

## International Research Environment

### Evidence A: Sample of mathematical research programs

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Some examples of programs conducted by national mathematical sciences institutes worldwide to attract international research leaders. Note the range of fields of application.

#### Stochastic Computation in the Biological Sciences

<http://www.newton.ac.uk/programmes/SCB/index.html>

**Centre:** Statistical and Applied Mathematical Sciences Institute (USA)

**The focus:** Statistical techniques are used to deal with problems associated with large datasets, indirect measurements, and/or complex underlying processes, principally for biological and medical sciences. Developing knowledge in these areas is being applied to biological processes including genetic inheritance and disease management. Many topical problems in the biological sciences lie either beyond the limit of current mathematical methods on today's computers, so there is an urgent need to extend the power and range of methods that will meet the increasing demands of the applied research community.

**The program:** A 12-month program of invited seminars, workshops, and targeted research programs is providing ground for productive collaboration between mathematicians, statisticians, and computational scientists working under the stochastic dynamics banner.

#### Managing Uncertainty - New Analysis Tools for Insurance, Economics and Finance

<http://www.newton.ac.uk/programmes/MUC/>

**Centre:** Isaac Newton Institute for Mathematical Sciences (UK)

**The focus:** Corporations and governments frequently make economic, insurance, and governance decisions based on inadequate frameworks for handling low probability, high severity events drawn from non-stationary time series. However, longer-term events (such as the potential impact of global changes in the environmental structure) are vital to understand.

**The program:** The program brought together mathematicians, statisticians, economists and environmental scientists who specialise in the analysis of financial, economic and environmental data to focus on the development of mathematical models and statistical prediction tools for extreme events, stationarity, and change; the development of alternative measures of risk; incorporation of model uncertainty into statistical calculations; and the extensions of multivariate time series.

## Mathematical and Statistical Approaches to Climate Modeling and Prediction

<http://www.newton.ac.uk/programmes/CLP/ws.html>

**Centre:** Isaac Newton Institute for Mathematical Sciences (UK)

**The focus:** Climate models and prediction need to examine alternative scenarios and to quantify uncertainty through the different stages in formulating and running predictive models and analyzing their results for projections. Both aspects require a much larger number of model evaluations than is currently possible with state-of-the-art global circulation model.

**The program:** The first theme is the development of improved stochastic sub-grid-scale physics models, which have the potential to improve the variability of ensemble climate simulations. The second aspect of the program concerns the use of statistical techniques to create a theoretically sound basis for probabilistic climate prediction. This programme will bring together world-leading researchers in climate modelling, mathematics and statistics in order to make progress in solving some of the major issues facing climate prediction.

## The Mathematics of Drug Resistance in Infectious Diseases

<http://www.fields.utoronto.ca/programs/scientific/10-11/drugresistance/>

**Centre:** Fields Institute (Canada)

**The focus:** Public health is a vital area of mathematical application. Infectious disease involves interactions between the agent (e.g., virus, bacteria), the host (e.g., susceptibility due to genetic, environmental and other factors), specific aspects of the environment, and the efficacy of preventive or therapeutic control measures (e.g., drugs, drug resistance). Mathematical modelling enables the evaluation and appropriate altering of agent-host-environment-control interfaces.

**The program:** A 2-month summer program focused on the emergence of drug resistance in infectious diseases, bringing together leading researchers in mathematical epidemiology/immunology from around the world in order to stimulate major progress in this area of applied mathematics. The program also provided an opportunity for graduate students and postdoctoral fellows to interact with these researchers in a productive and sustained way.

## Perspectives in Deformation Quantization and Noncommutative Geometry

<http://www.u-bourgogne.fr/monge/g.dito/rims2010/index.php?page=home>

**Centre:** Research Institute for Mathematical Sciences (Japan)

**The Focus:** The objective of the thematic year is to bring together mathematicians, physicists and mathematical physicists working in areas in

which deformation quantization and/or noncommutative geometry plays an important role.

