

# NEWS *letter*

## DIRECTOR'S MESSAGE

The activity level at Fields over the past 6 months has been extremely high; so high in fact that members are joking that we are adding a new wing (the new Bahen Centre for Information Technology is being built in our backyard). In this newsletter, I want to draw your attention to just a few of the many interesting activities that are going on. As well, the institute finds itself in an enviable financial situation and I encourage people to consider the call for proposals in the insert.

The highlight of the summer activities at Fields was most definitely the Legacy of John Charles Fields Symposium held in June. Spaced over three days there were talks by nine Fields medallists as well as two

historical talks. A full report can be found at [www.fields.utoronto.ca/legacyreport.html](http://www.fields.utoronto.ca/legacyreport.html).

Over 300 people attended the symposium and more than \$30,000 in sponsorship was obtained. Videos of the lectures are available on request for a nominal fee; if you are interested, send email to [geninfo@fields.utoronto.ca](mailto:geninfo@fields.utoronto.ca).

The fall thematic program this year is Infinite Dimensional Lie Theory and Its Applications. This is a one-term thematic program but nevertheless the activity level is very high with over 20 long-term research visitors and five postdoctoral fellows. Three workshops and three graduate courses provide the backbone of the activity; a brief report from Steven Berman on this program is included in this newsletter.

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## Overview of Infinite Dimensional Lie Theory and Its Applications

Our program began early in September with the arrival of the 20 or so post docs, graduate students, and long time visitors who eagerly began attending the courses being offered. One of these courses, given by Y. Billig, was on the interaction of affine Lie algebras and soliton theory, and led to some of the new developments in this theory which involved connections with toroidal Lie algebras. These toroidal algebras also played an important role in another course, by Y. Gao, which was on

the basic structure and representation theory of extended affine Lie algebras (EALA's for short). This course led its way from the affine algebras and toroidal algebras, which are some of the most important examples of EALA's, through to the classification and representation theory. Yet a third course was especially important as a "bridging course" for people attending the first half year to prepare themselves for the sister workshop in the second term on Symplectic Geometry. This course was given by E. Meinrenken.

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For up-to-date information about The Fields Institute

• Please visit our web site at [www.fields.utoronto.ca](http://www.fields.utoronto.ca)

• Write to us at [geninfo@fields.utoronto.ca](mailto:geninfo@fields.utoronto.ca) to receive our monthly e-newsletter

# Mathematics Education Forum

The Mathematics Education Forum of the Fields Institute promotes discussion of issues in mathematics education at all levels. Its membership comes from a wide spectrum of education and non-education sectors. For the past four to five years the Forum has spent much of its efforts on participating in the evolution and implementation of the latest Ontario mathematics curriculum. It is presently involved in three separate projects that aim to respond to the challenges raised by significant changes in the Ontario Educational System. Mathematics Education is not only impacted by a change in curriculum but also by a reduction in the number of years of schooling. The mathematics curriculum in the elementary and middle grades has been implemented and in secondary schools it is going through a progressive change. A new Grade 9 curriculum was implemented last year, Grade 10 this year, and so on. As of 2003 students will be graduating from this curriculum from Grade 12, together with peers who will be completing their OACs and a 13<sup>th</sup> year.

While these changes are occurring in the system, analysis of complete teacher data for 1998 forecast that nearly one in four Ontario teachers will retire by 2003 and nearly one in two will retire by 2008. The situation is in fact accelerated because the present government has taken a particularly hard line with teachers and more teachers have chosen early retirement than they had in the past. Mathematics is an area of grave concern: the Fields Forum received evidence that Ontario is facing a crisis as it is presently unable to graduate enough new mathematics teachers to replace the projected number retiring.

From the many problems that have developed and are arising as a result of these situations, the Forum has identified three areas in which it can act, areas in which it is likely to make positive contributions. To assist in the development of positions and proposals the Forum has struck three Task Forces:

- A Task Force on Mathematics Teacher Education co-chaired by Eric Muller (Brock) and Walter Whiteley (York);
- A Task Force, co-chaired by Ed Barbeau (Toronto) and Stewart Craven (Toronto Board of Education) focusing on the transition for Grade 12 graduates to College and University mathematics;
- A Task Force co-chaired by Shirley Dalrymple (York District School Board) and Sandy Dilena (Toronto Board of Education) working on one of the new Grade 12 courses "Mathematics of Data Management".

