



THE FIELDS INSTITUTE



FOR RESEARCH IN MATHEMATICAL SCIENCES



tenth
anniversary
CELEBRATION

June 18-19, 2002

WELCOME FROM THE DIRECTOR

/ Kenneth R. Davidson



Kenneth Davidson

The Fields Institute is now ten years old; and if you read the articles inside, you will see that from conception to birth required an incubation of another five years. I recall the excitement around the idea back in 1986, and that there was considerable uncertainty before it actually came to pass. Looking back over what has been accomplished in the past decade, I think that everyone

involved can be proud of how Fields has evolved. The original vision, enhanced by the ideas and energy of many people, has resulted in our institute being the focal point for a tremendous range of exciting activity in all of the mathematical sciences. We can now point to Fields as an important mechanism for the development of links among mathematicians, statisticians, computer scientists and other practitioners of mathematical tools, from the pure to applied to commercial development.

Enough advertising. This booklet is a retrospective from the personal perspectives of many of the players during the first decade. This is not a history, nor is it intended to be complete. Rather it is a collage of interesting anecdotes to help us remember some of the highlights of the Institute. Please join me in wishing the Fields Institute many successes for the future—and if this booklet reminds you of some great ideas that we never put into practice, then I look forward to talking to you about them.

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Cover photo: “Intuition”, a sculpture by John Robinson, presented to the Fields Institute in recognition of H.S.M. Coxeter’s 90th birthday

EARLY DAYS of the FIELDS INSTITUTE.

/ Jerrold E. Marsden

*Jerry
Marsden*



There are lots of things that come to mind about the early days of Fields; I will give a selection of the highlights, more or less as they occur to me, no doubt leaving out some important things.

It all began sometime in 1986 with a phone call from Bill Shadwick asking me if I was interested in the Directorship of a new planned Institute. I patiently listened and eventually agreed to give it a go. My great fondness for Canadian mathematics and my upbringing in Canada are what did it.

Bill explained to me how a group of Professors from Southern Ontario had gotten together and dreamed about the possibility of an MSRI/CRM style institute in Ontario. I am not sure if Elaine Riehm had yet come up with the brilliant idea of calling it the Fields Institute, but the name was certainly due to her. She had made the connection: Hamilton as Fields birthplace (and I do a lot of work in Hamiltonian dynamics) and Fields as the founder of the Fields medal.

Those of you who know Bill will appreciate the seemingly endless series of phone calls (many of them while he was in his car). But it was quite effective and we came up with a series of proposals. One of the big difficulties was to figure out WHO to propose the Institute to! The first try with NSERC failed, as the fit with their programs at the time was not good. But Bill did the needed legwork at the Government of Ontario and we eventually struck a sympathetic cord. This early groundwork was absolutely crucial to the eventual funding of the institute. The provincial government generously agreed to support a good fraction of the cost of running the institute; but I also recall a lot of late payments and paying people on the good will of the University of Waterloo, the

first home of the Institute. The staff at the time, led by Sue Embro and shortly thereafter with the able assistance of Sandra Valeriote, did a marvelous job in getting it off the ground.

We hobbled along in temporary quarters at Waterloo, with me doing a lot of commuting from California. I recall a meeting of the CMS in Vancouver (perhaps in 1990) at which we had arranged a special information meeting about Fields, when we had good indications that we would be funded. I was really surprised that almost nobody showed up! I guess that

they just did not believe this was real. It was a bit of dreamland at the time, I suppose.

The official opening was actually after we were already up and running, but we needed to make things official, so the date was set for Thursday, June 11, 1992. We worked hard at getting dignitaries to come and it was a very fine affair. We were officially off and open for business! It had worked!

To get things going, Bill and I hand-forged the first few programs, made deals with publishers,

(continued next page)



*Clockwise from top left:
May 1993, Langdon Hall Banquet, Sir Michael Atiyah and Jerry Marsden;
The Fields Institute at Waterloo;
Three Fields Directors—John Chadam, Don Dawson, Jerry Marsden;
Arthur Carty*

formed the Fields Institute book series, the distinguished lecture series, formed the Scientific Advisory Panel, the Board of Directors and the thousands of little things one needs to do to get a major institute going. We were very lucky to have Peter Nicholson as the founding chair of the Board; he was a wonderfully steady keel for the whole enterprise and taught us about keeping good books as well as getting legally and properly established with official bylaws, etc. Fields was very lucky to have him. Fields was also very lucky to have the support of Arthur Carty, the dean of research at Waterloo.

Somewhere in there, I made a trip to the CRM in Montreal where Francis Clarke and I hammered out the Fields-CRM prize, which I thought was a very nice thing to make us more like partners than competitors. We also started IMSI, the association of International Mathematical Sciences Institutes.

The Waterloo days were really good: we ran some first-rate programs and had some fantastic visitors (such as Marty Golubitsky) and had some great celebratory events too, such as the banquet for Atiyah's Distinguished Lecture. I recall wearing a tux—I don't do that too often. I also recall having to get up at 4 a.m. in the morning during the period I lived in Waterloo in an effort to try to keep up with my own research. It was downright exhausting. A brilliant idea occurred to Bill and me fairly early on: to make the permanent site of the institute a competition shortly after the Institute

was a reality. This competition turned out to be an excellent thing—we were pleasantly surprised about how fierce the competition was. Sue and Sandra organized the thing; we flew to Ottawa to start and then we took our hired bus and a rather distinguished site visit committee around to the 8 sites that were competing for Fields. It was quite an event. Well of course Toronto won, although Waterloo was not too happy with the committee's decision. President Prichard was a very convincing salesman. The city also promised things, such as a special distinguished woman visitor position, to be paid by the Mayor's office, but that was not to be.

After the Institute moved to Toronto, Bill left to pursue other options. He put so much into Fields, including much more detail on the architecture and the building than I ever had the patience for (including sending the architects to the Newton Institute for inspiration, interviewing Calvin Moore about MSRI, etc). The Institute owes so much to Bill.

It was around that time that Toronto was wooing me to come and make Toronto my permanent home. In fact, it was Steve Halpern, my undergraduate classmate who tried to convince me. He almost did, but in the end, I felt that I had done enough administration and Institute-forming for one lifetime and decided to pass the whole thing on to others and get back to do some more research. The Institute has flourished ever since and remains my proudest administrative accomplishment.



THE FIELDS INSTITUTE FOR RESEARCH IN MATHEMATICAL SCIENCES

“PREHISTORY” of the FIELDS INSTITUTE

/ Carl Riehm

Jerry Marsden mentioned that “a group of Professors from Southern Ontario had gotten together and dreamed about the possibility” of a mathematics institute. But it was Bill Shadwick who started the whole thing off.