**The Program:** Five workshops, one conference and a public lecture series held between April 2010 and February 2011. Shared activities with MSRI at Berkeley, USA and the University of Burgundy, France. The opening event includes short courses in the main areas of the program given by international experts.

### **Random Matrix Theory, Interacting Particle Systems and Integrable Systems**

[http://www.msri.org/calendar/programs/ProgramInfo/259/show\\_program](http://www.msri.org/calendar/programs/ProgramInfo/259/show_program)

**Centre:** Mathematical Sciences Research Institute (USA)

**The focus:** Random matrix theory has emerged as a model for a wide variety of problems in mathematics, statistical analysis of probability, physics, and engineering — with applications ranging from nuclear physics to transportation problems to wireless communications.

**The program:** A summer program of workshops involved researchers from the RMT field, graduate students, international post-doctoral fellows and other invitees, with the aim of broadening interest in and knowledge of this powerful aspect of mathematical theory and its breadth of applications. Special sessions were held for females and other under-represented groups.

### **Asymptotic Geometric Analysis**

<http://www.fields.utoronto.ca/programs/scientific/10-11/asymptotic/index.html>

**Centre:** Fields Institute (Canada)

**The focus:** This field focuses on developing ways of measuring and predicting concentration, distribution, and deviation as well as the study of shape, space and transformation. Geometric, probabilistic, and combinatorial methods developed in this form of analysis are used in many areas outside mathematics—from logistics and transportation methods to the study of fluid, quantum, and geometrical flows. Recent achievements in asymptotic geometric analysis demonstrate new and unexpected phenomena for the domains of mathematics and the range of sciences that deal with functions of infinitely growing numbers of variables.

**The program:** A half-year program of targeted research involving key researchers in the field with doctoral and post-doctoral researchers, workshops and lectures, seminars and courses. Extra support is available to support junior visitors and minority groups.

## Moduli Spaces

<http://www.newton.ac.uk/programmes/MOS/index.html>

**Centre:** The Mathematics Research Center of Stanford University (USA)

**The focus:** There have been startling advances in this area of mathematics in the last 3-5 years, leading to the discovery of unexpected links between seemingly unrelated areas of mathematics. The project has applications in mathematical physics, where moduli spaces frequently arise as solutions to classification problems, enabling a stronger understanding of the form of objects.

**The program:** The MRC will host a three year emphasis program on the topology and geometry of moduli spaces and related topics. There will be a series of conferences, workshops, minicourses, seminars, as well as both short and long term visiting researchers coming to the Stanford Mathematics Department to participate in this program. The areas of emphasis will be Hyperbolic Geometry and Geometric Group Theory, The Algebraic Topology of Moduli Spaces and String Topology, and The Algebraic Geometry of Moduli Spaces and Symplectic Geometry.

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## Evidence B: Some contributions of mathematical centres in other OECD countries

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### Pacific Institute for the Mathematical Sciences (PIMS)

<http://www.pims.math.ca/>

**Countries:** Canada and USA

**Members:** The University of Alberta, the University of Calgary, the University of British Columbia, Simon Fraser University, the University of Victoria, University of Washington, University of Regina, and the University of Saskatchewan.

**Mandate:**

- to promote excellent research and applications of the mathematical sciences,
- to facilitate the training of highly qualified personnel,
- to enrich public awareness of and education in mathematics (including enhancement of the mathematical training of teachers and students), and
- to create partnerships with similar organizations around the world, with a particular focus on Latin America and the Pacific Rim as well as the scientific networks of the European Community.