The Forum meets on Saturdays six or seven times a year. The Task Forces meet on a more regular basis as time permits.

**Eric Muller, Brock University**

## Infinite Dimensional Lie *continued from page 1*

Later in September we had the first of our workshops. Some of the more well known mathematicians attending from outside of Canada were G. Benkart, V. Kac, S. Kumar, O. Mathieu, G. Neeb, L. Scott, P. Slodowy, and E. Zelmanov. Just looking at this partial list of speakers gives one an idea of the depth and diversity covered by the many talks. Subjects ranged from representation theory, structure theory, geometric aspects of the infinite dimensional algebras, and groups which have grown out of affine Kac-Moody theory to the various applications within both mathematics and physics of these topics. One of the physicists in attendance was so excited by some of the ideas presented in a lecture by V. Kac that he said he would immediately begin some researches of his own around this topic. The mathematical level was very high, and the excitement generated by the speakers affected all in attendance, and this made for a lot more interaction than is usual.

Our program was fortunate to attract one of the leading experts on Vertex Operator Algebras, C. Dong, to attend for the entire term. He began presenting lectures on VOA's soon after the first workshop and these met for 3 hours each week and will continue throughout the first term. The connection of VOA's with the affine Kac-Moody Lie algebras is fundamental and well established and this same type of connection with some of the other algebras related to the affine algebras is beginning to be studied. Dong's lectures have played a big role in stimulating interest in this direction and several clusters of people in attendance are presently working on connections between toroidal algebras, EALA's, and VOA's. As the second workshop was on the topic of VOA's Dong's lectures also played the role of helping people gear up for this high level workshop.

The second workshop had been designed to bring together researchers in both mathematics and physics who are at the forefront of studies in and around VOA's and conformal field theory, both from an algebraic as well as a geometric view point. In particular the talks by C. Dong, M. Douglas, B. Feigin, J. Fuchs, R. Griess, Y.Z. Huang, J. Lepowsky, H. Li, J. Mason, F. Malikov, K. Nagatomo, A. Recknagel, V. Schomerus, and A. Tsuchia provided a broad picture of the diverse developments happening in the area. Both the algebraic and geometric approaches were presented with a lot of emphasis being placed on D-branes and geometric conformal field theory. Many speakers mentioned both G. Segal and M. Kontsevich for their influence in this area in their talks and we feel especially fortunate to have G. Segal coming in December to give a sequence of lectures as part of the Coxeter Lecture series.

B. Feigin stayed on after the VOA workshop and delivered a sequence of four lectures on some of his recent work with people in the Kyoto school which dealt with coinvariants in the representation theory of affine algebras. D. Harari is presently giving a mini-course on torsors in algebraic geometry, a subject which is related to galois cohomology and hence, to questions concerning forms of various groups and algebras which arise in Lie theory.

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# Call for proposals, nominations and applications

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*Please see the website for detailed information on the proposal and nomination process: [www.fields.utoronto.ca/proposals](http://www.fields.utoronto.ca/proposals)*

## Thematic Programs and General Scientific Activities

Proposals for year long or half-year programs at The Fields Institute are currently solicited for the academic years 2002-03 and beyond. We also support programs of one day to one month of concentrated activity in a specific area of current research interest in the mathematical sciences. These activities can be in the form of workshops, seminars, conferences and/or summer schools.

## Postdoctoral Opportunities at the Institute

Applications are invited for postdoctoral fellowship positions for the 2001-2002 academic year, the Thematic Year on Numerical and Computational Challenges in Science and Engineering. These fellowships provide for a period of at least one year engaged in research and participating in the research activities of the Institute.

Among other opportunities, one Jerrold E. Marsden Postdoctoral Fellowship will be awarded. It pays a stipend of \$40,000 (Cdn) and provides for a twelve-month period at the Institute conducting research and participating in the activities of the core program. No teaching is required. In addition to the stipend, a \$2000 (Cdn) research grant will be available during the tenure of the position. Standard NSERC guidelines will apply to this grant.

Postdoctoral applications should reach the Institute by January 2, 2001.