At that time, the Province of Ontario had just announced funding, at a very high level, for a few carefully chosen university research centres under its “Centres of Excellence” program, but there had been no mathematics-related application to it. A second round had been tentatively announced and Bill saw this as an opportunity to be grasped. He quickly enlisted help—by telephone of course!—and thus the “group of Professors” came into being. As it happened, the second round of funding never materialized, but it had served the purpose of catalyzing Bill into action.

Bill did not “think small”. Right from the beginning he had in mind a free-standing building for the institute, and even an eventual location. A constitution and governing laws were drawn up, and the Institute’s current documents, I think, reflect many of Bill’s (and no doubt Jerry’s) ideas at that time. At some point very early on, Bill even had in mind the atrium and the blackboards and comfortable chairs in the “halls” of the Institute building.

I still have a small pile of the original stationery which Bill insisted on having to make us look official, on which appear the names of the “Fields Institute Committee”, as the organizing committee was known at that time (perhaps late 1987), and as well as the names of a rather prestigious “Scientific Committee” (now called the Scientific Advisory Panel) consisting of Jerry Marsden, Vic Snaith (then at McMaster), Louis Nirenberg (Courant Institute), Jim Arthur (Toronto), Roger Brockett (Harvard), Steve Cook (Toronto), Leon Glass (McGill), Werner Israel (Alberta), and David Mumford (Harvard).



*Far left:
Carl Riehm
Left:
Peter
Nicholson*

Bill’s enlistment of Jerry and a little later of Peter Nicholson, at that time a Senior Vice-President of the Bank of Nova Scotia with a PhD in mathematics from Stanford, were absolutely critical in the success of the campaign to get the Institute off the ground. In addition to what Jerry has already said about Peter, the two of them gave the project credibility. They worked tirelessly and devotedly for many years, both before and after 1992 of course. And Jerry was a very good salesman for us. I recall going in June 1988 with Jerry and Bill to make a pitch to Fraser Mustard and the Board of the CIAR (Canadian Institute for Advanced Research).

We weren’t successful then either, but Jerry, in his low-keyed but forceful way, made a great impression.

Peter Nicholson’s role has not always been fully recognized, perhaps because no single person aside from Peter himself has been aware of all that he did. There were some difficult times, but Peter stayed the course.

Bill never gave up and finally the Fields Institute materialized in 1992, funded by the National Science and Engineering Research Council of Canada and the Ontario Ministry of Colleges and Universities. Bill really deserves the thanks of all mathematicians in Ontario and elsewhere in Canada. The Fields triumvirate of Jerry Marsden, Peter Nicholson and Bill Shadwick was a formidable team.

On the Pre-History of the FIELDS INSTITUTE

/ William F. Shadwick

It was the Ontario Centres of Excellence program which got the whole thing started. I gathered together a group who agreed that the opportunity was too good to simply let slip—Adrian Bondy, Grafton Hui, David Jackson, John Lawrence, John Wainwright and myself. We put together what we felt was a strong case for creating a full blown mathematics research institute. A key element in this was the fact that I knew John Polking, then Head of the Mathematics section of the National Science Foundation, from our time as members of the Berkeley MSRI.

As a result, I was able to confirm that the sort of funding levels available from the Ontario Government program were more than equal to the cost of running MSRI! The implications of this, to me, were pretty clear.

Adrian Bondy suggested that I get in touch with Carl Riehm to broaden the campaign. Carl was a key to marshalling support from the McMaster people including Vic Snaith and John Chadam who both carried substantial loads in the long drawn out campaign that followed.

The phone call to Jerry was a pivotal point. I must admit that when I made the phone call to Jerry to ask if he would take on the job of Director, I was anticipating relief at being able to give the whole thing up. But after a very long pause, he agreed to do it!

The Waterloo group sought support from UW President Doug Wright, who got behind us with enthusiasm. It was he who led me, indirectly, to Peter Nicholson. Doug suggested that I go to see John Roth at Nortel. The timing could not have been better, as Roth had just completed a study at Nortel which identified mathematics as the common factor in the backgrounds of their most productive employees. He recommended that we get in touch with one of his fellow members on the Prime Minister's Science Council—Peter J. Nicholson. I

remember being grateful for the suggestion, but somewhat dubious that a banker was the ideal person for the job!

Nevertheless, a meeting with Peter was duly arranged and John Chadam and I emerged from it with a chairman for our fledgling Board of Directors. It was one of several pivotal points

whose significance was immediate, although I doubt that anybody had a clear picture of just how much more work remained to be done at that point.

I don't recall in detail the sequence of events which led us from the speculative stage to funding, but I do recall that we got Janet Halliwell's attention by the testimony that Vic and I gave to a Parliamentary Committee. That was the beginning of our eventual success with NSERC. Also Tom Brzustowsky, as Deputy Minister, managed to keep us from sinking without a trace after the change of Ontario Governments. This was critical to our eventual funding there, in spite of the fact that we never got a chance to apply for Centres of Excellence money. Arthur Carty, as Dean of Research at Waterloo, was also a great help in shepherding the NSERC application through.

Long before our official opening in '92, the initial staff members, Liz Reidt and Sue Embro, worked outrageously long hours with dedication well above and beyond the call of duty—sometimes even without being paid. There was a very long path between the initial award of money and putting the temporary quarters together at Waterloo. We would never have gotten through it all without their extraordinary skills and enthusiasm.

Whatever credit may be due to me for this, it should also be recognised that Sandra Shadwick and our children William and Elizabeth played a critical role in encouraging me to keep going and in putting up with the inevitable costs of doing so.



Bill Shadwick

REMINISCENCES FROM THE CHAIR

/ John Gardner

It is hard to believe Fields is approaching its tenth birthday. Hard to believe because so much has been accomplished in what feels like a very short interval of time. The strength of the endorsements from so many individuals on the occasion of the recent NSERC site visit emphasizes the role that the Institute has developed for itself in ten short years.

Reflection leads to the realization that I have been involved with Fields one way or another since its conception, never mind birth. I remember a dinner party in the very early days of the last decade at Carl and Elaine Riehm's home in Burlington with Jerry Marsden and Peter Nicholson, all wrestling hard as they devised the Fields concept.

Several years later I was involved in the University of Toronto's governance, chairing its Business Board, when the issue on the table was the construction of a three story building on College Street, for an institute named Fields. U of T saw the importance of the Institute, and agreed to make a major commitment in order to become its host.

Today I find myself chairing the governance structure of a successful, internationally recognized mathematics institute.

The first ten years of human life are spent preparing the base; the second ten



John Gardner



develop and define a strong, energetic adult. After two decades the individual is ready to challenge the world. Fields, in its first ten years, has doubled the pace. It sees the opportunities ahead of it, and has access to the people and the resources that will enable it to make an ever-growing contribution to the development of the mathematical sciences.

Happy birthday, Fields. You are ready.

