FIELDSNOTES

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Renormalization and Universality in Mathematics and Mathematical Physics

THE ABOVE TITLE IS THE TOPIC OF the Fall 2005 thematic program at Fields, organized by P. Bleher of IUPUI, and M. Lyubich and M. Yampolsky, of the University of Toronto. It will be followed in Winter 2006 by the closely related program on Holomorphic Dynamics, Laminations, and Hyperbolic Geometry.

It is commonly known that when a magnetized piece of iron is heated over the *critical temperature* T_C, it will lose its magnetization. To understand this *phase transition*, imagine the atoms of iron as little compass arrows arranged in a regular lattice. For simplicity, assume that

> "Scaling laws appear in all the branches of science"

an arrow can only point "north" or "south". In a magnet, most arrows are oriented in the same way. When it is heated, the atoms will become agitated and some arrows will spin out of the alignment. At the critical temperature the alignment of the little magnets is completely destroyed and magnetization becomes zero.

The most remarkable feature of such a phase transition is *scale invariance*. Imagine colouring the little arrows black or white depending on their orientation. Under a microscope we would see complicated *quasi-fractal* islands of the two colours randomly formed by the arrows. When the temperature becomes critical, this picture will *appear the same at every scale* – nothing will depend on the degree of magnification!

Mathematically, if we take some statistical measurement in the picture we are observing, we get an expression of the form

$$(\text{size of the picture})^{\alpha}$$

The appearance of the power law is explained by the simple fact that a function $\text{const} \cdot x^{\alpha}$ under a change of scale $w = Ax$ remains in the same general form.

Finitely many *critical exponents* of such power laws completely characterize the phase transition; all the other innumerable degrees of freedom in our model can be integrated out and are irrelevant. This means that for large classes of similar systems the critical exponents will be the same, the property known as *universality*. As a way to compute these exponents, in 1960's Kadanoff, Wilson, and others developed a method, called *renormalization*. Renormalization acts on our system by averaging out some of the degrees of freedom. When this procedure is iterated, all

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2005 Coxeter Lectures
Renata Kallosh

Renata Kallosh

RENATA KALLOSH, PROFESSOR of Physics at Stanford University delivered the Coxeter Lectures on May 9 and May 11, 2005, at the Fields Institute, and on May 10, 2005, at the Perimeter Institute. Professor Kallosh obtained her Ph.D. at the Lebedev Physical Institute in Moscow. She was a professor at the Lebedev Physical Institute and a scientific associate at CERN before moving to Stanford University in 1990. Professor Kallosh has done fundamental research in a wide array of directions covering supersymmetry, supergravity, quantum theory of black holes, M-theory and string theory.

Her recent work is concerned with the role of M/string-theory in the cosmology of the early universe and in the study of dark energy. The first lecture, entitled *Towards String*

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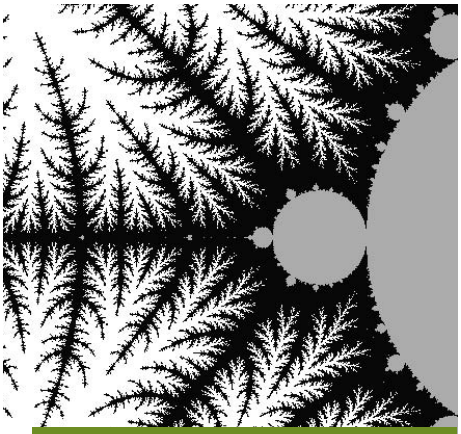


Mandelbrot set near the Feigenbaum parameter

the systems of an appropriate class converge to the same universal one.

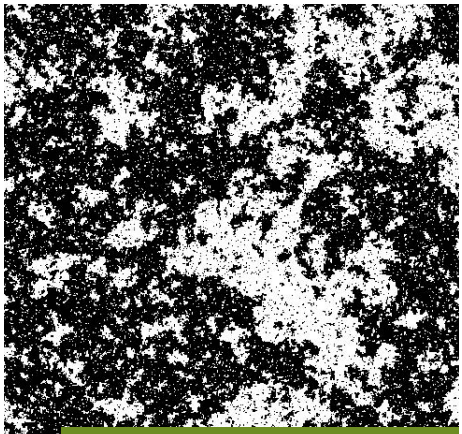
It is hard to exaggerate the importance of the concepts of scale invariance, renormalization and universality. Scaling laws appear in all the branches of science studying the dynamics of complex systems, be it the physics of gases and fluids, chaotic dynamics, or the biology of multicellular organisms.

Mathematically, understanding this paradigm has proved a great challenge. Notably, there is as yet no mathematical proof of universality in a magnet. A great breakthrough occured in the late 1970's when Feigenbaum and independently Coullet & Tresser observed universality in dynamical systems generated by iteration of very simple-looking formulas, such as $f(x) = x^2 + c$. The Feigenbaum universality manifests itself through scaling properties of the celebrated Mandelbrot set. The following two decades saw the development of a beautiful renormalization theory in dynamics, which studies scaling of the Mandelbrot and Julia sets. It has recently culminated in a rigorous proof of the Feigenbaum Universality in the consecutive works of Sullivan, McMullen, and Lyubich.

The main goal of the program is to bring together dynamicists and mathematical physicists working on various aspects of universality to foster further development in this exciting field.

> "understanding this paradigm has proved a great challenge"

The program will include three workshops: *Percolation, SLE, and related topics* (Sept 20-24); *Renormalization and universality in mathematical physics* (Oct 18-22); and *Renormalization in dynamical systems*, (Nov 29 - Dec 3). Graduate courses will be given by by I. Binder, K. Khanin, and M. Yampolsky. Several mini-courses are planned, including ones by P. Bleher, L. Kadanoff, and H. Koch. *Coxeter Lectures* will be given on September 13-15 by O. Schramm (Microsoft Research) and on November 23-25 by Lai-Sang Young (Courant Institute). Leo Kadanoff (Clay Senior Scholar, Chicago) and Mitsuhiro Shishikura (Kyoto) will be in residence in the Fields Institute for the whole program.



Islands of colours at the critical temperature

Pavel Bleher (IUPUI), Mikhail Lyubich (Toronto & SUNY Stony Brook), and Michael Yampolsky (Toronto)

2005 Coxeter Lectures: Renata Kallosh

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Cosmology, had a pedagogical flavor, and dealt with some of the questions raised in string theory and higher dimensional supergravity by the recent cosmological and astrophysical observations supporting dark energy and inflation. The sign and the size of the cosmological constant have fundamental implications for the laws of physics. Kallosh detailed some of the models obtained during the last couple of years in the framework of string theory that incorporate inflation and a positive cosmological constant. Many hopes of the scientific community are related to the experimental data from the Large Hadron Collider (LHC) expected to go on-line in 2007 at CERN. Kallosh took the audience on a tour de force and presented some of the crucial missing puzzle pieces that the future observations at the LHC might add to astrophysics and cosmology, as well as to supersymmetry and string theory.

The next two lectures were more technical and focused on the *Stabilization of Moduli in String Theory*. This is a theoretical method developed by Kallosh and her collaborators, as well as other groups, that cures some of the discrepancies suffered by previous string models in light of the recent observations. Near the black hole horizon, such models are based on special types of attractor K3 surfaces where a class of moduli are fixed by fluxes. The complex structures of such K3 surfaces can be determined explicitly with a Torelli type result. A careful analysis shows that stabilization of certain moduli is in fact a prerequisite for string cosmology. Other approaches were presented, some involving the so-called landscape of string theory. Another recent explicit result of Aspinwall and Kallosh provides the analysis of a geometrical model of M-theory compactified on a product of K3 surfaces and its dual type IIB orientifold theory, where the instanton effects and the fluxes generically fix all the moduli.