**Recent contributions:**

- 22 funded cooperative research groups in areas ranging across all the mathematical sciences
- attraction of outstanding faculty to PIMS universities
- sponsorship of numerous postdoctoral fellows and graduate student fellowships, distributed throughout PIMS sites on a competitive basis
- an International Graduate Training Centre in Mathematical Biology
- international summer schools
- applications of emerging areas of mathematics to seismic imaging, atmospheric modeling, environmetrics, and mathematical finance
- a yearly Industrial Problem Solving Workshop for students, faculty and industry
- focused industrial programs in areas of strategic interest, such as a project on the mathematics of oil exploration to connect the oil industry with world class academics working in geomathematics
- major or foundational contributions to international structures and programs such as [MITACS](#) (Mathematics of Information Technology and Complex Systems), [NPCDS](#) (National Program on Complex Data Structures), [AARMS](#) (Atlantic Association of Research in the

Mathematical Sciences), [BIRS](#) (the Banff International Research Station), and [PRIMA](#) (the Pacific Rim Mathematical Association)

- summer camps for students, teacher training sessions and a coordinated mentorship program

### **Le Centre de Recherches Mathématiques (CRM)**

<http://www.crm.umontreal.ca/>

**Country:** Canada

**Members:** 12 universities in Quebec and Ontario

**Mandate:** to serve as a national centre for fundamental research in mathematics and its applications

**Recent contributions:**

- 1,500 annual visiting scientists from around the world
- 10 laboratories directly involving more than 200 researchers
- hosting of a large number of guest researchers and postdoctoral fellows
- world-renowned thematic programming
- major grants from research grants coming from NSERC, FQRNT, CFI, CRC and CIAR and relevant industries
- a significant a publications program
- colloquia, conferences
- *Accromath*, to attract more young people to the mathematical sciences, and to stimulate their teachers by offering topical materials
- international collaborations (including multidisciplinary research, training and industry programs) based on current issues, such as the *Climate Change and Sustainability program*, involving mathematicians and statisticians from 13 institutions (8 in the United States and 5 in Canada)
- research projects undertaken by teams
- thematic activities organised on a national or international scale, open to all disciplines

### **Mathematical Sciences Research Institute (MSRI)**

<http://www.msri.org/>

**Country:** USA

**Institution:** University of California (Berkeley)

**Mandate:**

- the advancement and communication of fundamental knowledge in mathematics and the mathematical sciences

- the development of human capital for the growth and use of such knowledge
- the cultivation in the larger society of awareness and appreciation of the beauty, power and importance of mathematical ideas and ways of understanding the world.

**Recent contributions:**

- major advances in the field of national security (MSRI is the largest non-classified mathematics project of the National Security Agency)
- an acknowledged leader of activities for the public understanding of mathematics and its applications (e.g. nationally distributed video series)
- pure, applied and interdisciplinary mathematics research programs
- graduate courses, summer programs
- workshops and seminars on the mathematics involved in current issues (e.g. global warming a greener energy resources)
- hosting of every Fields Medalist and other outstanding mathematicians from around the world, and hosts over 2,000 annual scientific visits by mathematicians from the US and abroad
- postdoctoral fellowships and about 80 researchers in residence at any given time
- international congresses (e.g. [Assessing Students' Mathematical Knowledge: Issues, Costs and Benefits](#))
- research partnerships with corporate partners
- a wide range of programs ranging from K-12 mathematics and public understanding of mathematics to the most advanced current research
- a strong program of outreach to minority groups and actively recruits women and underrepresented minorities to participate in its research and development programs
- K-12 education programs for students and training for educators
- scientific, literary, musical, and other cultural events to generate public appreciation of mathematics
- publications including 250 papers developed annually by MSRI members and a 55-volume book series
- the world's largest streaming video collection of mathematics lectures - over 3,000 hours

**Statistical and Applied Mathematical Sciences Institute (SAMSI)**

<http://www.samsi.info/>

**Country:** USA

**Members:** a partnership between the USA National Science Foundation and the consortium of Duke University, North Carolina State University, the University of

North Carolina, and the National Institute of Statistical Sciences

**Mandate:**

- to forge a new synthesis of the statistical sciences and the applied mathematical sciences with disciplinary science, to confront the very hardest and most important data- and model-driven scientific challenges
- to bring together researchers who would not otherwise interact, focusing the people, intellectual power and resources necessary for simultaneous advances in the statistical sciences and applied mathematical sciences that lead to ultimate resolution of scientific challenges