## CRM - Fields Prize

The Centre de recherches mathématiques (CRM) and the Fields Institute for Research in Mathematical Sciences solicit nominations for this joint prize in recognition of exceptional achievement in the mathematical sciences. Previous recipients are Professor H.S.M. (Donald) Coxeter, Professor George A. Elliott, Professor James Arthur, Professor Robert Moody, Professor Stephen A. Cook, and Professor Israel Michael Sigal. Please see [http://www.fields.utoronto.ca/proposals/crm-fields\\_prize.html](http://www.fields.utoronto.ca/proposals/crm-fields_prize.html) for details.

## National Program Committee Grants

The three Canadian Institutes in the Mathematical Sciences -- CRM, Fields and PIMS-- support joint activities in the mathematical sciences through the National Program Committee. Program proposals of national interest lying outside the direct mandate of any of the individual institutes are welcome. Please see <http://www.fields.utoronto.ca/proposals/natprogcomm.html> for details.



# Activities at the Fields Institute January – August 2001

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*Please see the website for detailed information on these activities, and more at [www.fields.utoronto.ca/programs](http://www.fields.utoronto.ca/programs)*

## Thematic Programs

### Symplectic Topology, Geometry And Gauge Theory, January-June 2001

Organizers: Michele Audin, Yakov Eliashberg, Helmut Hofer, Jacques Hurtubise, Lisa Jeffrey, Boris Khesin, François Lalonde, Eckhard Meinrenken

For more information, write to us at [symplectic@fields.utoronto.ca](mailto:symplectic@fields.utoronto.ca)

January 9 - 14	Quasiclassical And Quantum Structures Organizers: P. Etinghof and B. Khesin
March 26 - April 7	Symplectic And Contact Topology, a Joint Fields/CRM Workshop Organizers: S. Donaldson, B. Dubrovin, Y. Eliashberg, A. Givental, H. Hofer, B. Khesin and F. Lalonde
June 4 - 13	Hamiltonian Group Actions And Quantization Workshop Organizers: M. Audin, J. Hurtubise, L. Jeffrey and E. Meinrenken
January-April	Graduate Courses <ul style="list-style-type: none"> <li>• Symplectic Geometry &amp; Hamiltonian Group Actions: L. Jeffrey</li> <li>• Infinite Dimensional Lie Groups And Gauge Theory: B. Khesin</li> <li>• Moduli Spaces Of Flat Connections: E. Meinrenken</li> <li>• Introduction To Symplectic Field Theory: Y. Eliashberg</li> </ul>

### Numerical and Computational Challenges in Science and Engineering. August 2001-02

Organizers: U. Ascher, H. Brunner, T. Chan, T. Coleman, W. Enright, J. Flaherty, P. Forsyth, M. Fortin, A. George, K. Jackson, B. Langford, B. Russell, S. Shen. For information: [numerical@fields.utoronto.ca](mailto:numerical@fields.utoronto.ca)

July 29 – August 3 International Conference on Scientific Computation and Differential Equations (in Vancouver)

## GENERAL SCIENTIFIC ACTIVITIES

*For information write to us at: [geninfo@fields.utoronto.ca](mailto:geninfo@fields.utoronto.ca)*

April 16-21	Partial Differential Equations in Mathematical Physics and Applied Mathematics Organizers: W. Craig and C. Sulem
May 14-18	Summer School in Quantum Information Processing Organizers: R. Cleve, D. Lidar, M. Mosca
June 22-23	A Workshop in Honour of Allan Borodin, "Borodin at 60" Organizer: S. Cook
July 23-29	Arithmetic, Geometry and Physics and Calabi-Yau Varieties and Mirror Symmetry Organizers: J. Lewis and N. Yui
August 16-17	Eighth Annual Workshop on Selected Areas in Cryptography (SAC2001) Organizers: S. Vaudenay and A. Youssef
August 20-25	Problems & Perspectives on the Calculus of Variations: Physics, Economics, and Geometry Organizer: R. McCann



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# The CRM and the Fields Institute are pleased to award the 2000 CRM-Fields Prize to Israel Michael Sigal

Israel Michael Sigal is one of the leading experts in the mathematical analysis of non-relativistic quantum theory worldwide. His theorem with Soffer on the N-body problem provided a completely rigorous solution to a major unsolved problem due to Schroedinger and was critical in establishing a firm mathematical foundation for quantum mechanics.

