysis suggests an time-reversal autocalibration method for uncalibrated arrays. Simulation results will be presented that illustrate these theoretical predictions.

Joint work with R. Rangarajan.

poster	**Edwin A. Marengo** Northeastern University	Time-Reversal Imaging with MUSIC Including Multiple Scattering
poster	**Eric Miller** Northeastern University	Geometric Methods for Multi-Parameter, Multi-Source Inverse Problems
poster	**James Stiles** University of Kansas	Adaptive Transmit Signal Coding for Multimode Radar

Tuesday, June 29

All talks are in Rapson Hall 100 unless otherwise noted.

9:00–9:30	**Coffee**	Just outside Rapson Hall 100
9:30–10:00	**John Sylvester** University of Washington	Deductions About Size and Location Based On Scattering Data

Abstract: There are many successful techniques for deducing the location of point sources or scatterers from a limited number of acoustic or electromagnetic measurements. These measurements are far too few to uniquely identify a general

source or even give an upper bound on its support. Nevertheless, the task of remote sensing is to infer what we can about size and location from exactly such limited data sets.

In several cases, will show that this data does uniquely determine a lower bound on a suitably defined notion of support of a source or scatterer.

We will take the Helmholtz equation as a model and consider some specific data sets, i.e.

1) broadband (many frequencies) measurements at a few angles

2) a single frequency far field measured from multiple angles (i.e one monochromatic incident wave, many sensors)

3) single frequency (multi-angle) backscattering data

In the last two cases we can find a lower bound on the convex hull of the support and a similar but weaker notion in the first case.

We will discuss the spectrum of the operator which maps sources to far fields and describe the role it plays in the computation of what we wil call the convex scattering support of the data.

10:00–10:30	**Yen-Hsi Richard Tsai** Princeton University	A Level Set Framework for Visibility Related Variational Problems

Abstract: We introduce a frameowrk and construct algorithms based on it to handle optimization problems that deal with the maximization of visibility information for observers when obstacles to vision are present in the environment. Related applications include certain types of path-planning and pursuer-evader problems. This framework uses a function that encodes visibility information in a continuous way. This continuity allows for powerful techniques to be used in the discrete setting for interpolation, integration, differentiation, and set operations. Using these tools, we are able to limit the scope of search and produce locally optimized solutions.

10:30–11:00	**Coffee Break**	Just outside Rapson Hall 100

11:00–11:30	**James H. McClellan** Georgia Institute of Technology	Processing Algorithms for Near Field Imaging of Buried Targets

Abstract: One class of imaging algorithms is based on the idea of time reversal. A multi-static response matrix is built by using an array of sources and receivers in which each source probes the medium individually. The processing is carried out in the frequency domain, one frequency at a time. By using the singular value decomposition of the response matrix and an estimate of the Green's function for the medium, an imaging algorithm is developed which can determine the spatial positions of buried targets. The Green's function estimate used is for the Rayleigh wave only. A generalized version of this algorithm has been developed for near-field targets when wavefront curvature is significant.

A second class of algorithms is based on the CLEAN algorithm used in radio astronomy. A robust highresolution version, called RELAX, can be modified to work in the scenario of passive buried targets. These algorithms are based on a least-squares analysis over the band of frequencies occupied by the Rayleigh wave. From received data and an array model for the Green's function of near-field targets, an iterative least-squares solution is used to estimate both the target positions and the reflected signals.

These imaging algorithms require an estimate of various parameters of surface waves in a nonhomogenous medium, like soil. An algorithm for estimating dispersion curves (phase velocity vs. frequency) for surface wave has been developed. This technique is based on a combination of temporal Fourier transforms and spatial pole-zero modeling. It is able to estimate the wave velocity, wave number of individual wave packets, as well as extract the Rayleigh wave. The parameters of the extracted Rayleigh wave are then available for use in the imaging algorithms.

Joint work with Mubashir Alam and Waymond R. Scott, Jr.

11:30–12:00	**Waymond R. Scott, Jr.** Georgia Institute of Technology	Experimental Investigation of Techniques for the Detection of Near Surface Targets in Cluttered Media

Abstract: Systems are under development at the Georgia Institute of Technology for the detection of near surface targets that use electromagnetic or seismic waves individually or in combination. One system utilizes a seismic source to propagate Rayleigh waves through a medium such as soil. Non-surface-contacting electromagnetic sensors are used to detect the displacement of the medium created by interaction of the Rayleigh waves with a target, such as a landmine. In another system using ground penetrating radar (GPR), only electromagnetic waves are used to detect buried targets. Both these system have been tested in a relatively uncluttered medium and have yielded encouraging results, demonstrating that the systems are effective for the detection of buried targets. However, when the medium is filled with a large number of scattering objects, the waves will be broken up by the scatterers in the medium to the point that the wave front no longer interacts with the target as it would in an uncluttered medium. This causes detection of a target to be uncertain or impossible.