**Recent contributions:**

- a significant program of research publications, including program reports, monographs and technical reports
- a series of principal research programs and shorter summer programs that include opportunities for (a) research fellowships for periods of up to one year, associated with the individual SAMSI research programs, (b) new researcher fellowships, and (c) post-doctoral fellowships
- mentored visiting graduate student positions, with emphasis on under-represented groups
- an extensive education and outreach program
- scheduled research programs (see <http://www.samsi.info/programs/index.shtml>) with sponsored visiting researchers
- brings together established and young researchers from academia, industry, national laboratories and government to define the central problems and catalyze the research that addresses those problems

**Research Institute for Mathematical Sciences (RIMS)**

<http://www.kurims.kyoto-u.ac.jp/en/index.html>

**Country:** Japan

**Base:** Kyoto University

**Mandate:**

- The Research Institute for Mathematical Sciences (RIMS) was founded at Kyoto University in April 1963 with the aim of promoting research in the mathematical sciences throughout Japan. In this capacity, RIMS hosts numerous short- and long-term domestic visitors, and frequently serves as a site for research conferences.
- RIMS also fosters young talent through the graduate-level education as well as by accepting postdoctoral fellows.
- in addition, RIMS is an active centre of international joint research, and, as such, plays host to a steady stream of long-term foreign visitors.



### **Recent contributions:**

From the 2007 International review of RIMS:

- the research activities of RIMS are outstanding, and the Institute has long been recognised as one of a small number of leading international research centres in mathematical sciences. Many current and former faculty members are internationally-known leaders in research, bestowed with honours and prizes, sought after to speak at international conferences, and able to attract eminent international visitors to RIMS.
- RIMS plays an important and increasingly international role in fostering young talent, through graduate-level education, support of postdoctoral fellows, and other “outreach” activities.
- as a cooperative research institute, RIMS welcomes many research visitors in mathematical sciences from Japan and overseas for conferences, symposia and workshops. The RIMS Project Research since 1991 is the core of its activities as an international cooperative research centre, and many external proposals for workshops and symposia are also accepted.

### **Institute for Mathematical Sciences (IMS)**

<http://www2.ims.nus.edu.sg/>

**Country:** Singapore

#### **Mandate:**

- the mission of the Institute is to foster mathematical research, both fundamental and multidisciplinary, in particular, research that links mathematics to other disciplines
- to nurture the growth of mathematical expertise among research scientists
- to train talent for research in the mathematical sciences
- to serve as a platform for research interaction between the scientific community in Singapore and the wider international community

#### **Recent Contributions:**

- theme programs of two months duration
- Summer and Spring Schools
- public lectures, school lectures and maths camps
- hot topics workshops
- international visitor program
- Lecture Notes Series with World Scientific

### **Mathematisches Forschungsinstitut Oberwolfach (MFO)**

<http://www.mfo.de/>

**Country:** Germany

**Base:** Oberwolfach (single location)

**Mandate:**

- bringing researchers from around the world together for short intense periods, providing them with ideal conditions under which to pursue research activities which will influence and stimulate the future development of the field.
- the Institute concentrates on cooperative research activities of larger or smaller groups. In all activities, participation of promising young scientists plays an important role
- operates long-standing series in broad areas, such as number theory, topology, dynamical systems, geometry, logic, function theory, and stochastics provide a consistent forum in which new results are presented.

**Recent contributions:**

- regular week-long meetings, around forty-five of which are held each year
- a working team is held twice a year to bring together people who wish to learn about a particular topic that they are experts in
- a series of advanced courses, these courses are designed to introduce young people to a currently active area of research
- Research in Pairs, pairs of researchers work together at Oberwolfach for periods ranging from two weeks to three months.