His recent contributions to quantum electrodynamics provide a consistent mathematical description of the theory proposed by Feynmann, Schwinger and Tomonaga and represent a revolutionary approach to the subject.

Professor Sigal is currently a University Professor and the Norman Stuart Robinson Chair at the University of Toronto.



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Both of these were part of our Sophus Lie Lecture Series which ran throughout the term. All of the term-long participants were involved with various research projects, often joint projects with other participants, and much new and exciting work has resulted. We have had lectures by all the visitors, post-docs, and grad students participating in our program. There is also planned a Fields Communications Series publication which will present the work of the speakers in the VOA workshop as well as several Fields Monograph Series publications. One of these will be based on the course given by Y. Gao and the other will be based on C. Dong's course. The amount of mathematical activity has kept all involved extremely busy and the level of the mathematics has been very high. It is already clear that some important new directions are emerging from some of the research carried out here.

**Steve Berman, University of Saskatchewan**

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The thematic program for the winter and spring term is Symplectic Topology, Geometry and Gauge Theory. Four graduate courses and three workshops are planned including a joint workshop in March with the CRM that, it is rumored, will include seminars on the train between Montreal and Toronto! To get more information on this program, see [www.fields.utoronto.ca/symplectic.html](http://www.fields.utoronto.ca/symplectic.html).

For the year 2001-2002, the thematic program is Numerical and Computational Challenges in Science and Engineering.

Planning for this program is well underway and over 50 long-term visitors are anticipated. To find out more about this program, see [www.fields.utoronto.ca/numerical.html](http://www.fields.utoronto.ca/numerical.html).

The Fields Institute remains committed to its activities in Mathematics Education. The main focus for this activity is the Mathematics Education Forum that meets monthly; a report is included here. The Fields plays a key role as a neutral meeting ground for a variety of educational organizations, and in Ontario there is a big need for this, given the shortage of qualified mathematics teachers and the switch to a new curriculum for a four-year high school program.

One of the most exciting new activities around Fields is our Commercial/Industrial Mathematics program growing out of Fields' involvement in the financial community and MITACS. The growing interaction between mathematicians and the business communities is truly a Canadian success story and one that is only in its infancy. A report on this program, written by our Research Liaison Officer Ben Schwartz, is included.

**Bradd Hart, Acting Director**

Be sure to visit our web site for updates  
on all Fields activities.

[www.fields.utoronto.ca](http://www.fields.utoronto.ca)

# Fields Commercial and Industrial Mathematics Program

The Commercial and Industrial Mathematics program (CIM) acts as a conduit connecting the mathematics community and businesses that benefit from research in the mathematical sciences. The CIM program seeks to transfer results in the mathematical sciences to the business community and transmit the mathematical needs of the business community to the mathematics community. This year the MITACS initiative has played a central role in the CIM program.

The Network of Centres of Excellence MITACS, which stands for the Mathematics of Information Technology and Complex Systems, provides mathematical models, software tools, and highly qualified personnel to assist Canadian firms. MITACS includes eight Ontario based multi-university projects administered through the Fields Institute. These exciting university/industry collaborative research projects contribute to key sectors of the economy: the biomedical, commercial/industrial, information technology, manufacturing, and trading/finance sectors.

The Fields is continuing to cultivate the enormously popular financial mathematics seminar series. This seminar series has a wide appeal in both the academic and business communities. In addition, the Fields is assisting the Toronto chapter of the Global association of Risk Professionals (GARP) to develop their own monthly seminar series. The GARP seminar series seeks to expose mathematical problems and solutions in the emerging profession of financial risk analysis and management.

To foster further interactions between researchers and business the Fields is hosting and organizing several workshops and professional courses. Waterloo's Centre for Applied Cryptographic Research (CACR) has been using Fields facilities for their information security workshops. Professor Thomas Salisbury and Professor Moshe Milevsky combined forces to teach a highly successful two-day course on 'Probability Theory and Modern Finance', and Dr. Dan Rosen, Director of Research, Algorithmics Inc., taught a popular course on 'Quantitative Methods for Credit Risk Management'.

Housed at and incubated by the Fields Institute are two budding firms, and two research centres, all of which build mathematical tools with commercial applications: Sigma, a financial analysis and management firm; Karthika, developing a new cryptographic system based on Abelian varieties; The Ontario Centre for Energy Finance; and The Individual Finance and Insurance Decisions Centre.

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