Paul Horja (Fields)

STRINGS05

THE STRINGS 2005 CONFERENCE WAS held July 11 to 16 as the culmination of the activities organized for the theme year, "The Geometry of String Theory", which was hosted jointly by the Fields Institute and Perimeter Institute (in Waterloo). The "Strings" conferences are the premiere international conference series in the field of string theory. Strings05 brought 425 of the world's leading string theorists to the University of Toronto's Medical Sciences Building; the first such conference to be held in Canada. Our local organizing committee consisted of Alex Buchel (Perimeter/UWO), Jaume Gomis (Perimeter), Kentaro Hori (Toronto), Robert Myers (Perimeter/Waterloo) and Amanda Peet (Toronto).

As is traditional with the "Strings" meetings, the bulk of the conference was devoted to invited talks highlighting recent progress in the field and charting out new directions. As organizers, we strived to create an exciting scientific program with a wide variety of topics which reflect the most important new developments in the field. A sampling of topics includes: new developments in the microscopic description of black hole entropy, understanding physics on the string theory landscape, a possible holographic description of the quark-gluon plasma, and supersymmetry breaking in type IIB flux compactifications. A quick glance at the schedule also shows a broad range of speakers, extending from established luminaries, such as Renata Kallosh (Stanford), Ashok Sen (Harish-Chandra Research Institute, India) and Ed Witten (IAS, Princeton), to new upcoming postdocs and graduate students, such as Henriette Elvang, (UCSB), Vyacheslav Rychkov, (Amsterdam), and Andrei Starinets, (Perimeter). The appearance of many young faces at the speakers podium came from our concerted efforts to provide nurturing for the younger generation of string theorists that will be leading the field in upcoming years. This eye to the youth of our field was also seen in the four review talks. Frederik Denef (Rutgers), Niklas Beisert (Princeton) and Freddy Cachazo (Perimeter) were, of course, chosen for the central role which they played in the recent advances which they reviewed but these three all happened to be under 30 as well. Young researchers were also prominent at the poster session, with over 50 presentations on a wide variety of topics, from "D-term Cosmic Strings from N=2 Supergravity" to "Statistics of toric Calabi-Yau four-folds". The multitude of participants who viewed these may have been encouraged by our strategic positioning of coffee and refreshments at the end of the poster hall.

Conference participants

The conference ended on a high note. Shing-Tung Yau (Harvard) closed the technical session with a seminar on "Superstring theory with torsion" and an invitation to Strings06 in Beijing next year. As the final session on Saturday afternoon, we had public lectures by two international superstars in string theory: Robbert Dijkgraaf (Amsterdam) and Lennie Susskind (Stanford).These masterful lecturers led the capacity audience of over 500 on entertaining tours of warped space-time, black holes, strings, the big bang and the ultimate fate of the universe.

As well as being sponsored by Perimeter and Fields, the Strings05 meeting received enthusiastic support from an array of Canadian research organizations, including the University of Toronto, the Pacific Institute of Theoretical Physics, le Centre de recherches mathematiques, the Canadian Institute for Advanced Research, the Canadian Institute for Theoretical Astrophysics, the Institute of Particle Physics and the Pacific Institute for the Mathematical Sciences. Funding from the National Science Foundation also facilitated the participation of junior participants from American universities. Further most of the speakers forgave our offer to cover their travel expenses so that these funds could be used to partially support postdoc and student participants.

At the close of the meeting, it seems that everyone headed off with good memories of their visit to Toronto. Undoubtedly, Strings05 provided an immense boost to the international profile of string theory research in Canada. Interested readers can view the talks at the Strings05 website.

In closing, we would like to thank the staff at both Perimeter and Fields for all their help in bringing the meeting together and ensuring that everything ran smoothly. In particular, the organizing committee would like to thank Alison Conway, Fields' Program Manager, and her staff for their calm guidance and continued efforts over the past year in ensuring the great success of the meeting.

Jaume Gomis and Robert Myers (Perimeter)

STRINGS RETROSPECTIVE

THIS YEAR'S THEMATIC PROGRAM on the Geometry of String Theory was hosted jointly by the Fields Institute and Perimeter Institute for Theoretical Physics (in nearby Waterloo). The activities were essentially divided equally between Fields and Perimeter. The lead organizers were Kentaro Hori (Toronto), Lisa Jeffrey (Toronto), Misha Kapranov (Toronto/Yale), Boris Khesin (Toronto), Robert Myers (Perimeter/Waterloo) and Amanda Peet (Toronto).

The central idea defining string theory is that when viewed with sufficiently high resolution all elementary particles will appear to be extended one-dimensional objects, i.e., strings. We have found that from this relatively simple starting point emerges an extraordinarily rich mathematical structure. For example, the internal consistency of the theories requires that the strings propagate in a ten-dimensional spacetime. So, six of the dimensions must be curled up on a compact geometry in order to reproduce the four-dimensional physics which we observe. In fact it is the intricacies of the internal geometry which are responsible for the complex physical interactions which emerge in the four-dimensional world. This is a simple example which illustrates the central role which geometry plays in string theory. Further string theory incorporates 'supersymmetry', a symmetry which changes the spins of elementary particles pairing each fermion with a boson – this is the origin of the 'super' in superstrings. On the physical side, supersymmetry plays an important role in taming high energy divergences which appear in theories of point particles. On the mathematical side, this symmetry is fundamental in constructing new topological invariants, as arise, e.g., Seiberg-Witten theory.

String theory originated from a 'failed' attempt to describe the nuclear interactions in the 1960's. However, soon after, it evolved towards a very much more ambitious goal of being 'the theory of everything'– that is providing a unified framework to describe all of the elementary particles and fundamental forces in nature. Combining Einstein's theory of gravity with the standard quantum theory used to describe physics at subatomic scales has lead to perplexing inconsistencies which have mystified physicists for over fifty years. Hence finding a quantum theory of gravity is often seen as the holy grail of theoretical physics. String theory is seen by many as the leading contender in this quest since as well as containing the appropriate structures to describe elementary particle physics, gravity is required by the internal consistency of the theory. However, even after more than three decades of intense investigation, our current understanding of string theory remains inadequate to understand whether or not it consistently describes physical phenomena at all energies, i.e., from the Planck scale, where the effects of quantum gravity and strings are manifest, through to energy scales accessible in present-day experiments.

Perhaps in an analogous way, string theory may also be fostering a unification of mathematics. For example, the 'mirror symmetry' of strings on Calabi-Yau manifolds displays a close connection for symplectic geometry and algebraic geometry. There seem to be hints of new connections between such diverse areas of mathematics as derived categories, elliptic cohomology, geometric Langlands correspondence, quantum cohomology, differential geometry varieties with special holonomy and of special Lagrangian varieties. It is also clear that the full physics potential of this remarkable theory will only be realized once significant progress has been made in understanding its mathematical structure.