In an effort to extend the application of the seismic system to a highly cluttered medium, the time reversal method is applied to the seismic system, and evaluated for focusing Rayleigh wave fronts at a desired location. Experimental results are presented for a propagation medium with no scatterers present, and with multiple scatterers present. Time-reverse focusing results are also compared to uniform excitation and time-delay beamforming methods.

In addition, multistatic arrays of sensors are investigated to see if they are more robust in a highly cluttered medium than are bistatic sensors. Experiment results for mutistatic arrays of seismic and GPR sensors are presented with and without scatters present. These results will be compared to the bistatic results. Imaging techniques will be investigated using this data.

Joint work with Pelham D. Norville, Kangwook Kim, James H. McClellan, and Gregg D. Larson.

12:00–2:00	**Lunch Break**	

2:00–2:30	**Gregoire Derveaux** Stanford University	Near-Field Imaging: A Study of the SNR Issue

Abstract: We investigate the use of near-field data collected by GPR for imaging the surface displacement induced by the propagation of a seismic wave used to detect the presence of landmines underground. The information carried by evanescent waves can be used to achieve subwavelength resolution, but since they decay rapidly this information is easily corrupted by noise. Using a simple propagating model for the scalar wave equation, the effect of noise is analyzed theoretically and is illustrated by numerical examples. The interest of the use of broadband signals for enhancing the resolution while reducing the level of noise is shown.

2:30–3:00	**Jochen Schulz** University of Goettingen	A Multiwave Range Test for Obstacle Reconstructions With Unknown Physical Properties

Abstract: We propose a multi-wave version of the range test for obstacle reconstruction in inverse scattering theory. The range test has originally been proposed to obtain knowledge about an unknown scatterer when the far field pattern for one plane wave only is given. Here, we extend the method to the case of multi-wave data in a way such that the full shape of the unknown obstacle can be reconstructed. We provide a proof for the convergence of the range test for the reconstruction of the shape of one or several objects when the boundary condition of the scatterer is not known. Numerical examples for the multi-wave reconstructions are provided.

3:00–3:30	**Coffee Break**	Just outside Rapson Hall 100
3:30–4:15	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
6:00	**Workshop Dinner**	Orchid Cafe, 304 Oak Street. Tel 612-331-4061

Wednesday, June 30

All talks are in Rapson Hall 100 unless otherwise noted.

9:00–9:30	**Coffee**	Just outside Rapson Hall 100
9:30–10:00	**Qing H. Liu** Duke University	Multimodality Inversion for Image Reconstruction of Objects Buried in Multilayered Media with Radar and Seismic Measurements

Abstract: Image reconstruction of heterogeneous objects of arbitrary shape buried in the multilayered earth is an important and challenging research area in subsurface sensing. Such applications are common to geophysical exploration, environmental characterization, and subsurface sensing of landmines, unexploded ordnance and underground structures.

Both electromagnetic and seismic waves have been widely used to detect and characterize underground structures. However, little has been done to combine electromagnetic and acoustic measurements in a joint inversion for a better characterization of targets. In this work, we explore the joint electromagnetic/seismic characterization in order to improve the reconstruction of underground structures.

The joint reconstruction problem is cast as an inverse scattering problem in a multilayered medium. We have developed fast forward and inverse solution methods for both 2-D and 3-D heterogeneous objects in multilayered media based on the stabilized biconjugate-gradient fast Fourier transform method for individual modalities. For the joint inversion, we developed a technique based on a least-squares criterion of the data misfit and mutual information theory to combine electromagnetic and acoustic scattering data. Numerical results show that the joint EM/Acoustic inversion method can provide more information for the underground structures than the stand-alone electromagnetic or acoustic imaging modalities. These improved imaging results are due to the complementary nature of electromagnetic and acoustic waves in underground structures.