OPENING OF THE FIELDS INSTITUTE, 1992

/ Carl Riehm

The Fields Institute opened its doors in January of 1992 with its first thematic program “Control Theory”, organized by Bruce Francis (Electrical Engineering, Toronto), Ivan Kupka (Mathematics, Toronto), William Shadwick (Pure Mathematics, Waterloo) and George Zames (Electrical Engineering, McGill). Earlier, much preparation had taken place at a furious pace, getting the quarters at 185 Columbia St. West (adjacent to the University of Waterloo campus) ready for occupancy, appointing a Board of Directors with Peter J. Nicholson as chairman, drafting and adopting a charter and a set of regulations to govern its day-to-day operations, and assembling a capable administrative staff. All of this was carried out with great dispatch and expediency.

The quarters provided office space for 30 senior visitors, 18 short-term visitors and post-doctoral fellows, and 15 graduate students. There were two seminar rooms with seating for 90 people.

The official opening was held on Thursday, June 11 of that year, with lectures and a banquet in the Davis Centre of the University of Waterloo. The day began at 9am with remarks by the Director of the Institute, Jerrold Marsden, followed by talks by the directors of other mathematics research institutes. Phillip Griffiths, Director of the Institute for Advanced Study in Princeton spoke on “*Exterior Differential Systems*”, Avner Friedman, Director of the Institute for Mathematics and its

Applications at the University of Minnesota, spoke on “*The IMA experience with industry*”, and Francis Clarke, Director of the Centre de recherches mathématiques at the Université de Montréal, gave a lecture entitled “*Nonsmooth analysis: a survey*”.

During lunch, Cathleen Morawetz (Courant Institute) spoke on “*Some thoughts about applied mathematics in Canada*”, and a Fields Institute Distinguished Service Award was made to Heinz Götze of Springer-Verlag.

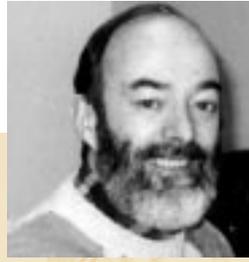
The afternoon session began with the first Fields Institute Distinguished Lecture, “Bezout’s theorem and complexity theory”, delivered by Stephen Smale of Berkeley. It was followed by “*The role of research mathematicians in mathematics education*” by Stephen Halperin (University of Toronto), “*Integrating graphics technology into the calculus curriculum*” by Beverly West (Cornell), and “*The Fourier transform in the analysis of scientific data*” by David Brillinger (Berkeley).

The final session of the afternoon consisted of remarks by William Shadwick, Deputy Director of the Fields Institute, and representatives of the participating universities, the Ministry of Colleges and Universities of Ontario, and NSERC.

During the evening a well-attended banquet took place. Israel Halperin (Toronto) led off the speakers, followed by Irving Kaplansky, Director of the Mathematical Sciences Research Institute in Berkeley, who addressed the audience on “*Toronto and MSRI Reminiscences*”. The final speaker of the evening was Derek York of the Physics Department at the University of Toronto and Globe and Mail Science columnist, speaking on the importance of research in mathematics and of the founding of the Fields Institute.



Left from the top:
Cathleen Morawetz:
David Brillinger:
Philip Griffiths:
Derek York



Peter Fillmore

Days and Nights at CHATEAU ELLIOTT

/ Peter Fillmore

Chatting with George Elliott about plans for the 1994-95 program on operator algebras (he chaired the program committee and I was a member), we had the idea of renting a house large enough to accommodate—besides us—some shorter-term participants. It turned out that a suitable faculty house was available, about two miles from the Waterloo campus, where the Institute was then located. So we went ahead, and it proved to be a great success, not only in terms of a place to stay, but also as a sort of social center. Somewhere along the line, someone (I don't recall who) christened it "Chateau Elliott", and the name stuck.

Among the many guests I recall are Masamichi Takesaki (UCLA), Jamie Mingo (Queen's), Jerry Kaminker (IUPUI) and Norberto Salinas (Kansas). Norberto, who is blind, used a speech synthesizer to "read" his e-mail early each morning. The voice of this bilingual gadget echoed through the house, sometimes in English, sometimes in Spanish, punctuated by Norberto's verbal asides.

On the social side, we had many dinner guests, as well as a number of larger parties. There was a memorable Christmas party and, later in the year, a joint birthday party for Gert Pedersen and my wife Anne Ellen. The cuisine at the Chateau could be rather variable, from peanut butter at the lower end, to delicacies prepared by Noriko Yui (George's wife) and brought back from Kingston in the trunk of George's venerable Volvo. I have a mental image of George at one of these occasions, deep in a mathematical discussion, a glass of beer in one hand and a glass of milk in the other, taking sips from them alternately.

Of course, a lot of mathematics got done as well. It was an exciting year during which many people turned up including Connes, Jones, Haagerup, Voiculescu and Kirchberg. I wrote my

book "A User's Guide to Operator Algebras" and Ken Davidson wrote another, "C*-Algebras by Example". There was a great sense of being at the centre of the action, as several major developments (including an important breakthrough, by Kirchberg and Phillips, in the "Elliott program") happened there and were studied in seminars.



George Elliott



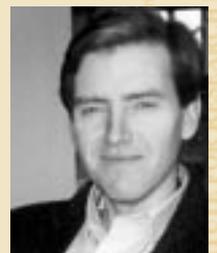
Noriko Yui



Man Duen Choi



Masamichi Takesaki



James Mingo



*Far left:
Sandra Valeriotte
Left:
Site visit bus group*

SITE VISIT Road Trip

/ Sandra Valeriotte

I had just started work as the Executive Assistant at the Fields Institute when Bill Shadwick handed me a file and asked me to organize the site selection trip! I didn't have a clue as to what he was talking about or what I was supposed to do! After reading the file, I decided that all I needed to do was... book transportation to and from all the sites, get all the members of the Site Selection Committee together in one city at the same time in order to rendezvous with the “tour bus” (plus get them back to their own parts of the world after the site selection trip), stay on a tight schedule and move from city to city, go to meeting after meeting and also book all the accommodation and food and beverage. No problem!

I think I started by booking the “executive bus” from Trentway Wager in Toronto. We needed a very comfortable bus that would transport the entire site selection committee plus staff from Ottawa to Kingston, Toronto, Hamilton, Guelph and Waterloo. Next on the list was to book all the lodging and food and beverage. At this point, I think that all the dates had been confirmed for the visits, so it was just a matter of “filling in the blanks”. All the assistants at the host universities were very helpful and provided names of good catering companies and hotels to use. Amazingly, it all went very smoothly. The food was ready on time and quite good for catered “bus food”. The only big mistake we made was in ordering soup for the last meal on the bus on the way home (a minor

detail in the end—but not a good thing to order for consumption on a moving vehicle!). The accommodation was great as well. I don't believe that I will ever again stay at Langdon Hall for under \$80/night! We managed to get great corporate rates for top class hotels.