Running the program jointly with Perimeter Institute produced a particularly active year with over 800 participants, two parallel seminar series (one at each site), seven workshops, four graduate courses, three mini-courses and a graduate summer school. The program concluded in July by hosting Strings05, the premier international conference in string theory. The program attracted many of the world leaders in their respective fields. The most exciting topics at the forefront of research in string theory were reported on through all of the various activities, and innumerable collaborations and interactions were stimulated by all of this activity.

The activities in the fall term (between September and January) were planned to emphasize mathematical aspects, while those in the spring term (February to July) were planned to emphasize physical aspects. The workshops were: Forms of Homotopy Theory: Elliptic Cohomology and Loop Spaces (September 27-October 2, 2004); Mirror Symmetry (held at Perimeter, November 19-23, 2004); Topological Strings (January 10-14, 2005); N=1 Compactifications (March 21-25, 2005) ; String Phenomenology (held at Perimeter, March 28-April 1, 2005); Gravitational Aspects of String Theory (May 2-6, 2005) and Schubert Varieties (June 8-12, 2005).

A three-week graduate summer school, Strings, Gravity and Cosmology at Perimeter brought 23 first-class lecturers and roughly 90 students from all over the world for lectures which ran from introductory material to new (as yet unreported) research results. Our final event was Strings05, held on July 11-16, 2005 at the University of Toronto. The "Strings" conferences are the main international meetings in the field of string theory and they are held annually to bring together the world's leading researchers to present and discuss the latest developments of string theory. Strings05 marks the first time such meeting was held in Canada!

There were two additional associated events which were partially sponsored by the thematic program. The first was the Great Lakes Geometry Conference (held at Perimeter on April 30-May 1, 2005). The second was a special session at the Canadian Mathematical Society summer meeting, held at University of Waterloo (June 4-6, 2005) on String Theory and Integrable

Systems. The driving force of the program was the regular seminar series, with parallel series held at both Fields and Perimeter, and regular travel arranged between the sites.

There were two graduate courses taught at Fields on physics topics in the fall term: Mirror Symmetry by Kentaro Hori and String Theory by Amanda Peet. In the spring the courses were: Homological Algebra by Ragnar Buchweitz and Symplectic Geometry and Topology by Boris Khesin. Over the year, there were three minicourses: The first, Frobenius Manifolds, Integrable Hierarchies, was given by Boris Dubrovin (SISSA, Trieste) at Fields in November, 2004. The second minicourse was held at Perimeter over two weeks in February and March on Generalized Geometries in String Theory with lectures by Marco Gualtieri (Fields), Yi Li (Caltech), and Mariana Grana (ENS). The final minicourse consisted of lectures at Fields in March and May given by B. Khesin (Toronto), M. Gekhtman (Notre Dame) and A. Marshakov (Moscow) on Toda Lattices: Basics and Perspectives.

The thematic program also included five sets of special lectures by a superb collection of speakers. These activities began with the Coxeter lecture series by Nigel Hitchin (Oxford) on November 15-17, 2004. Nigel lectured on the geometry of generalized complex manifolds, a topic which is tied to string theory by the study of B-fields and which was also seen in the winter minicourse at Perimeter. On January 17-20, 2005, we had the Coxeter lecture series by Robbert Dijkgraaf (Amsterdam). Robbert began with a beautiful general lecture on Mathematics in String Theory and followed this by two lectures on Topological String Theory. Next on April 4-7, 2005, the Distinguished Lecture Series by Edward Witten (IAS, Princeton) dealt with the mathematical background behind well-known constructs in theoretical physics. Renata Kallosh (Stanford) was the final Coxeter lecturer delivering a series of talks on May 9-11, 2005 describing recent progress on using string theory to describe early universe cosmology. All of the above lecture series included lectures delivered at both the Fields and Perimeter Institutes. The final special lecture was a Clay Math Institute Public Lecture by Eric Zaslow entitled Physmatics on June 2, 2005 at Fields – Eric was a Clay Institute Senior Scholar whose funding from the Clay Institute supported his participation in the program.

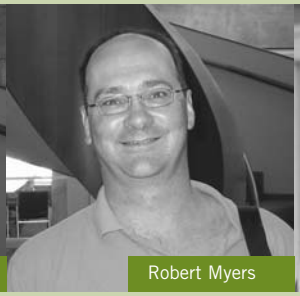
At Fields, the theme year participants included twelve postdoctoral fellows in both physics and mathematics: Marco Gualtieri, Manfred Herbst, Paul Horja, Nan-Kuo Ho, Shabnam Kadir, Kris Kennaway, Seongchun Kwon, Ruxandra Moraru, Martin Pinsonnault, Ashish Saxena, Alex Yong and Ke Zhu. Horja held the Marsden postdoctoral Fellowship and Gualtieri, Ho, Pinsonnault and Yong came with NSERC Postdoctoral Fellowships. A substantial number of graduate students participated in the program, attending the graduate courses and the graduate Summer School. The program sponsored approximately forty long term visitors, who spent anywhere from one month to the entire year at Fields and/or Perimeter as program participants. Activities at Fields were funded in part by sponsorship from Perimeter Institute. Further funding was also provided by the Connaught Fund of the University of Toronto, the University of Toronto at Scarborough and the National Science Foundation.

Of course, the goal of the string program was to stimulate new science, and also to foster discussions between mathematicians and physicists on new directions of research. The full impact of such a program is often difficult to measure and the new ideas which it stimulates usually do not come to fruition immediately. However, it is already clear that this program made a substantial contribution towards advancement of the theory and fostering interaction between its different domains and researchers with different backgrounds. As an example of the fruitful interactions, the course and workshop on Mirror Symmetry catalyzed collaboration of two world-class geometers, A. Bondal (Steklov Mathematical Institute) coming from algebraic geometry and W.-D. Ruan (University of Illinois, Chicago) specializing in symplectic geometry. The workshop on Topological Strings provided a stage for intensive discussions between mathematicians and physicists. It was recognized there, for the first time, that the topological string partition function should be regarded as the wavefunction of some quantum system, both in mathematics and physics. Ragnar Buchweitz's course on Homological Algebra catalyzed many discussions around the question of what is the right mathematical language for string theory. Even after Ragnar's course finished, he and many program participants continued in a series of regular meetings to discuss Maximal Cohen-Macaulay modules and their relation to D-branes in Calabi-Yau and Landau-Ginzburg models. These meetings saw a vigorous exchange in which mathematicians and physicists taught each other what they knew and tried to learn something they wanted to know. These are just a few examples of the numerous collaborations and interactions which were generated by the string program.


Lisa Jeffrey


Misha Kapranov


Boris Khesin


Robert Myers


Amanda Peet

Lisa Jeffrey (Toronto) and Robert Myers (Perimeter & Waterloo)

Forest Fires and Point Processes

Sharpsand Immature Jack Pine Behaviour Experiment

FOREST FIRES ARE A NATURAL COMPONENT of many of Canada's forested ecosystems but they also pose threats to public safety, property and forest resources. Every year, forest fires cause millions of dollars worth of damage and force the evacuation of some communities. Such problems will be exacerbated as people establish more homes and cottages in and near forested areas and climate change alters forest vegetation and weather.

The purpose of the workshop on Forest Fires and Point Processes held May 24-28, 2005 at the Fields Institute was to bring together forestry researchers and statisticians to identify areas of potential collaboration. The meeting was organized by John Braun (Western), David Martell (Toronto), and Rick Schoenberg (UCLA), and supported by NPCDS, Fields, MITACS, Tembec, the Sustainable Forest NCE, and the Ontario Ministry of Natural Resources.