10:00–10:30	**David Castanon** Boston University	Non-Myopic Approaches to Adaptive Sensing: Challenges and New Results

Abstract: In this talk, we discuss formulations and approaches for adaptive sensing problems with non-myopic objectives. We focus on problems related to object classification. The talk presents a mathematical framework for adaptive sensing, and develops a lower bound to the optimal achievable performance that can be used for practical adaptive sensing control. Numerical experiments demonstrate the relative advantages of non-myopic adaptive strategies versus myopic strategies.

10:30–11:00	**Coffee Break**	Just outside Rapson Hall 100
11:00–11:30	**Bojan Guzina** University of Minnesota	An Alternate Course to 3D Seismic Imaging

Abstract: In the context of seismic exploration, a comprehensive 3D imaging of subterranean structures is commonly associated with the interpretation of thousands of motion measurements via elastodynamic models that are inherently based on domain discretization. In contrast, this investigation is concerned with the mapping of major underground openings where only a few measurements can be made, usually on the ground surface. In such instances boundary integral equation (BIE) methods, which target only the outline of a hidden structure, can be used to deal with the limited field data. This boundary-only imaging approach, which offers formidable computational savings, has its origins in radar and sonar technologies. So far, however, it has been largely unexplored in the context of seismic surveys.

On modeling the subterranean domain as a semi-infinite solid, the problem of active imaging is reduced to the minimization of a misfit between experiment and theory in the context of surface seismic waveforms. For a rigorous treatment of the gradient search technique used to solve the inverse problem, sensitivities of the predictive BIE model with respect to cavity parameters are evaluated using an adjoint field approach. Despite its computational advantages, however, this method suffers from the lack of robustness owing to its critical dependence on a suitable choice of initial "guess." To provide the BIE imaging method with a rationally selected initial "guess" (in terms of obstacle location, topology, and geometry), the concept of topological derivative, rooted in the theory of structural shape optimization, is extended to

elastic wave scattering and applied to the featured inverse problem. As a viable alternative to the topological derivative approach, this talk will also highlight a near-field elastodynamic generalization of the linear sampling method in acoustics and electromagnetics as it pertains to "rapid" ground probing. A set of numerical examples is included to illustrate the performance of proposed imaging tools. The results suggest a possibility of rendering 3D seismic imaging tractable for everyday engineering applications.

11:30–12:00	**Tim Zajic** Lockheed Martin	Probabilistic Objective Functions for Sensor Management

Abstract: Multi-sensor, multi-target sensor management is at root a problem in nonlinear control theory. Several previous talks have been concerned with the problem of formulating a foundational and yet practical basis for control-theoretic sensor management, using a comprehensive and yet intuitive Bayesian paradigm. Single-sensor, single-target control requires a core objective function that determines the degree to which the sensor Field of View (FoV) overlaps the predicted target track. In the multi-sensor, multi-target case we have formulated the control problem, and in particular the problem of formulating objective functions, in Bayesian terms-i.e., in terms of posterior distributions. We have also proposed an approximate multisensor-multitarget sensor management approach. This approach is based on multi-hypothesis trackers as approximations to the general multitarget Bayes filter, in conjunction with "natural" probabilistic objective functions (such as, the probability that all predicted tracks will be contained in the field of view of at least one sensor). We have also shown how to extend this reasoning to multistep look-ahead sensor management. In this talk we describe preliminary simulations illustrating the approach. We also show how both the general and approximate approaches can be modified to incorporate prioritizations due to the tactical importance of targets.

Joint work with Ronald P. Mahler.

12:00 **Closing**

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PART III: CURRENT IMA PARTICIPANTS

FIRST YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Gerard Awanou	University of Georgia
Karen Ball	Indiana University
Antar Bandyopadhyay	UC Berkeley
Tim Garoni	University of Melbourne
Chuan-Hsiang Han	North Carolina State University
Lea Popovic	UC Berkeley

SECOND YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Olga Brezhneva	Russian Academy of Sci.
Herve Kerivin	University Blaise Pascal-France
Tamon Stephen	University of Michigan
Jing Wang	University of Minnesota

POSTDOCTORAL MEMBERS IN INDUSTRIAL MATHEMATICS

NAME	PREVIOUS INSTITUTION	INDUSTRIAL AFFILIATION
Lili Ju	Iowa State University	VA Hospital
Haewon Nam	Texas A & M University	GE
Jun Zhao	Texas A & M University	Schlumberger