The Site Selection Committee Members were great. They were all very enthusiastic and serious about the job they were chosen to do. After every visit, the group would unwind on the bus for a few minutes, then quickly start into the discussions about the visit they had just had. They talked on and on about every detail, not wanting to miss a thing. It was a very difficult decision, as all the universities put on great site visits and they all wanted the Fields Institute very badly. After the last site visit more intense discussions took place on the bus. Everyone had their favourite sites, including the staff (of course our choices weren't made based on good science or great supporting faculties, or money offered—but on “how far would we have to move/drive”, how big would our offices be, what kind of night life would there be...very important aspects that should have been on the list!).

From my perspective, the site selection trip was a great success—everyone showed up, we lost no one, we never went hungry or thirsty, we had a hotel room every night and we made it to all the sites on schedule... and of course, a very important decision was made in the end!

MEMORIES of the Fields Institute

/ John Chadam



*Left: John Chadam
Below: Andrew Wiles*



MMy earliest memories of the Fields Institute are of endless days (and nights) with Bill Shadwick writing proposals to fund this gem of an idea. By the time I had arrived on the scene Bill's enthusiasm had already exhausted countless collaborators so that when funding was finally secured it was almost a letdown for us. But not for long. With the pent-up energy of many local supporters and the incredible generosity to the fledgling Institute of the VIP long-term visiting mathematicians (Barbara Keyfitz, Marty Golubitsky, Steve Wiggins and Jerry Marsden, who took on the Directorship), a very successful first program in Dynamical Systems was launched. Many of the young researchers who accepted a postdoctoral fellowship at Fields that year over a more traditional job have now risen to international prominence. In fact, their professional trajectories can be seen to have been highly sensitive to the initial conditions at Fields.

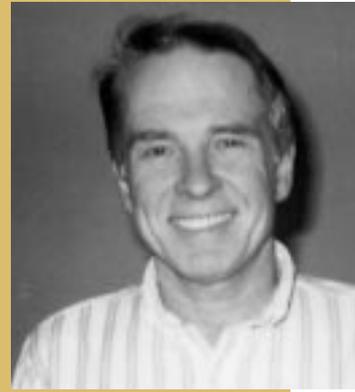
I took over as Director during the years when the move from Waterloo to Toronto occurred. All of the angst associated with a major dislocation of this sort was put into perspective when we arrived at 9 a.m. on the much delayed opening day to find George Elliott already installed and lecturing to a well-attended seminar in the main lecture room. Anyone who has ever been involved with building projects knows that funds often run out before completion. One glaring example was that our library was left as an empty shell. I am extremely grateful to my dear friend and former colleague from McMaster University, Jim Stewart, who generously provided the Fields Institute's first gift to fund the completion of the second-floor library. I would be remiss if I did not acknowledge the untiring work and dedication of the staff during this

time. Individually and as a team, they contributed immeasurably to the successful launching of the Institute.

There were many special moments during the Institute's first year in Toronto. During the first month Andrew Wiles gave a public lecture attended by over 1000 people in Convocation Hall. By the end of the year the monthly Math Finance seminar had attracted so much interest that the closing lectures, held at the old Toronto Stock Exchange, overflowed the overflow room. For many the high-point of the year's activities was Coxeter's 90th Birthday Party. Not only did we hear a piece of music composed by Professor Coxeter when he was 16 but we also commemorated a sculpture in his honor done by John Robinson. Hosting the lunch when the two met for the first time was a special treat for me. During those two hours the artist whose abstract works show an intuitive understanding of Mathematics and the mathematician who has a deep appreciation of art developed the ideas for yet another of Robinson's pieces. There were charmingly awkward moments as well. For example, as part of the formal opening, the Institute held a workshop on Graphics and Visualization. Nigel Lloyd and the NSERC representatives chose to arrive when all of the workshop participants were watching an advance copy of the animated movie "Toy Story".

On the 10th Anniversary of The Fields Institute I can honestly say that the first 15 years were great. Best wishes for the next decade.

In Conversation with **DEREK CORNEIL**



Derek Corneil

/ Alison E. Conway

When the Fields Institute officially opened in November 1995 at 222 College Street, it was the completion of many people's planning and dreams, and the beginning of Fields in its permanent location on the campus of the University of Toronto. Behind the scenes at the University there had been a group of supportive people who had contributed and in March 2002 I went to talk to one of them, Derek Corneil, to get his inside view of how Fields came to Toronto.

Meeting with Derek in his book-lined office at the University was an opportunity to look back to 1993 when a condition of continued funding support for the Institute from the governments of Ontario and Canada required that a permanent site for the Institute be selected. As an indication of its appeal, seven Ontario universities applied to be the host institution for the Fields.

When the Site Selection Committee bus pulled into the University of Toronto campus, President Robert Prichard personally greeted the bus and hopped on to extend his own warm welcome. The Committee was then whisked into a day of high-powered meetings with more than twenty people, including almost all high-level university administrators, who were present to support the University of Toronto bid. Even June Rowland, the Mayor of Toronto joined the team to show support.

Soon after the acceptance of the University of Toronto's bid the next phase of negotiations involved finding an appropriate location and facilities for Fields. It came as a surprise to me to hear from Derek that College Street had not been the first choice of location. Originally a children's library on St. George Street known as Boys and Girls House had been chosen. When it became clear that renovation and expansion of the existing building would not meet the Institutes' needs, it was recommended that a new building be constructed.

Derek explained that the Institute was fortunate that new construction on campus was at that time a possibility for the University. "For many years the University had been limited by city bylaws that required adequate parking space for all its buildings but with the recent construction of a large parking garage on campus, it now became possible for the University to use open space for new buildings."

Kuwabara Payne McKenna Blumberg was chosen as the architectural firm and a team of Fields, KPMB and University representatives researched mathematical facilities, including the Newton Institute for inspiration. Although Bill Shadwick, Fields Deputy Director, envisioned a grand design for Fields, with features such as fireplaces for the offices of the director and deputy director, a rooftop patio and a library extending out over the main entrance, these plans were eventually revised in favour of a more economical exterior façade with the emphasis on an interior that provided an environment conducive to mathematical activity. Yet Derek remembered how even the best-laid plans can go astray as construction began and disaster struck in the form of an abandoned oil tank, leaking toxic materials, found buried in what was to become the foundation for the building. Contingency funds were strained as contaminated soil surrounding the tank now had to be shipped as far away as Sarnia for soil treatment. Happily though, a mild winter and the efficiency of the construction company, PCL Constructors, Canada Ltd., enabled the construction to proceed with no additional delays or major surprises.

And so, on Friday, November 17, 1995 Rose Wolfe, Chancellor, University of Toronto, and Dr. Peter Nicholson, Chairman, The Fields Institute, with Adel Sedra, John Snobelen and Nigel Lloyd welcomed the Institute and its 3 sponsoring universities, McMaster, Waterloo, Toronto and 9

affiliate universities, to the official opening of the Institute's permanent home with its host the University of Toronto.