The forest fire research community has made steady progress over the past four decades, in increasing our understanding of the nature of forest fires. Mathematical models for predicting fire occurrence have been developed. Deterministic spread models are being implemented for planning purposes and for use in computer simulations to aid in prediction of the future behavior of existing and potential fires. Such models are used in conjunction with queueing models in the strategic management of fire-fighting resources such as aircraft and fire fighters. Although much has been learned about the interactions of weather and fuel-types, and their effects on fire spread and intensity, a large number of questions remain. For example, how can jump-fires ignited by burning bark and other firebrands, carried by the wind in advance of a spreading fire, be modeled as a stochastic process? How can the fire hazard in particular areas be estimated reliably? What are the potential impacts of climate change on fire regimes and fire management systems?

Statisticians can play a role in helping to answer these and other questions. Stochastic models, and point process models in particular, should prove to be very useful in attacking these kinds of problems. In recent years, point process intensity models have been successfully used in the study of earthquakes and volcanoes. Related intensity models have high potential in the forest fire context. For example, the times and locations of lightning strokes and fire ignitions can be viewed as a bivariate point process.

The meeting heard a range of presentations on the forestry side, ranging from an overview of the problems and language of forest fire management, to discussions of problems specific to Ontario, the U.S., to Boreal forests, and even to Spain. On the statistical side, presentations ranged from a tutorial on point processes to the application of sophisticated statistical techniques to forest fire data. These techniques ranged from the realm of spatial statistics and mixed-effects modeling to propensity score analysis. Existing models for fire spread were described, and new models were proposed; one based on an interacting particle system, and the other based on a generalization of the renewal process to higher dimensions. Talks of both theoretical and applied scope were well-received in both the forestry and statistical 'camps'. Clearly there is interest in developing collaborative ties between the forestry community and statisticians, which will be pursued in many ways, including a proposed NPCDS project.

John Braun (UWO)

Numerical and Analytic Methods in Fluid Dynamics

THE STUDY OF FLUID DYNAMICS HAS driven the development of numerous fundamental analytic and numerical methods of applied mathematics. As the sophistication of physical models increases and the scope of applications expands, the impetus for further developments is as great as ever. This three day workshop, held May 5–7, 2005 at Carleton and funded by Fields and MITACS, brought together researchers from both of these essential sides of applied mathematics. It provided the opportunity to share in the latest developments, and foster new collaborations and avenues of research. In total there were over 28 participants including 18 students. The organizers were David Amundsen and Lucy Campbell (Carleton).

Each of the invited speakers presented a series of three lectures. Yves Bourgault (Ottawa) provided an extensive review and discussion of computing wave problems with finite element methods, beginning with the fundamental issues of stability, conservation, positivity etc. and leading into multi-phase flows and air flows charged with dispersed particles. Dale Durran (Washington) spoke on the numerical issues which arise in atmospheric modeling and various techniques to address them. After discussing the fundamental issues related to diffusion and dissipation (both physical and numerical), he discussed global strategies for minimization of error and construction of non-reflecting boundary conditions. Sherwin Maslowe's (McGill) lectures concerned the method of matched asymptotic expansions for boundary layer problems and the derivation of the boundary layer equations in the context of fluid flows. He also spoke about solving eigenvalue problems arising in hydrodynamic stability theory, for example rotating pipe flow. Ray Spiteri (Saskatchewan) gave a series of lectures on Implicit-Explicit (IMEX) methods for solving ordinary differential equations such as those which arise from discretization of convection-diffusion-reaction problems. He introduced a wide array of methods along with a discussion of their advantages and weaknesses. On each day an hour was set aside for contributed talks by students, postdocs and other researchers.

Workshop participants

> "the sophistication of physical models increases and the scope of applications expands"

Despite the busy schedule of lectures, participants were also able to get out and enjoy the beautiful spring weather in Ottawa. On the first day participants were treated to a reception barbecue on the Carleton campus overlooking the rapids of the Rideau River, certainly a suitable spot for experimental observation of fluid dynamics! In addition, as the workshop coincided with the first weekend of the Annual Tulip Festival in Ottawa, the second day ended with a leisurely walk from the Carleton campus to the tulip beds on Dow's Lake and a nearby restaurant. By all accounts the workshop was a tremendous success.

David Amundsen and Lucy Campbell (Carleton)

The 11th International Conference on DNA Computing

BIOMOLECULAR COMPUTING has emerged as an interdisciplinary field that draws together computer science, mathematics, molecular biology, chemistry and physics. Our knowledge of DNA nanotechnology and biomolecular computing increases dramatically with every passing year. The international meeting on DNA Computing (formerly DNA Based Computers) has been the main international forum where scientists with different backgrounds, yet sharing a common interest in computing, meet and present their latest results. The 11th International Meeting on DNA Computing, now under the auspices of the International Society for Nanoscale Science, Computation and Engineering (ISNSCE), focused on the current experimental and theoretical results with the greatest impact.

Conference participants

DNA11 was organized by Lila Kari and Mark Daley at the University of Western Ontario, June 6-9, 2005. With a total of 150 participants, DNA11 was the best attended DNA Computing conference to date.

The first day of the meeting was devoted to tutorials on computer science, molecular biology and DNA nanotechnology. Four 55-minutes invited talks were delivered by senior scientists. Eshel Ben-Jacob (Tel Aviv) spoke on bacterial intelligence and DNA computing. James Gimzewski (UCLA) described recent works exploring nanomechanical characterizations of cell bacteria and proteins. Pehr Harbury (Stanford) presented recent results on the use of DNA molecules to govern generalized output processes. Eric Klavins (Washington) spoke on robotic self-organization. There were twenty three 25-minute oral presentations of research contributions, where the last minutes of each talk were devoted to an active time for questions and comments. Also, a poster session was held where forty five posters were presented.

With Len Adleman (the founder of the field of DNA Computing) in attendance, and with an impressive array of talks combining theoretical aspects with the latest achievements in nanotechnology, DNA11 has been a successful and inspiring meeting. The Fields Institute was the main sponsor for the conference. In addition, the conference was supported by MITACS, BIOMAR Inc. and the University of Western Ontario.

Lila Kari (UWO)

Summer School in Operator Algebras

33rd Canadian Operator Symposium (CoSy)

THE UNIVERSITY OF OTTAWA HOSTED a pair of linked events in June, starting with a two-week summer school in Operator Algebras June 7–17, 2005, and concluding with the 33rd Canadian Operator Symposium (CoSy) June 19–24, 2005. The symposium was dedicated to George Elliott, on the occasion of his 60th birthday. George is one of Canada's leading mathematicians, and a driving force behind operator algebras in Canada. Both events were sponsored by the Fields Institute. Additional funding was supplied by a NSERC Leadership Support Initiative grant, held by J. Mingo, M. Neufang, A. Nica, and R. Speicher and by a grant from the US National Science Foundation to support US participants at the summer school and CoSy. The organizers were Thierry Giordano, David Handelman and Vladimir Pestov from Ottawa, together with Jamie Mingo (Queen's) and Matthias Neufang (Carleton).

The summer school was a great success. Over 75 mathematicians participated in at least one week of the summer school, nearly 60 of which number attended both weeks. The participants came from Canada, the US and many European countries. The success of the summer school is largely due to the exceptional quality of the lecturers, who each delivered a series of 5 ninety minute lectures.

