The Year in Review

IMA Institute for Mathematics and its Applications
A Very Vibrant Year

The 2014-2015 Annual Thematic Program on Discrete Structures turned out to be even more productive and exciting than we had anticipated when we planned this program two to three years ago. The program was not only timely, but I could not have asked for a better group of organizers. Their expertise and involvement were especially noteworthy.

We selected 11 postdoctoral fellows to participate in the annual program, and since discrete math is one of the strengths of the School of Mathematics at the University of Minnesota, a good number of faculty were also in residence at the IMA. Together with the large number of long-term visitors, many of whom spent the entire academic year here, the IMA was abuzz with activities. Each of the eight workshops was well attended, and the level of enthusiasm was palpable. The coffee breaks were notable as they were often at a high decibel level, and evenings were busy with groups often working into the night. I especially want to thank Leslie Hogben who, along with Andrew Beveridge, Jerry Griggs, Gregg Musiker, and Prasad Tetali, put together a wonderful IMA Volume entitled Recent Trends in Combinatorics, consisting of papers submitted by selected participants from the annual program.

Other notable activities included a joint IMA and National Institute for Mathematical Sciences (NIMS) workshop on Math in Industry, which took place in Daejeon, Korea in October. We also held an industry-initiated workshop on hydraulic fracturing in May. The July workshop on biological charge transport had its roots from the IMA's 2008-2009 Annual Thematic Program on Mathematics and Chemistry. This nascent topic emerged from several discussions between Bob Eisenberg (Rush University Medical Center), Chun Liu (Pennsylvania State University), and Yoichiro Mori (University of Minnesota, Twin Cities). It is rewarding to see that a research community working on the mathematical modeling of charge transport has emerged.

Moving Forward

When I wrote this column last year, I took the occasion to announce the National Science Foundation (NSF) decision to end its funding of the IMA through its Math Institutes program. The recommendation granted the IMA a ramp-down award of two years, ending on August 31, 2017. Since then many things have happened to convince us that the IMA must continue – even without the NSF core funding.

As soon as the news became public, the community outcry was loud and clear. An impassioned opinion piece by Barbara Keyfitz, President of the International Council on Industrial and Applied Mathematics (ICIAM), supporting the IMA was published in the society's newsletter in January 2015. A petition drive organized by former IMA postdoc Nilima Nigam (Simon Fraser University) asking the NSF to reconsider its decision garnered over 3,500 signatures. (Please also read Nilima's article in the December 2015 issue of the Notices of the American Mathematical Society.) The IMA's industrial partners wrote a joint letter to the NSF questioning the decision. Many IMA alumni left very personal accounts of the impact the IMA had on their careers at ima-alumni.org. In addition to private conversations, I personally received many emails expressing disappointment at the NSF decision.

Clearly, the IMA is a valuable resource to the mathematical sciences community. It simply cannot just disappear when the NSF funds run out. Together with Peter Olver, Doug Arnold, and other strong supporters of the IMA at the University of Minnesota, we made a decision to find ways to continue the IMAs important mission. I agreed to stay as director while the IMA finds its footing. My goal in the next few years is to make sure that the IMA lasts another 35 years. I am an eternal optimist; the challenges that the NSF decision has created represent new opportunities.

Over the past year, the directorship and IMA supporters have been actively working toward establishing a new vision of the IMA where global leadership in the mathematical sciences is achieved by bringing transformative change to industry, government, and academia. This new vision includes leveraging the IMA's strengths in its brand, industrial expertise, its ability to convene experts to solve problems, and to develop talent. We are exploring ideas for programs that will have the greatest impact on the community that we serve. Concurrently, we are considering new funding models and partnerships.