When I asked Derek if all the challenging meetings with Fields and University staff had been worth it, he replied that for him the success of the 1999-

2000 program in Graph Theory and Combinatorial Optimization that he helped organize, drove home the importance of the Fields Institute to the mathematical sciences community and the unique research environment the Fields provides. "Yes, it was well worth all the problems."

CRM/FIELDS PRIZE WINNERS

/ Carl Riehm

The first CRM/Fields Prize was awarded in 1995. It is awarded each year to recognize exceptional contributions in research in the mathematical sciences. The recipients are chosen by the Advisory Committee of the CRM and the Scientific Advisory Panel of the Fields Institute



H.S.M. COXETER of the University of Toronto was the first recipient, in 1995. He was chosen because of his fundamental contributions to geometry and group theory, subjects in which his name is represented by "Coxeter groups" and "Coxeter diagrams". He delivered a lecture entitled "*Evolution of Coxeter-Dynkin Diagrams*" at the award ceremony, and also gave another talk for undergraduates "*Euler's formula for polyhedra*".



GEORGE A. ELLIOTT of the University of Toronto and the University of Copenhagen was the Prize winner in 1996 for his work in operator algebras, K-theory, non-commutative geometry and topology, in particular for his work in classifying C^* -algebras via invariants related to ordered K-theory. His talk at the presentation was entitled " *C^* -algebras at the CRM.*"

(continued next page)



CRM/FIELDS PRIZE Winners



The third recipient of the CRM/Fields Prize was **JAMES ARTHUR** of the University of Toronto, for his contributions to automorphic forms, number theory, representation theory and harmonic analysis on real and p-adic lie groups. He delivered a lecture entitled “*Harmonic Analysis and Trace Formulas*”, in which he showed how trace formulas relate characters and conjugacy classes in groups, and how they apply to group representations and number theory.



The 1998 CRM/Fields Prize was awarded to **ROBERT V. MOODY** of the University of Alberta, for his seminal contributions to algebra and its applications, and in particular to what have become known as “Kac-Moody algebras”. His lecture “*What is Aperiodic Order?*” was on the topic of his current research interest.



STEPHEN A. COOK of the University of Toronto was the 1999 winner of the CRM/Fields Prize, for his work in computational complexity theory in which he introduced the theory of NP-completeness in 1971. His lecture, “*The Achievements and Challenges of Computational Complexity*”, was an historical overview of that subject.



The year 2000 CRM/Fields Prize was awarded to **ISRAEL MICHAEL SIGAL** of the University of Toronto for his seminal work in the mathematical analysis of non-relativistic quantum theory, in particular for his contributions to the establishment of a firm mathematical foundation for quantum mechanics. His lecture “*Some Mathematical Problems of Quantum Field Theory*” described some analytical problems in Quantum Field Theory and some of the recent results and approaches.



WILLIAM T. TUTTE of the University of Waterloo was the recipient of the Prize in 2001 for his contributions to graph theory and matroid theory, in which he provided some of the most fundamental results. He delivered a lecture “*60 Years in the Nets*”, in which he spoke about one “thread” of his research that began while an undergraduate student at Cambridge.



The most recent CRM/Fields Prize winner was **JOHN B. FRIEDLANDER** of the University of Toronto for his work in analytic number theory, especially for his contributions to the theory of prime numbers and L-functions. He will deliver a lecture at the time of the presentation of the prize next fall.



Homotopy Programme Organizers
From top left:
P. Selick: S. Halperin: D. Ravenel:
S. Kochman: W. Dwyer: R. Kane

THEMATIC PROGRAM IN Homotopy Theory

/ Richard Kane

The 1995-96 Thematic Program in Homotopy Theory was a broad survey of homotopy theory in each of its two traditional areas—stable and unstable theory—attended by over 200 participants with a significant international profile. Some of the major themes were rational homotopy theory, loop spaces and classifying spaces, Adams spectral sequences, and simplicial homotopy theory.

Particular attention was also paid to the role and impact of homotopy theory in other areas of mathematics, as well as in other disciplines. There was a very successful weekly lecture series (entitled the “Poincaré Lectures”) on this theme. As well, there was a conference on Algebraic K-Theory at which V. Voevodsky announced and lectured on his ground-breaking proof of the “Milnor Conjecture”, and a workshop on Homotopy, Geometry and Physics.

Two of the four graduate courses gave rise to Fields Institute Monographs, “*Introduction to Homotopy Theory*” by P. Selick, and “*Bordism, Stable Homotopy and Adams Spectral Sequences*” by S. Kochman.

The Program took place during the transitional year when the Fields Institute shifted its physical location from Waterloo to its permanent site in Toronto. It provided what amounted to a “trial run” of the organizational structure of the Institute in its new setting. At times, particularly during the first few weeks of the Program, life was somewhat of an adventure, but the staff, notably Becky Sapping and Karen Walker who handled most of the arrangements for the Program, worked very hard to make everyone’s stay uncomplicated and pleasant.

Reminiscences OF MY DAYS AT FIELDS

/ Donald A. Dawson



In June 1995, the 50th Anniversary Summer Meeting of the Canadian Mathematical Society was held at the University of Toronto. This historic occasion showcased the achievements of Canadian mathematics in the 50 years since the Society was founded. One of the highlights of the meeting was the opportunity to visit the construction site of the permanent home of the Fields Institute thus also providing a glimpse into the future.

The dream of Canadian mathematicians to build in Canada a truly international facility in the mathematical sciences had arisen out of the widespread understanding in our community that research institutes will play a crucial role in the future development of our discipline. At that time I had no inkling that a little more than a year later I would be given the opportunity to serve as Director of the institute.

The existence of such a wonderful facility immediately created a whole new set of opportunities for fundamental research, mathematical education and the growing interface of mathematics with other disciplines. One of my first experiences was with the Mathematical Finance Seminars that had been initiated by John Chadam, the former Director. It

was quite an experience to witness a standing room only audience consisting of nearly equal parts young mathematicians and professional practitioners from Toronto's vibrant financial community – with excited discussions at the coffee break of the latest advances and opportunities in the one of the newest mathematical sciences. Since the beginning, this ability to capture the opportunities created by the increasing penetration of mathematics into new areas ranging from the genetics of complex diseases to cryptography and the emerging competitive energy sector has been a major success of Fields.