The summer school prepared students to get the most out of the advanced talks given at the symposium. CoSy itself represented a chance to assemble a large and active group of operator researchers. During the banquet held in honour of George Elliott, many colleagues, friends and former students of George emphasized not only the importance of his mathematical contributions and achievements, but also the important and frequent help he offers to young researchers in operator algebras. In 1994-95, George was the main organizer of a very successful year-long program in Operator Algebras at the Fields Institute. He rented a large house always filled by short and longer term visitors. This house was quickly known as Château Elliott. P. Fillmore, who was the master of ceremony of the banquet, delighted the audience with many anecdotes on the daily life in the chateau. The nearly one hundred participants of CoSy heard 11 plenary talks and 36 shorter presentations.

Thierry Giordano (Ottawa)

2005 Canadian Mathematics Education Forum

Stephen Lewis Public Lecture

THE 2005 CANADIAN MATHEMATICS Education Forum was held May 6-8, 2005 on the campus of the University of Toronto, with some events taking place at the Fields Institute. It was organized under the aegis of the Canadian Mathematical Society, with the support of the Fields Institute, and twenty-two other sponsors. The co-chairs included Florence Glanfield (Saskatchewan), Frédéric Gourdeau (Laval) and Bradd Hart (McMaster). Planned over a two year period by the three co-chairs, with input from a program committee of 36, it attracted over 200 participants drawn in roughly equal numbers from K-12 teachers, from mathematics education researchers, and from mathematicians. A deliberate effort was made to ensure balanced participation by region, and simultaneous translation was provided for all plenary sessions. In 2003, the CMS's previous forum was held in Montreal, stimulating a national discussion about mathematics education and setting the stage for the 2005 event. The CMS has announced its intent to sponsor similar forums every 2 or 3 years.

The purpose of the 2005 forum was to engage in a national and on-going dialogue about important issues and concerns in the development and future of mathematics education in Canada, at all levels of schooling. The overall theme of the forum was "Why Teach Mathematics?" a phrase meant to be interpreted in multiple ways. Three sub-themes were identified: mathematics and society, mathematics in the classroom, and the mathematics education community in Canada. Together these provided the perspectives from which forum participants provided responses to the overall themes.

The plenary portion of the program consisted of three panel discussions. Three parallel sessions on the first day provided brief and at times inspirational presentations titled *Sharing Successes*. But the main work of the forum was conducted by the 10 working groups, each meeting three times over the course of the forum. Together, the groups' participants worked to create projects, initiatives, and documents that outlined ways in which Canadians may address issues and concerns arising out of mathematics education. The final plenary session of the forum included reports from all groups. Work continues after the forum, to share these ideas and documents widely with policy makers, school boards, universities, colleges, parents, students, and the general public in a variety of ways.

Stephen Lewis (photo by Nicole Toutounji, UNICEF)

> "the importance of mathematics education in creating a questioning and informed public"

On May 6, as part of the forum, Stephen Lewis delivered a public lecture titled *Deciphering our World*. The large audience in the University of Toronto's Medical Sciences auditorium was treated to a lively and engaging exploration of the importance of mathematics education in creating a questioning and informed public. Mr. Lewis is the UN Secretary-General's Special Envoy for HIV/AIDS in Africa. He is a Companion of the Order of Canada, a former leader of the Ontario New Democratic Party, and has served as Canadian Ambassador to the United Nations, and as the Deputy Executive Director of UNICEF in New York. He is a director of the Stephen Lewis Foundation, which is dedicated to easing the pain of HIV/AIDS in Africa.

His talk contained a passionate and moving description of the plight of HIV/AIDS sufferers in Africa, and the social and personal devastation brought on by this disease. The effort to raise awareness of this scourge among the public and among policy makers provides an example of the general problem of communicating complex social issues in today's society. In that context, a numerate and well educated public is essential, since the language of public debate is increasingly that of statistics. A familiarity with data, graphs, and mathematical reasoning is necessary in order to assess (and debunk if necessary) the arguments for or against particular programs or courses of action. To that end, Mr. Lewis applauded the work of the forum, in seeking to improve mathematics education in Canada, and to bring mathematical ideas to life for Canadian students. Not only is fear of mathematics an impediment to full participation in the public debate of important social and economic issues, but failure in the mathematics classroom erects barriers to employment in today's knowledge-based and technological economy. Efforts to broaden the success of Canadian students in mathematics, and remove these barriers, are thus one element in the pursuit of equity and social justice.

Tom Salisbury (Fields)

MOPTA 05

ON JULY 25 – 27, 2005 THE OPERATIONAL Research Group at the University of Windsor, in Association with the Optimization group of the Great Lakes Section of SIAM, hosted MOPTA 05: Modeling and Optimization: Theory and Applications. This marked the first time that MOPTA was not held at its home of origin, McMaster University. The Windsor organizers stayed true to MOPTA traditions, providing an excellent array of internationally known invited speakers representing a nice blend between theory and applications.

Conference participants

The plenary speakers presented excellent one hour talks that covered topics ranging from the development, management and evaluation of optimization software to the application of optimization to medicine, and chemical, electrical, and design engineering. In addition to the invited talks there were 18 half-hour contributed plenary talks, and 11 contributed talks given in parallel sessions. By design, these talks also reflected the conference goals of bridging modeling (applications) with theory (optimization); and we enjoyed talks from the auto industry, from physicists, from established researchers and from graduate students.

The number of registered participants was close to 80 with almost half of them graduate students. While most participants were from Southwest Ontario and the Great Lake States, we also hosted guests from Australia, Israel, and Asia. In his opening remarks, Florian Potra noted that the MOPTA series is establishing itself as one of the important international conferences in optimization. With its tradition of providing breakfast and lunch onsite, a banquet, excellent invited speakers, and a limited number of parallel sessions, this conference is certainly an excellent networking event for graduate students and faculty. It's impossible not to make new friends and future colleagues.

The attendees and organizers are thankful for the financial support MOPTA 05 received from the Fields Institute, MITACS and the University of Windsor.

Be sure to look for details on MOPTA 06 to be held next summer at the University of Waterloo.

Richard Caron (Windsor)

Schubert Calculus and Schubert Varieties

THE TOPICS OF THIS WORKSHOP held June 8–12, 2005 at the Fields Institute are at the intersection of algebraic geometry, representation theory, symplectic geometry, and combinatorics. Although the basic questions of the field trace back to the earliest roots of algebraic geometry, exciting and fundamental developments are in full swing today.

Here is a simple prototypical problem of Schubert calculus: how many red lines R_1 and R_2 in 3-space (think real, then complex, then projective) intersect given "random" blue lines B_1, B_2, B_3, B_4? The answer is 2.

In the 19th century, the "proof'" would be as follows: move B_1 and B_2 until they intersect, and do the same for B_3 and B_4. Then R_1 is defined by the two points of intersection and R_2 is defined by the intersection of the two constructed planes. The claim is that one can "degenerate" the general situation to this special situation without changing the answer. Justifying such claims for this problem and many others became the topic of Hilbert's 15th problem (which is now mainly solved, thanks to decades worth of developments in intersection theory).

Thinking of this problem in terms of the space of lines in 3-space (or the grassmannian of planes in C^4), we study the Schubert variety of all lines that meet a given line Bi. Then the above question translates to: how many "points" in our grassmannian are in the intersection of four of these Schubert varieties? This is then re-interpreted in terms of the cohomology ring of the grassmannian. The answer becomes computational, but such computations have beautiful combinatorial structure that we study today.