**Centre de Recerca Matemàtica**

<http://www.crm.es/>

**Country:** Spain (Catalonia)

**Base:** Barcelona

**Mandate:**

- monitoring emerging areas in mathematics and their applications, as well as offering incentives and resources so that researchers in traditional areas or younger researchers can join these emerging sectors.
- promoting research in multidisciplinary strategic directions not sufficiently represented in Catalonia with its own research staff, as well as doctoral and post-doctoral grant holders
- to serve the mathematical community by hosting research visitors for mid- and long-term stays in order to carry out joint projects with other researchers, and organising activities of various formats

**Recent contributions:**

- Thematic Networks, for multidisciplinary research training and practice in areas considered to be of interest and relevant at the present time. In areas

such as Computational Neuroscience, Industrial Mathematics, Quantitative Finance

- extended research programs during which a number of specialists in a topic are gathered together
- hosting research visitors for mid- and long-term stays in order to carry out joint projects
- the centre employs its own research staff and offers master, doctor and postdoctoral research training positions
- advanced courses for postgraduate students

### **The Fields Institute**

<http://www.fields.utoronto.ca/>

**Country:** Canada

**Base:** University of Toronto

#### **Mandate:**

- to enhance mathematical activity in Canada by bringing together mathematicians from Canada and abroad, and by promoting contact and collaboration between professional mathematicians and the increasing numbers of users of mathematics
- to support research in pure and applied mathematics, statistics and computer science, as well as collaboration between mathematicians and those applying mathematics in areas such as engineering, the physical and biological sciences, medicine, economics and finance, telecommunications and information systems

#### **Recent contributions:**

- a series of thematic and other scientific programs (e.g. [Drug Resistance in Infectious Diseases](#))
- distinguished lecturer series
- seminars, working groups, summer schools
- conferences in multidisciplinary issues (e.g., 2001: Mathematics of Medical Imaging)
- undergraduate research programs
- post-doctoral fellowships, research immersion fellowships (international)
- support for outreach projects (competitive)
- support for national and international mathematical institutes and societies

### **The Isaac Newton Institute for Mathematical Sciences**

<http://www.newton.ac.uk/>

**Country:** UK

**Centre:** University of Cambridge

**Mandate:**

- a national and international visitor research institute, bringing together research workers with very different backgrounds and expertise around topics with a broad base in the mathematical sciences
- to raise UK standards and instructional courses, aimed primarily at younger researchers and research students
- to establish breakthroughs, new research directions and collaborations

**Recent contributions:**

- Major research programs (e.g., [Statistical Challenges Arising from Genome Resequencing](#), [Gyrokinetics in Laboratory and Astrophysical Plasmas](#))
- seminars, satellite meetings, research and industry workshops
- visiting professors' program
- an extensive publications program, including [Major publications](#), a [Preprint Series](#), [Web Seminars](#), [Programme Reports](#), [Annual Reports and Statistics](#), [Posters in the London Underground](#), [Maths Goes Underground Booklet](#)

**Chern Institute of Mathematics**

[http://www.cim.nankai.edu.cn/nim\\_e/index.htm](http://www.cim.nankai.edu.cn/nim_e/index.htm)

**Country:** China

**Mandate:**

- the Institute's goal is to draw mathematicians around the world to promote the development of pure and applied mathematics in China, and to train advanced personnel in mathematics.
- the principle followed by the Institute is: "Based at Nankai, face the whole country, and eye the world."
- the Institute does not run formal theme programs, instead concentrating on hosting conferences and workshops and a large number of domestic and international visitors.

**Recent contributions:**

- thirteen conferences in 2009
- eighty five visitors in 2009
- strong group on Quantum Information within the Institute's Theoretical Physics division.
- Summer Schools
- postdoctoral fellowship program
- joint meetings with other international centres

## The Mathematics of Information Technology and Complex Systems Inc. (MITACS)

<http://www.mitacs.math.ca/>

**Country:** Canada (a distributed centre)

**A network of research centres:** A MITACS centre is a focal point for international quantitative research activity in areas of strategic importance to Canada and the world. It is a natural evolution of a national research project intended to maintain a critical mass of Canadian expertise.