As a member of the organizing committee of the 1998-99 Probability Program I experienced first hand the synergy created through creative interaction between mathematicians and researchers from other fields. This program was organized around new mathematical developments arising from physics, communications, finance, and biology, each creating intellectual excitement and international interest. The program began with a workshop on polymers and percolation which developed into one of the important scientific directions of the program

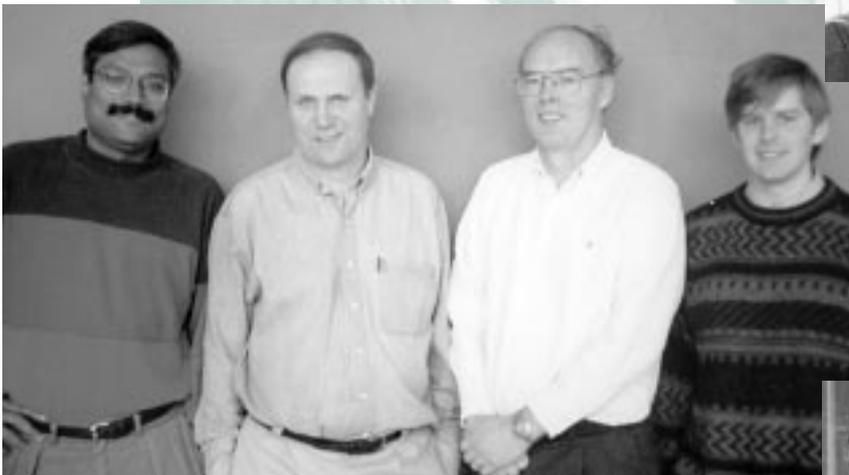
involving both senior Canadian researchers at the forefront of this field and postdoctoral fellows. The communications segment included a session in an Ottawa high tech laboratory that attracted communications engineers grappling with the problems of building a stable environment for the Internet of the future. As a result of the enormous international interest created by the Probability in Finance workshop, it had to be relocated to the ROM to accommodate the approximately 300 participants.

The last segment of the program explored the mathematics of population biology in light of the revolutionary developments taking place in molecular biology, including a NATO workshop that brought together 150 researchers from across Europe and North America. One of the most remarkable mathematical developments highlighted in the program was the completely unexpected relation established by Gordon Slade, one of the program organizers, and his collaborators, linking critical percolation clusters and other random combinatorial objects arising in statistical physics in high dimensions and integrated super-Brownian motion, the central object appearing in the lectures and workshop organized by Edwin Perkins, with origins in mathematical population biology.

Among the unforgettable memories of my years at Fields are those unique moments when I had

the opportunity to witness some of the great scientific minds of our time grappling with the most profound questions of our subject, thanks to the Fields Distinguished Lecture Series, Coxeter Lecture Series and CRM-Fields Prize Lectures. Among others, these included the CRM-Fields lectures of James Arthur outlining his seminal work related to the Langlands program to unify large parts of mathematics, Stephen Cook explaining the implications and recent work revolving around the fundamental notion of NP-complete problems first formulated by him in 1971 and now a defining concept of computer science, and the Distinguished Lectures Series by Nobel Prize winner Pierre-Gilles de Gennes on the deep mathematical problems of phase transitions arising in material science.

A further very special opportunity presented itself with the Symposium in celebration of the Legacy of John Charles Fields as part of the World Mathematical Year 2000 activities. In this exciting event nine Fields medallists gave their personal perspective on some of the major developments in 20th century mathematics as well as their views on the future of mathematical research in the 21st century. With an impressive record of achievement in its first ten years, there is every reason to believe that the Fields Institute has a significant role to play in this future.



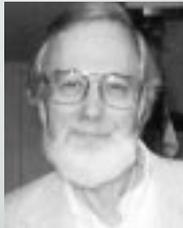
*Top:
Pierre Gilles de Gennes:
Centre (from the left):
Raj Srinivasan, Peter Glynn,
David McDonald, Stephen Turner
Below:
Hans Foellmer*



THE LEGACY OF JOHN CHARLES FIELDS

The International Mathematical Union declared the year 2000 to be World Mathematical Year (WMY) and in response, the Fields Institute organized a symposium called "The Legacy of John Charles Fields" from June 7th to 9th. This centerpiece of the Canadian celebration of the WMY featured lectures by nine Fields medalists, two historical lectures given by Tom Archibald and Michael Monastyrsky, and a panel discussion on the future of mathematics. The aim of the symposium was to raise awareness of the Canadian visionary John Charles Fields and his exceptional legacy to the world of mathematics.

John Milnor,
State University
of New York,
Stony Brook
Fields Medal
1962



Sir Michael Atiyah,
University of
Edinburgh
Fields Medal
1966



Stephen Smale,
City University of
Hong Kong,
Fields Medal
1966



Alan Baker,
Cambridge
University
Fields Medal
1970



Alain Connes,
Collège de France;
Institute des Hautes
Études Scientifiques
Fields Medal
1982



Vaughan Jones,
University of California,
Berkeley
Fields Medal
1990



Richard Borcherds,
University of California,
Berkeley
Fields Medal
1998

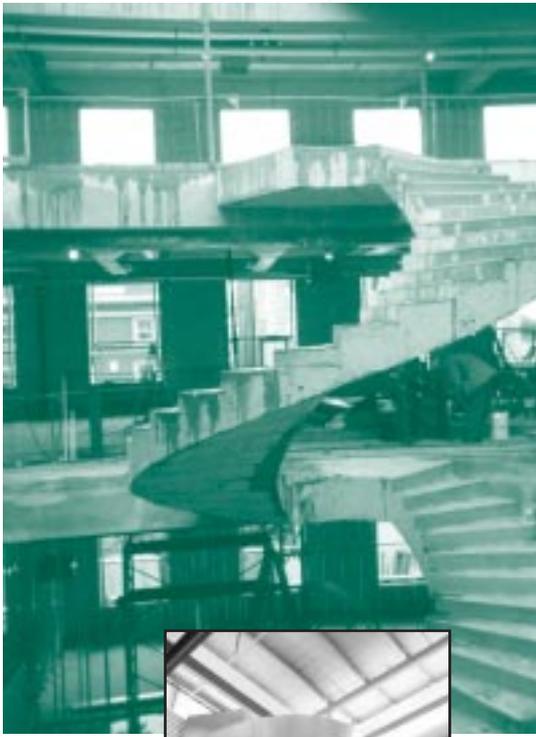


Timothy Gowers,
Cambridge
University
Fields Medal
1998



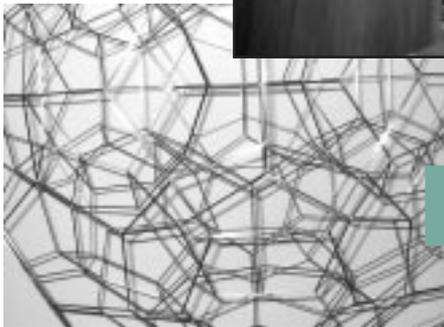
Maxim Kontsevich,
Institute des Hautes
Études Scientifiques
Fields Medal,
1998





ARCHITECTURAL Design and **THE** **FIELDS** INSTITUTE

Alison E. Conway and Maryam Ali



*Top right:
Fields Institute*

*Top left:
The helical staircase under
construction*

*Centre:
The finished staircase*

*Below:
Detail of
“120-CellMobile”,
a sculpture
by Marc Pelletier
presented to the
Fields Institute
in appreciation
of H.S.M. Coxeter’s
lifelong contributions to
geometry on the occasion
of his 95th birthday.*

The permanent home for the Fields Institute was completed in November 1995. The design was the accomplishment of a team headed by Thomas Payne, associate-in-charge Luigi LaRocía and project architect Lexi Koltwagner of the architectural firm of Kuwabara Payne McKenna Blumberg. The layout and construction of the Fields building involved creating plans to suit the needs of the mathematical community. KPMB and Thomas Payne pride themselves in having introduced three dynamical elements in the buildings, – a large wood burning fireplace, a wood-paneled helical stair, and an elliptical reception desk.