The main goals of the workshop were two-fold. First, it was to provide a forum whereby nonexperts could learn about the main themes of research through mainly expository lectures in an informal atmosphere. Second, it was meant to connect researchers at the University of Toronto and York University, who have worked in the field from two different directions (geometry and combinatorics). The workshop formed part of the Geometry of String Theory thematic program and was organized by Lisa Jeffrey, Megumi Harada, and Alistair Savage (Toronto); and Alexander Yong (UCB).

Perhaps the best testimony of the attractiveness of the format was that although the workshop offered no travel support (being originally conceived as a local event), it had student and faculty attendance from a number of non-regional institutions, including the University of Michigan, Ohio State University, the University of Regina, the University of California, Berkeley and the Universidad de Cantabria (Spain)!

Lisa Jeffrey (Toronto)

The IFID Centre 4th Annual Conference

Fixed and Variable Annuities: A Do-It-Yourself Pension Plan?

THE INDIVIDUAL FINANCE AND Insurance Decisions Centre hosted its 4th Annual Conference on May 31, 2005. This year the focus of the conference was the topic of fixed and variable annuities, which are increasingly drawing the attention of academics, practitioners and retirees as traditional defined benefit pensions are on route to becoming a rarity and human life expectancy continues to increase. Opening remarks were delivered by Moshe Milevsky, Associate Professor of Finance at the Schulich School of Business and the Executive Director of The IFID Centre, who was the organizer of the one day event.

Jeffrey Brown (Illinois at Urbana-Champaign), who has served as the Senior Economist at the White House Council of Economic Advisers, as well as a member of the President's Social Security Advisory Board, delivered the Keynote Address. He discussed the benefits of annuitization, the characteristics of the life annuity market, the psychological challenges and misconceptions that discourage the purchase of these products, as well as anticipated future developments in the area.

Phelim Boyle (Waterloo) followed with his presentation of the characteristics and behaviour of complex guarantees that are offered on tax-sheltered accumulation variable annuities. Next, William Reichenstein (Baylor) stressed the importance of working with after-tax dollars for asset allocation decisions and discussed optimal asset location strategies for individual investors. Insightful comments were added by Tom Salisbury (Fields Institute) and Chester Spatt (Carnegie Mellon), the discussants of the papers presented by the two aforementioned speakers.

The afternoon session consisted of a panel of three speakers and provided attendees with insights into recent developments in the life annuity market. Lowell Aronoff (Cannex Financial Exchanges) discussed the history, evolution and implications of the life annuity exchanges for the Canadian and US markets. Next, Garth Bernard (MetLife) presented the keys to successful innovation and development of products that serve the personal financial planning industry, and Paul Kaplan (Morningstar, Inc.) presented the results of Monte Carlo simulations that investigate whether certain financial retirement strategies are probabilistically feasible, when particular combinations of variables are altered. The ensuing period of attendees' questions, directed at the panel members, highlighted additional issues and challenges pertaining to annuities that future retirees and the insurance industry face.

The IFID Centre wishes to thank all speakers and attendees who participated in this conference, as well as the generous sponsors of the event, including MITACS, Ibbotson Associates and Cannex Financial Exchanges.

Anna Abaimova (IFID Research Associate)

Workshop on Number Theory and Random Matrix Theory

IN EARLY JUNE, 2005, A WORKSHOP WAS held at the University of Waterloo on number theory and random matrix theory. This workshop brought together number theorists and physicists from around the world and was intended as a satellite workshop to the summer CMS meeting at University of Waterloo, June 4-6. Many participants in the workshop stayed on for a CMS session on L-functions and algebraic curves. It was organized by Yu-Ru Liu, David Mckinnon and Michael Rubinstein of the University of Waterloo. Funding was provided by Fields, PIMS, Perimeter Institute and the University of Waterloo.

The workshop was meant to explore connections between number theory and random matrix theory. The first connection between number theory and random matrices was made in the seventies. Hugh Montgomery had just worked out the pair correlation statistic for the zeros of the Riemann zeta function, and, on a visit to the Institute for Advanced Studies, was describing his results to Freeman Dyson. Dyson, who had studied similar statistics for the eigenvalues of random matrices in the context of modeling the energy levels of nuclei, pointed out that eigenvalues of large unitary matrices share the same behaviour that Montgomery had uncovered for the zeros of the Riemann zeta function. This supported the Hilbert-Polya conjecture, namely that the Riemann hypothesis should be true because the zeros of zeta somehow correspond to the eigenvalues of some unitary operator.

In recent years, there has been a flurry of activity in this area. Montgomery's results have been shown to extend to other L-functions of number theory. This has led to insight into questions concerning the value distribution of L-functions and ranks of elliptic curves. On the other hand, questions raised by number theorists have stimulated work on analogous problems in random matrix theory and has helped to push further the rich subject of random matrices.

The workshop included amongst its participants some of the number theorists and physicists who have been at the forefront of this approach, as well as a good number of postdocs and graduate students.

Michael Rubinstein (Waterloo)

OTHER EVENTS

SINCE THE BEGINNING OF MAY, many more Institute activities have taken place than there is room to report on here in detail. The retrospective on the *Geometry of String Theory* gives a full report on events in that program. The *IMACS Symposium on Iterative Methods in Computer Science* was held May 5-8 at the University of Toronto (organizers C. Christara, P. Forsyth, T. Terlaky, and J. Wan). A *Workshop on Mathematical Modeling and Analysis of Computer Networks* was held May 6 at the University of Waterloo, as part of the Networking 2005 conference, with organizers Shie Mannor and Peter Marbach. Mayer Alvo and Jon Rao organized a *Workshop on Empirical Likelihood Methods,* May 9-11 at the University of Ottawa. Graduate students Nikolai Slobodianik, Tao Sun, and Konstantin Zukker ran the *Southern Ontario Statistics Graduate Student Seminar Day* at York University, May 12-13. Bruce Allison's 60th birthday was the occasion for a *Workshop on Non-associative Algebras,* held May 12-14 at Fields (organizers Yun Gao, Oleg Smirnov, and Yoji Yoshii). Subsequent events were: *Ottawa-Carleton Discrete Mathematics Day* (May 13-14 at the University of Ottawa, organizers S. Boyd, L. Moura, D. Panario, M. Sajna, B. Stevens, and S. Wang), *Modelling the Rapid Evolution of Infectious Disease* (May 14-17 at the University of Western Ontario, organizers Lindi Wahl, Glenn Webb, and Xingfu Zou), *Mathematical programing in Data Mining and Machine Learning* (June 1-4 at McMaster University, organizers N. Cristianini, L. El Ghaoui, J. Peng, K. Scheinberg, R. Shioda, and T. Terlaky), the International Linear Algebra Society's 12th conference (June 26-29 at the University of Regina, run by S. Fallat, D. Farenick, C.-H. Guo, and S. Kirkland), *Large Deviations and Rare Events in Networks* (July 4-5 at the University of Ottawa, organizers David McDonald and André Dabrowski), the *Canadian Undergraduate Mathematics Conference* (July 13-17 at Queen's University), *Control of Infinite-Dimensional Systems* (July 25-29 at the University of Waterloo, organizers John Burns and Kirsten Morris), *Profinite Groups and Applications* (August 8-11 at Carleton University, organizers Luis Ribes and Ben Steinberg), the *17th Canadian Conference on Computational Geometry* (August 10-12 at the University of Windsor, organizers P. Bose, A. Mukhopadhyay, Y.H. Tsin, and S. Wismath), and the *1st Franco-Canadian Workshop on Combinatorial Algorithms* (August 18-20 at McMaster University, organized by A. Deza, F. Franek, W. Smyth, and M. Soltys). Fields also helped support the summer meetings of the CMS, SSC, and CAIMS, as well as the ongoing activities of AARMS.