### Mandate:

- linking [businesses](#), [government](#) and [not-for-profits](#) with over 50 of Canada's [universities](#) to develop cutting-edge tools to support the growth of our knowledge-based economy (connecting Canadian businesses and organizations to the next generation of highly skilled knowledge workers).
- helping businesses and organizations access advanced university expertise so that they can develop and commercialise products
- developing and attracting a new generation of Canadian researchers and entrepreneurs through [skills training & entrepreneur workshops](#), [technical training events](#), [graduate and post-doctoral internships](#) and [outreach activities](#)

### Recent contributions

- graduate and post-doctoral internship program
- [Globalink program](#) (e.g., connecting some of India's best and brightest minds with Canadian business leaders, professors and students)
- funding of mathematical sciences research projects throughout the country, focusing on five key economic sectors ([biomedical & health](#); [environment & natural resources](#); [information processing](#); [risk & finance](#); and [communication, networks & security](#) through the [Networks of Centres of Excellence](#) (NCE) program.

## Evidence C: Recent publications arising from mathematics research centres

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The following gives a sense of the types and numbers of publications by a sample of the centres listed above. Note that these are only some of the publications listed in the centres' reports and websites and that they do not include many of the numerous refereed journal articles published by participants during or after theme programs. Compilation of such lists would require inspection of each participant's c.v. However, even without these, it is clear that mathematics research centres such as we are proposing are hugely productive in terms of high-level publications.

### Isaac Newton Institute for Mathematical Sciences, Cambridge

- 56 books; see <http://www.newton.ac.uk/inibooks.html>
- 40–50 pre-prints per year in the [Isaac Newton Institute Preprint Series](http://www.newton.ac.uk/preprints2010.html); e.g. 2010: <http://www.newton.ac.uk/preprints2010.html>
- numerous individual and co-authored refereed journal articles and chapters in edited collections; see published program reports <http://www.newton.ac.uk/reports/>
- at least 6 journal articles produced by participants annually as listed in statistical appendices to annual reports; e.g. <http://www.newton.ac.uk/reports/0809/appendices.html>

### Fields Institute

- 51 monographs since 2000; see <http://www.ams.org/cgi-bin/bookstore/bookpromo/fimseries> and <http://www.ams.org/cgi-bin/bookstore/bookpromo/ficseries>
- an electronic journal devoted to case studies in industrial mathematics: [Mathematics-in-Industry Case Studies \(MICS\)](http://www.ams.org/journals/mics)
- other publications as listed in the annual reports; e.g., [Annual Report 2009](http://www.ams.org/annual-report-2009)

### Mathematical Sciences Research Institute

- The MSRI book series (Cambridge Press) with 19 volumes since 2000; see <http://library.msri.org/books/index.html>
- [Mathematical Sciences Research Institute Publications](http://www.msri.org/publications) (8 books published by Springer)
- Pre-print series, with an average of 20 papers per year since 2000; see [MSRI Preprint Series](http://www.msri.org/preprint-series)

### The Mathematics Research Center of Stanford University

- >50 books and pre-print articles; see [ftp://math.stanford.edu/pub/papers/](http://math.stanford.edu/pub/papers/)

### Pacific Institute for the Mathematical Sciences (PIMS)

- the Institute's annual reports list an average of 98 books and refereed journal articles per year for the last 5 years; see for example [PIMS Annual Report, 2009](http://www.pims.math.ca/annual-report-2009)
- 20 other scientific publications; see <http://www.pims.math.ca/resources/publications/pims-scientific-publications>

### **Le Centre de Recherches Mathématiques (CRM)**

- [André Aisenstadt Monograph Series](#), (9 books) written by distinguished visitors to the Centre
- 21 monographs in the [CRM Monograph Series](#)
- an extensive collection of other [monographs, lecture notes, and proceedings](#)

### **Statistical and Applied Mathematical Sciences Institute (SAMSI)**

- an average of 23 refereed journal articles per year since 2000, as detailed in annual scientific reports; e.g. [2008-2009 NSF Annual Report](#)
- an average of 9 published technical reports per year since 2000; see <http://legacy.samsi.info/reports/>
- books from theme programs; e.g., [Statistics in Public Resources, Utilities and Care of the Environment](#) (5 books)

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