Construction Superintendent Chris Webber described the construction of Fields helical stair as “just fascinating”, as architect and form makers worked out the process of simulating the cylindrical shape in a computer, then deconstructing the shapes onto a flat plane to design the concrete forms. John Volcko, the Project Manager, would recall Tom Payne’s early morning visits to the site to see the project unfold.

The spatial strategy, such as corridor-balconies and central atrium, provide spacious informal areas to accommodate the routes of the peripatetic mathematician as well as to provide informal areas for casual interaction or intense brainstorming sessions.



Left to right:
Judy Compton:
Eric Mueller:
Shirley Dalrymple:
Bill Langford

SECONDARY SCHOOL MATHEMATICS Curriculum Project

/ Judy Crompton

With the goal of revising the entire secondary school mathematics curriculum, the Ontario Ministry of Education adopted a process different from anything used in the province before. Through an open bidding service called MERX, it put out a series of “Requests for Proposal” for the writing of thirteen secondary school curriculum projects - with mathematics as one of them. In late summer of 1997, the plan came to the attention of members of the Fields Institute Mathematics Education Forum and, well before the RFP was released, a Proposal Writing Committee was in place. This committee considered carefully many important factors, including whether the Fields group should make a bid on the contract at all, what the philosophy of its curriculum would be, and why the Ministry might choose a Fields bid over others. Because of the early start, the committee was in an advantageous position once the RFP was released in mid-January of 1998. After examining the RFP and receiving the support of the Fields Institute, the group decided to make a bid.

Then some very intense work began. A team was identified, a work plan created, a budget constructed, and a myriad of other details taken care of. With the untiring support of Fields Deputy Director Bill Langford and his assistant Brenda Law, the Fields Institute’s bid for the contract to write the secondary school mathematics curriculum was submitted at the end of February 1998.

The Institute was awarded the contract in late April of 1998. Work started on May 4; the contract specified four deadlines, the last one December 18, 1998. The Fields team, composed of thirty-three people drawn from across the province, represented

all levels of mathematics education and the business community as well. The team was divided into two groups, one to develop the grade 9/10 curriculum and the other to develop the grade 11/12 curriculum. The two teams worked both separately and jointly, forging a guiding vision of the curriculum that motivated and directed the project.

The vision of the curriculum can be summarized as:

- provision of the mathematics that students need to study the post secondary programs of their choice;
- balance between process and content in learning mathematics; and
- engaging students in the learning of mathematics so that they will see its power, its meaning, and its relevance to their lives.

Mathematical modelling and applications lie at the heart of the completed curriculum, blended with the embedded development of critical manipulative skills.

A process associated with each deadline collected written feedback from about twenty organizations and oral feedback from about twelve others. The oral feedback was presented at meetings held at the Ministry of Education office throughout the project; these meetings were consistently constructive and positive, and contributed significantly to the final curriculum. Upon the completion of the Fields contract, the curriculum was transferred to the Ministry of Education, where the feedback process continued.

A second level of feedback involved the validation of the grade 11-12 curriculum by universities and colleges. A validation panel composed of their representatives met twice, once in January of 1999

to give recommendations regarding the draft curriculum, and then again in June of 1999 after revisions had been made.

The grade 9/10 curriculum was released in June of 1999 and the 11/12 curriculum in June of 2000. Since the new curriculum is a significant shift from the status quo ante, the great challenge facing mathematics educators now is its implementation. It is essential that teachers receive meaningful support in terms of resources and in-service guidance as they move in new directions. To this end, the Fields Institute Mathematics Education Forum has

remained actively involved throughout the implementation period.

In summary, the writing of the secondary school mathematics curriculum was exhausting, exhilarating, stressful, exciting, frustrating, rewarding—everything you would expect from a project of this magnitude and importance that involved the breaking of new ground in a very short time. All members of the writing team were grateful for the opportunity to work at the Fields Institute and for the ongoing support, encouragement and participation of its directors and staff.

MITACS: Mathematics of INFORMATION TECHNOLOGY and COMPLEX SYSTEMS / Donald A. Dawson



*Left to right:
Luis Seco,
Evangelos Kranakis,
Bradd Hart,
Don Dawson,
Arvind Gupta,
Ben Schwartz,
Richard Snell*

In 1997 we conceived the idea of a national initiative to address the new mathematical challenges arising in a number of key sectors of the Canadian economy—such as information technology, finance, and the health sciences. With the cooperation of Nassif Ghoussoub, Director of PIMS, and Luc Vinet, Director of CRM, mathematicians from across Canada were invited to explore ways for the mathematical community to meet these challenges. The National Centres of Excellence program

appeared to be a logical home for such a major initiative, and so, in spite of initial skepticism in some quarters, a decision was made to submit a Letter of Intent to this program in January 1998. The letter proposed the formation of a network of mathematical scientists from across Canada structured into project teams including researchers from both universities and industry. The mathematical communities centered around the three mathematical institutes—CRM, Fields and PIMS—provided a natural

(continued next page)

starting point. The MITACS Letter of Intent was one of only 11 letters out of 72 that were subsequently invited to submit a full proposal.

At this point a national call for proposals to MITACS was announced. The response from the mathematical community and potential industrial partners was amazing—more than 85 projects were proposed, involving 400 mathematical scientists. 21 of these projects were selected to serve as the initial core of the network. At the same time Steve Halperin was recruited as the Program Leader of the network.

An immense effort went into coordinating input from across the country and the three institutes to produce a coherent and compelling proposal to the NCE in a relatively short time. The final draft was produced in a late night session at the Fields Institute involving Arvind Gupta, Steve Halperin and myself.

The site visit by the evaluation committee featured presentations from the three institute directors, the “theme” representatives, Steve

Halperin, and a summing up by Peter Nicholson who emphasized the importance of MITACS to the Canadian economy and the impressive track record of the institutes.

The announcement that MITACS was one of three successful new NCE’s was made at a news conference held at the University of Toronto faculty club on October 16, 1998.

By the following March, MITACS had set up its head office at the University of Toronto and the 21 projects were up and running.

In August of that year, Steve Halperin resigned as Program Leader. I served as interim Program Leader until Arvind Gupta became Program Leader later that year.

The first Annual General Meeting of MITACS was held in June 2000 at the University of Toronto. This was a tremendous success with participation of 226 students, 80 scientists and 30 industrial partners, highlighted by plenary addresses by Sir Michael Atiyah (University of Edinburgh), Robert Miura (UBC) and Arjen K. Lenstra (Citibank).