The Mathematics Education Forum organized a discussion of curricular change in Ontario in June, and a symposium on *Designing Mathematical Thinking Tools* took place June 10-12 at the University of Western Ontario, run by G. Gadanidis, W. Higginson, R. Kay, K. Sedig, and C. Suurtamm. In May, the Quantitative Finance Seminar heard from Didier Sornette, and the Industrial Optimization Seminar from Andrew Conn and Chandu Visweswariah, while the PRMIA risk management seminar listened to Bill Fung and Ron Mock in June. Seminars continued to meet in Applied Mathematics, Set Theory, Probability, and Quantum Information. The new seminar series of the *Centre for Mathematical Medicine* heard from Carl Panetta in May and Jack Tuszynski in July.

Tom Salisbury (Fields)

D. Sornette, Finance Seminar

NOTED

ROBERT MCCANN WINS 2005 CMS COXETER-JAMES PRIZE

Rob was a conference organizer during the PDE program in 2003

ANDREW GRANVILLE WINS 2006 CMS JEFFREY-WILLIAMS PRIZE

Andrew recently finished a term serving on the Fields Scientific Advisory Panel

THOMAS SALISBURY ELECTED AS NEXT CMS PRESIDENT

Tom is completing his term as the Deputy Director of the Fields Institute in July 2006

Message from the Director: Enjoying the AGM

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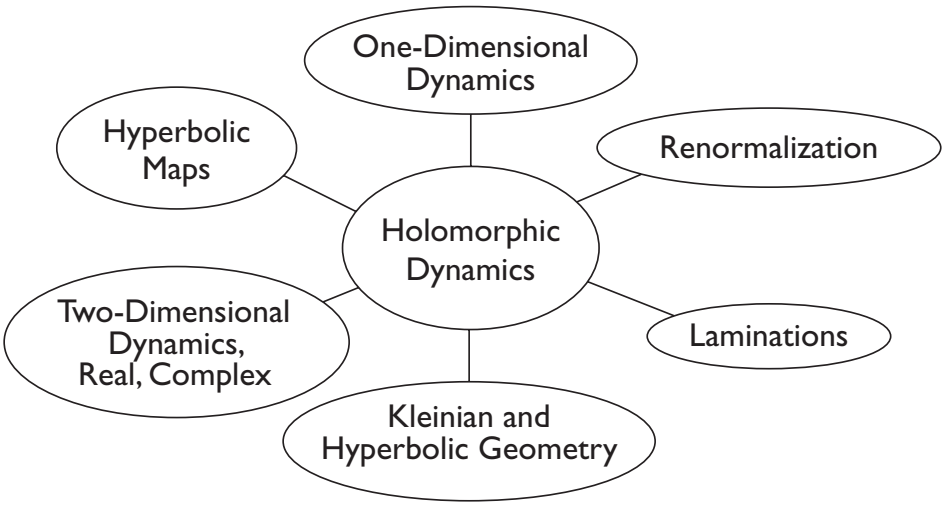
2005" held in July, declared a proof that "Toronto is better than Paris". Beyond the coming year's program in holomorphic dynamics and related topics, programs in Cryptography (Fall 2006), Homotopy Theory and Applications (Winter/Spring 2007) and Operator Algebras have been approved. General Scientific Activity, Summer Schools, NPCDS, CIM, Math Education and prizes and lectures have all flourished this year. A new activity, an industry-oriented seminar on optimization, organized by Tamas Terlaky, is off to an excellent start. We are proud to report that beginning in 2006, the CRM-Fields prize will be renamed the CRM-Fields-PIMS prize, with PIMS joining as an equal partner.

This year, five new Fields Institute Fellows were announced: David Boyd (UBC), Walter Craig (McMaster), Lisa Jeffrey (University of Toronto), John Mighton (JUMP), and Tamas Terlaky (McMaster). This recognition is awarded to individuals who have made outstanding contributions to the Fields Institute, its programs, and to the Canadian mathematical community. Fields congratulates the new Fellows and thanks them for their service to Fields and to mathematics.

The AGM was followed by a brief meeting of the Board of Directors and a reception at Fields. In the evening, the institute hosted a banquet at Hart House for members of the corporation, Fields staff and guests. Ron Dembo, founder of *Algorithmics*, and now Board member and founding CEO of *0footprint*, delivered an inspiring talk titled "The Golden Age of Mathematics". The gist of his message was that the industrialized countries must move towards sustainability, and an important tool to move an environmental agenda forward will be mathematical modelling. Ron's eloquent evocation of the desire of the public – in Canada and abroad – for green products, and his announcement of the mission of his new company, to develop this inchoate desire into a market, was a startling blend of idealism and entrepreneurial pragmatism. It touched a chord with every member of the audience, and stands as a good metaphor for the passions that motivate our mission.

Barbara Keyfitz (Fields)



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The Fields Institute is grateful to all its sponsors for their support.

The Fields Institute for Research in Mathematical Sciences publishes FIELDSNOTES three times a year (September, January, and May).

Director: Barbara Lee Keyfitz
Deputy Director: Thomas S. Salisbury
Managing Editor: Maryam Ali
Distribution Co-ordinator: Tanya Nebesna
Scientific Editor: Carl Riehm

Call for Proposals, Nominations, and Applications

For detailed information on making proposals or nominations, please see the website: www.fields.utoronto.ca/proposals

General Scientific Activities

Proposals for short scientific events in the mathematical sciences should be submitted by October 15 or March 15 of each year, with a lead time of at least one year recommended. Proposals will be considered at other times as funds permit. Activities supported include workshops, conferences, seminars, and summer schools. If you are considering a proposal, we recommend that you contact the Director (bkeyfitz@fields.utoronto.ca) or Deputy Director (salt@fields.utoronto.ca).

Thematic Programs

Deadlines for letters of intent and proposals for semester or year-long programs at the Fields Institute are March 15 and August 31 each year. Organizers are advised that a lead time of several years is required, and are encouraged to submit a letter of intent prior to preparing a complete proposal. They may consult the directorate about their projects in advance to help structure their proposal.

Postdoctoral Opportunities

Applications are invited for postdoctoral fellowship positions for the 2006-2007 academic year. The thematic program on Cryptography will take place at the Institute from August-December 2006, while the thematic program on Geometric Applications of Homotopy Theory will run from January-June 2007. Qualified candidates who have recently completed a PhD in a related area of the mathematical sciences are encouraged to apply. The fellowships provide for a period of engagement in research and participation in the activities of the Institute. They may be offered in conjunction with partner universities, through which a further period of support may be possible. One recipient will be awarded the Institute's prestigious Jerrold E. Marsden Postdoctoral Fellowship. Applicants seeking postdoctoral fellowships funded by other agencies (such as NSERC or international fellowships) are encouraged to request the Fields Institute as their proposed location of tenure, and should apply to the address below for a letter of invitation. Additional support is available (pending NSF funding) to support junior US visitors to these programs. Individuals wishing to combine fellowships at MSRI in fall 2006 and at Fields in winter 2007 should indicate this on their application. Applications are encouraged from all qualified candidates, particularly aboriginal peoples, persons with disabilities, members of visible minorities and women.