LONG TERM VISITORS

Greg Anderson	University of Minnesota
Hee-Jeong Baek	Seoul National University (BK 21 Math-SNU)
Maury Bramson	University of Minnesota
Rene Carmona	Princeton University
Hans Foellmer	Humboldt Universitat zu Berlin
Shmuel Friedland	University of Illinois - Chicago
Ulrich Horst	Humboldt Universitat zu Berlin
Naresh Jain	University of Minnesota
Mohammad Kazim Khan	Kent State University
Hye-Ryoung Kim	Seoul National University (BK 21 Math-SNU)
Jeong Hyun Lee	Seoul National University (SRCCS)
Richard P. McGehee	University of Minnesota
Amir Niknejad	University of Illinois - Chicago
Greg Rempala	University of Louisville
Arnd Scheel	University of Minnesota
Michael Stutzer	University of Colorado - Boulder
Yuhong Yang	Iowa State University
Ofer Zeitouni	University of Minnesota

VISITORS IN RESIDENCE (as of 24 May 2004)

Nils A. Baas	Norewegian Univ. of Science and Tech.	6/06/04 – 6/17/04
Bernard Badzioch	University of Minnesota	6/07/04 – 6/18/04
John Baez	University of California - Riverside	6/06/04 – 6/19/04
Michael Batanin	Macquarie University	6/06/04 – 6/19/04
Clemens Berger	University of Nice	6/06/04 – 6/18/04
Julie Bergner	Notre Dame University	6/06/04 – 6/19/04
Liliana Borcea	Rice University	6/26/04 – 6/30/04
William Boshuck	John Abbott College	6/06/04 – 6/18/04
Parcifal Bourgeois	Vrije Universiteit Brussel	6/25/04 – 6/30/04
Larry Breen	Universite Paris 13	6/06/04 – 6/18/04
Ronnie Brown	University of Wales	6/06/04 – 6/18/04
Manuel Bullejos	University of Granada	6/06/04 – 6/18/04
Yves Capdeboscq	Universite de Rennes	6/26/04 – 6/30/04
Lawrence Carin	Duke University	6/26/04 – 7/01/04
David Castanon	Boston University	6/26/04 – 6/30/04
Sunil Chebolu	University of Washington	6/06/04 – 6/18/04
Margaret Cheney	Rensselaer Polytechnic Institute	6/26/04 – 6/30/04
Eugenia Cheng	Cambridge University	6/06/04 – 6/20/04
Dan Christensen	University of Western Ontario	6/05/04 – 6/11/04
Douglas Cochran	DARPA/DSO	6/26/04 – 6/30/04
Leslie Collins	Duke University	6/26/04 – 6/30/04
David Neil Corfield	Oxford University	6/06/04 – 6/18/04
Alissa Crans	University of California - Riverside	6/06/04 – 6/18/04
Steven F. Davis	U. S. Army Research Office	6/26/04 – 6/30/04
Alexei Davydov	Macquarie University	6/06/04 – 6/19/04
Aurora Ines Del Rio Cabeza	University of Granada	6/06/04 – 6/19/04
Gregoire Derveaux	Stanford University	6/26/04 – 7/01/04
James Dolan	University of California - Riverside	6/06/04 – 6/19/04
Josep Elgueta	Universitat Politecnica de Catalunya	6/05/04 – 6/20/04
Anthony D. Elmendorf	Purdue University	6/06/04 – 6/18/04
Ulrich Fahrenberg	Aalborg University	6/05/04 – 6/19/04
Lisbeth Fajstrup	Aalborg University	6/12/04 – 6/18/04
Mark Feshbach	University of Minnesota	6/07/04 – 6/18/04