H.S.M. (Donald) COXETER

/ Arthur Sherk

I first met Donald Coxeter in his office in University College at the University of Toronto. The year was 1955, and I was a masters student at McMaster, writing a thesis under the supervision of Norman Lane. Knowing of my desire to continue graduate studies in Geometry, Norman said that I should go to U of T and study under Coxeter, beginning that summer. So Norman took me to Toronto and introduced me to Donald (of course he was “Professor Coxeter” to me in those days). The three of us had a nice chat, albeit brief, since we were all going to a mathematical colloquium that afternoon, of which Donald was the chair.

He readily agreed to supervise me, although personal supervision would have to wait until autumn,

since his summer plans would take him away from Toronto. Since I had the opportunity to continue with my scholarship support in the summer, it was agreed that I would work on my own for the summer months. A few days later, I received a long letter from Donald, confirming our agreement, and listing some ten problems, any of which I might consider as a basis for the Ph.D thesis.

I spent the next five or six months looking into these problems, reading, and attending lectures. Halfway through the Fall Term, I told Donald that I would like to choose the topic of Regular Maps for my thesis. He said: “Fine, we’ll schedule you to talk about it in the Colloquium some time next spring.” That jolt was certainly a jump start to my thesis research, but it worked; by the time the colloquium date came around in the spring of 1956, I had something to talk about.

Some time after I had finished the Ph.D. degree and had joined the U of T staff, Donald and I were talking over some plans when he paused and said: “Please address me as Donald from now on, not as Professor Coxeter.”

Other former Coxeter students tell of very similar experiences. To me, this is just one of many evidences of Donald’s complete lack of a self-important or superior attitude, in spite of the accomplishments and the honours he has received that might justify such feelings.

Donald has always had a great respect for learning. He has used every opportunity that came his way to enhance his own enormous store of mathematical knowledge, regardless of how lowly or unexpected the source may have been. In the early Sixties, when Donald was writing his book *“Introduction to Geometry”*, he asked me to read the first draft as he was writing it. That first draft was hand-written on the backs of pages of his voluminous correspondence. (As a pioneer in the present climate of recycling, Donald had saved the letters that he had received, after answering them. The backs of the pages were perfectly blank and therefore could be reused.

His writing of this first draft was clear and precise, with very little crossed out or erased. As I read the hand-written pages, I marveled at his well-known lucid and economic reasoning. It seemed to flow effortlessly from his pen; his characteristic handwriting put a great deal on one page, with hardly a single word crossed out. To my mind it was usually impossible to suggest improvements in the text.

I recall one occasion when I did not understand a concept which he was explaining, so I asked him about it. He clarified in a few words, and I thanked him. A day or two later, Donald, George Duff and I were lunching together when George brought up a little mathematical problem that he had heard from somewhere. In a rare flash of intuition, I gave him the answer immediately. This impressed George, and he was generous in his praise. Donald’s comment was equally generous; he said that a recent remark of mine had caused him to completely rewrite two pages of his book manuscript. This had to be a reference to our talk of two days before, so I told him with some surprise that the question I had asked him was for my benefit, not a suggestion to improve his manuscript. Donald’s reply was: “Yes, I know, but isn’t it nice when we can both profit from a well-asked question?”

As is well-known, Donald has a keen interest in art, an intellectual inheritance from both of his parents. The mathematical spin that he

put on art, though, was his own. It was the structure and symmetry of a work of art, be it music, painting or sculpture that caught his interest.

On more than one occasion, Donald gave a lecture entitled *“Mathematics and Music”*, illustrating his points by playing, on the piano, any relevant parts of the music under discussion. He would sometimes liken a musical composition to a theorem, and go through comparable examples point by point. Thus at one and the same time, he was educating the musicians in his audience in mathematics, and the mathematicians in music.

Donald Coxeter and the Dutch artist M.C. Escher became friends after Donald’s attention had been drawn to some of Escher’s work. Escher himself had very little mathematical background, but much of his work showed a deep intuitive mathematical touch. Although Coxeter was amused by the optical illusions Escher created, he was more impressed by the innate symmetry of his work, with the suggestion of the presence of regular and semi-regular Euclidean tessellations and of frieze patterns. It was on Donald’s suggestion that Escher created a painting illustrating hyperbolic tessellations, which he then presented to Donald. The original still hangs in Coxeter’s home, and plates of the original appear in some of Coxeter’s more recent papers and books.



Frederick Helson, John Chadam, Ronnie Brown, Donald Coxeter with “Intuition”, a sculpture by John Robinson, presented to the Fields Institute in recognition of H.S.M. Coxeter’s 90th birthday

Background: Detail of Escher’s painting illustrating hyperbolic tessellations

FIELDS THEMATIC PROGRAMS, COXETER and DISTINGUISHED LECTURE SERIES and DISTINGUISHED LECTURE SERIES IN STATISTICAL SCIENCE

THEMATIC PROGRAMS

Control Theory, 1992-93

Riemannian Geometry Micro-Program, Summer, 1993

L-functions, 1993-94

Dynamical Systems and Bifurcations Theory, Fall 1993

Geometric Mechanics Micro-Program, Summer, 1994

Operator Algebras and Applications, 1994-95

Homotopy Theory, 1995-96

Mathematical Foundations of Long Range Aperiodic
Order, Fall, 1995

Algebraic Model Theory, 1996-97

Singularity Theory and Geometry, Winter, 1997

Microlocal Methods in Geometric Analysis and
Mathematical Physics, Fall 1997

Complexity Theory, Winter 1998

Probability and its Applications, 1998-99

Special Year on Graph Theory and Combinatorial
Optimization, 1999-2000

Mini-Program on Causal Interpretation and
Identification of Conditional Independence Structure,
Fall, 1999

Symplectic Topology, Geometry and Gauge Theory,
2000-01

Infinite Dimensional Lie Theory and its Applications,
2000-01

Numerical and Computational Challenges in Science
and Engineering, 2001-02

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LECTURE SERIES

1992

Phillip Griffiths

Stephen Smale

Vaughan Jones

Michael Berry

1993

Sir Michael Atiyah

1994

Gerd Faltings

Andrew Wiles

Nancy Kopell

David Mumford

1995

Dan Voiculescu

Alain Connes

Charles Fefferman

Roger Penrose

Raoul Bott

Andrew Wiles

1996

Robert Macpherson

Sergei V. Novikov

1997

Alex J. Wilkie

Mikhael Gromov

Vladimir Arnol'd

Richard B. Melrose

Vladimir Buslaev

1998

Alexander A. Razborov

Avi Wigderson

Pierre-Gilles de Gennes

1999

Richard Durrett

László Lovász

2000

Paul Seymour

Peter G. Hall

Graeme Segal

2001

Alexander B. Givental

Peter Shor

Gene Golub

2002

Randall LeVeque

Donald Fraser