The deadline for postdoctoral applications for the 2006-2007 programs is December 9, 2005, although late applications may be considered.

CRM–Fields–PIMS Prize

Nominations are invited for this joint prize in recognition of exceptional achievement in the mathematical sciences. The candidate's research should have been conducted primarily in Canada or in affiliation with a Canadian university. Previous recipients are H.S.M. Coxeter, George A. Elliott, James Arthur, Robert Moody, Stephen A. Cook, Israel Michael Sigal, William T. Tutte, John Friedlander, John McKay, Edwin Perkins, Donald A. Dawson and David Boyd.

Nominations for the CRM-Fields-PIMS Prize should reach the Institute by October 1, 2005.

Distinguished Lecture Series in Statistical Science (DLSS)

Nominations are being solicited for the sixth Fields Institute Distinguished Lecture Series in Statistical Science, to be given in Spring, 2006. The awardee will be an internationally prominent statistical scientist, who will give two lectures (one general, one specialized) at the Fields Institute. The previous lecturers are Peter G. Hall, Donald Fraser, Don Dawson, Sir David Cox and Brad Efron.

The deadline for DLSS nominations is October 15, 2005.

Send applications, nominations, and proposals to: The Director, Fields Institute
222 College Street, Toronto, Ontario, M5T 3J1 Canada

Fields Activities

Chalk it up to Mathematics

SEPTEMBER TO JANUARY 2006 *at Fields unless otherwise indicated*

Detailed information: www.fields.utoronto.ca/programs

Thematic Programs

RENORMALIZATION AND UNIVERSALITY IN MATHEMATICS AND MATHEMATICAL PHYSICS: FALL 2005

Organizers: P. Bleher, M. Lyubich and M. Yampolsky

SEPTEMBER 2005
Start of graduate courses

SEPTEMBER 13–15, 2005
Coxeter Lecture Series
Oded Schramm (Microsoft)

SEPTEMBER 20–24, 2005
Workshop on Percolation, SLE, and Related Topics

OCTOBER 18–22, 2005
Workshop on Renormalization and Universality in Mathematical Physics

OCTOBER 24, 2005
Clay Math Institute Public Lecture
Leo Kadanoff (Chicago)

NOVEMBER 23–25, 2005
Coxeter Lecture Series
Lai-Sang Young (Courant)

NOVEMBER 29–DECEMBER 3, 2005
Workshop on Renormalization in Dynamical Systems

HOLOMORPHIC DYNAMICS, LAMINATIONS, AND HYPERBOLIC GEOMETRY: WINTER 2006

Organizers: B. Kleiner, M. Lyubich, Y. Minsky, M. Shub and M. Yampolsky

JANUARY 2006
Start of graduate courses

JANUARY 5–9, 2006
Workshop on Partially Hyperbolic Dynamics, Laminations, and Teichmuller Flow

JANUARY 9–11, 2006
Distinguished Lecture Series
Gregory Margulis (Yale)

General Scientific Activities

SEPTEMBER 2, 2005
Opening ceremonies – Centre for Mathematical Medicine

SEPTEMBER17, 2005
Carleton Applied Probability day, at Carleton University

SEPTEMBER 21–25, 2005
Jordan Algebras and Related Fields, at the University of Ottawa

OCTOBER 13–15, 2005
Current Issues in the Analysis of Incomplete Longitudinal Data

OCTOBER 21–23, 2005
Grand Mathematical Challenges in Medical Imaging Processing, at the University of Waterloo

OCTOBER 27, 2005
2005 CRM-Fields Prize Lecture
David Boyd (UBC)

NOVEMBER 5, 2005
Graduate School Information Day

NOVEMBER 4–5, 2005
Credit Risk, at the University of Western Ontario

NOVEMBER 9–10, 2005
Distinguished Lectures in Statistical Science
Brad Efron (Stanford)

NOVEMBER10–13, 2005
Data Mining Workshop

NOVEMBER 14, 2005
Symposium Celebrating New Fellows of the Royal Society of Canada
Peter Abrams (Toronto), David Jackson (Waterloo), Edward Sudicky (Waterloo)

From the Director: Enjoying the AGM

MOST OF THE YEAR, WE GO ABOUT OUR business of planning events and realizing plans, comfortable with our successes and learning from our mistakes. The Annual General Meeting is a time to take stock of ourselves and to report to our members.

This year's AGM started with a well-attended meeting with representatives of sponsoring universities, whose support of Fields is warmly appreciated, and on whose input we rely. Reciprocally, sponsors get both tangible and intangible benefits for their contribution. Representatives of the Principal Sponsoring Universities and the directorate discussed the importance of documenting results, and different departments compared notes on how to get the most benefit from their postdoctoral fellow (PDF) programs. Next year, Fields would like to experiment with some new initiatives: increasing contact between PDFs, enhancing their visibility, and encouraging nearby universities to invite Fields visitors to their institutions. The meeting stressed also the importance of making good appointments to the corporation, expanding Fields involvement to all departments within the university that use mathematical sciences; and setting up effective Sponsoring Universities Activities Committees. Overall, the exchange marked another step in a continuing dialogue.

> "One focus of the program will be the famous MLC conjecture that asserts that the Mandelbrot set is locally connected"

Barbara Keyfitz

The intellectual highlight of the afternoon was a lecture by Mikhail Lyubich, co-organizer of next year's thematic programs, "Renormalization and Universality in Mathematics and Mathematical Physics" in Fall 2005 (described elsewhere in this newsletter) and "Holomorphic Dynamics, Laminations and Hyperbolic Geometry" in Winter/Spring 2006. Misha began his lecture with the diagram reproduced here, and proceeded to explain the central role of holomorphic dynamics. He described the rich world of rational maps, the early work of Julia and Fatou, Smale's horseshoes, and the notion of universality which has profound connections to physics. One focus of the program will be the famous *MLC* conjecture that asserts that the Mandelbrot set is locally connected, a particular case of the Rigidity Problem. More of this story will unfold during the coming year's workshops, beginning with "Percolation, SLE and related topics", September 20-24. Between the two programs, the Distinguished Lecture Series will be given by Gregory Margulis on January 9-11, 2006, and there will be three Coxeter Lecture Series, by Oded Schramm, Lai-Sang Young andYair Minsky. Among the distinguished long-term visitors, Clay Senior Scholar Leo Kadanoff will give a public lecture on October 24. We anticipate another exciting and interdisciplinary year.

Following tea, the AGM itself was chaired by John Gardner, who began on the positive note that the revision of the by-laws has been a success. As of this year, Board members serve as individuals, rather than as representatives of some constituency. Now the Board is more focused on the Institute and its needs. One of our needs is more funding so that we can keep up with the growing number of outstanding activities generated by our members and Scientific Advisory Panel. John illustrated this need, along with our potential for success in private fundraising, by presenting a cheque to the Institute at this meeting.

The interdisciplinary and inter-institutional (with Perimeter) String Theory program has lived up to its promise. In fact, participants at the final conference, the international "Strings

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