Zbigniew Fiedorowicz	Ohio State University	6/06/04 – 6/18/04
Thomas M. Fiore	University of Michigan	6/06/04 – 6/18/04
Stefan Forcey	University of Vermont	6/06/04 – 6/18/04
Joaquim Fortuny	European Joint Research Centre	6/26/04 – 6/30/04
Carl A. Futia	[None]	6/06/04 – 6/13/04
Philippe Gaucher	Universite Paris 7 Denis-Diderot	6/12/04 – 6/19/04
Eric Goubault	Commissariat l'Energie Atomique	6/13/04 – 6/19/04
Nick Gurski	University of Chicago	6/06/04 – 6/18/04
Mehdi Hakim Hashemi	University of Minnesota	6/07/04 – 6/18/04
Claudio Hermida	IST Lisbon	6/06/04 – 6/19/04
Alfred Hero	University of Michigan	6/26/04 – 6/30/04
Thomas Hunter	Swarthmore College	6/06/04 – 6/18/04
Martin Hyland	Cambridge University	6/06/04 – 6/18/04
Ekaterina Iakovleva	Ecole Polytechnique	6/26/04 – 6/30/04
David Isaacson	Rensselaer Polytechnic Institute	6/26/04 – 6/30/04
Michael Johnson	Macquarie University	6/06/04 – 6/18/04
Andre Joyal	Universite du Quebec a Montreal	6/06/04 – 6/18/04
Ludmil Katzarkov	University of California - Irvine	6/06/04 – 6/18/04
Joachim Kock	Universite du Quebec a Montreal	6/06/04 – 6/18/04
Wojciech Komornicki	Hamline University	6/07/04 – 6/18/04
Sanjeevi Krishnan	University of Chicago	6/06/04 – 6/18/04
Stephen Lack	University of Western Sydney	6/06/04 – 6/19/04
Yves Lafont	Universite de la Mediterranee (Marseille)	6/06/04 – 6/18/04
Karl Langenberg	Gesamthochschule Kassel-Universitat	6/25/04 – 7/01/04
Aaron Lauda	University of California - Riverside	6/06/04 – 6/18/04
Tom Leinster	University of Glasgow	6/06/04 – 6/19/04
Gary Lieberman	Iowa State University	6/23/04 – 6/26/04
Qing H. Liu	Duke University	6/26/04 – 6/30/04
Marco Mackaay	University do Algarve	6/12/04 – 6/19/04
Michael Makkai	McGill University	6/06/04 – 6/19/04
Gianfranco Mascari	Consiglio Nazionale delle Ricerche (CNR)	6/06/04 – 6/18/04
J. Peter May	University of Chicago	6/06/04 – 6/18/04
William Messing	University of Minnesota	6/06/04 – 6/18/04
Francois Metayer	Equipe PPS Universite Paris 7	6/06/04 – 6/18/04
Jean-Pierre Meyer	The Johns Hopkins University	6/06/04 – 6/17/04
Douglas Miller	Schlumberger-Doll Research	6/26/04 – 6/30/04
Eric Miller	Northeastern University	6/26/04 – 6/30/04
Joshua Paul Nichols-Barrer	Massachusetts Institute of Technology	6/06/04 – 6/18/04
Michael Oristaglio	Witten Technologies	6/26/04 – 6/30/04
Simona Paoli	University of Warwick	6/06/04 – 6/18/04
George C. Papanicolaou	Stanford University	6/26/04 – 7/01/04
Timothy Porter	University of Wales	6/06/04 – 6/18/04
John Power	University of Edinburgh	6/06/04 – 6/19/04
Fernando Reitich	University of Minnesota	6/26/04 – 6/30/04
Tony Robbin	Yale University Press	6/06/04 – 6/19/04
Andrew Michael Salch	University of Rochester	6/06/04 – 6/18/04
Jochen Schulz	University of Goettingen	6/26/04 – 7/01/04
Waymond Scott	Georgia Institute of Technology	6/26/04 – 6/30/04
Jaemin Shin	Iowa State University	6/07/04 – 6/10/04
Michael Shulman	University of Chicago	6/06/04 – 6/19/04
Richard Steiner	University of Glasgow	6/05/04 – 6/19/04
Danny Stevenson	University of Adelaide	6/06/04 – 6/18/04
James Stiles	University of Kansas	6/26/04 – 6/30/04
Ross Street	Macquarie University	6/06/04 – 6/19/04
John Sylvester	University of Washington	6/26/04 – 6/30/04
Gary Nan Tie	The St. Paul Companies	6/06/04 – 6/18/04

Bertrand Toen	University of Nice	6/10/04 – 6/13/04
Bart Truyen	Vrije Universiteit Brussel (VUB)	6/25/04 – 6/30/04
Richard Tsai	Princeton University	6/26/04 – 6/30/04
Chrysoula Tsogka	Stanford University	6/26/04 – 7/01/04
Gabriele Vezzosi	Universita degli Studi di Firenze	6/11/04 – 6/19/04
Michael Vogelius	Rutgers	6/26/04 – 6/30/04
Alexander A. (Sasha) Voronov	University of Minnesota	6/06/04 – 6/18/04
Mark Weber	University of Ottawa	6/06/04 – 6/19/04
Ittay Weiss	Utrecht University	6/04/04 – 6/19/04
Rob Williams	AFRL/SNAT	6/26/04 – 6/30/04
Andrew Yagle	University of Michigan	6/26/04 – 6/30/04
Marek Zawadowski	University of Warsaw	6/06/04 – 6/18/04

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