We have already begun responding to the needs of the mathematical sciences community by developing two exciting new programs. With the number of doctoral degrees awarded in mathematical sciences vastly outweighing the number of open tenure-track positions each year, the IMA is offering an intense six-week Math-to-Industry Boot Camp designed to train graduate students for employment outside of academia. The IMA received new funding from the NSF for this innovative program. Additionally, IMA Participating Corporations have made it clear that big data has become a driving force in industry. In response, the IMA has created the IMA Data Science Lab, led by Gilad Lerman (University of Minnesota, Twin Cities). The goal of the lab is to serve as a hub for collaboration between industry and academic researchers and to provide industry with access to academic research and tools for data analysis.

Other opportunities, including a partnership with NIMS that will add an international profile to the IMA, are currently being pursued. I am optimistic that the IMA will continue to significantly contribute to the mathematical sciences by training and opening pathways for the next generation of mathematicians and facilitating the creation of new research communities. I do hope to have the opportunity to connect with you all in the coming months to talk about the exciting things we will be doing.

Fadil Santosa
Director
Discrete Structures: Analysis and Applications

Discrete mathematics is a flourishing field, and many of its subfields, such as combinatorics, are taking a more dominant role in the mathematics community, attracting the attention of researchers from other disciplines.

“Discrete math is exploding. It seems like every area of mathematics comes up with problems that are discrete,” said annual program organizer Jerrold Griggs, University of South Carolina. “People coming to the workshops and long-term visitors will have a better sense of where the field is and get a clear picture of what people are doing and what tools they’re using, and how to use those tools for problems they’re working on.”

The three fall workshops focused on combinatorics and the theory underlying discrete structures.

“To come up with efficient algorithms that are potentially useful comes with the understanding of the theory,” Griggs explained. “The third workshop on geometric and enumerative combinatorics is the one I was involved with the most. One of the topics [discussed was] you have a configuration shaped like a board and have some tile pieces in certain shapes that can be rotated to try to enumerate how many ways to fill up the board with tiles. So, it seems like a fun problem somehow, but this is actually involved with models and statistical physics. You can see that the answers on the mathematical side are valuable to physicists. It’s often the case that pure math can be applicable.”

According to year organizer Prasad Tetali (Georgia Institute of Technology), the techniques and ideas in combinatorics and related fields contribute to applications in electrical engineering and machine learning while also contributing to progress on the challenging questions in machine learning, optimization, and statistical inference.

Griggs and Tetali were both impressed by Terence Tao, a professor at the University of California, Los Angeles and featured speaker at the second workshop in late September. Tao is a mathematical celebrity often dubbed the “Mozart of Math” and winner of numerous honors. He demonstrated his breadth of knowledge not only through his three scheduled lectures on Inverse Littlewood-Offord theorems, but by filling in for a canceled speaker on a moment’s notice and giving an additional three lectures, including one on the structure of approximate groups.

The spring program focused on applications of probability, analysis, and discrete mathematics, topics such combinatorial and convex optimization, statistical inference, and randomized algorithms and numerical linear algebra, and also featured an extremely popular workshop on information theory and concentration (of measure) phenomenon.

Annual program organizer Sergey Bobkov (University of Minnesota) was also one of the workshop organizers for “Information Theory and Concentration Phenomena.” The workshop reflected on major contributions in two large areas of mathematics: information theoretic tools and phenomena in high dimensions.

“In the recent years, these two areas have become closer to each other and have united researchers from different fields,” Bobkov said. “This remarkable fact is rather interesting since the area of high dimensional phenomena represents one of the mainstreams in modern mathematics, with an unbounded range of applications.”

Another workshop well-received by participants was the “Power and Randomness of Computation,” which brought together researchers in mathematics and computer science at the Georgia Institute of Technology’s interdisciplinary research center in Algorithms and Randomness.

Throughout the year, the IMA hosted more than 60 long-term visitors and had 14 postdoctoral fellows in residence.

More information, including videos of the lectures, is available online at www.ima.umn.edu/2014-2015.
Finding a Mathematical Institute Close to Home

The 2014-2015 annual program on discrete structures and a convenient location made the IMA an appealing destination for the Iowa State University (ISU) Math Department.

According to Leslie Hogben, the Dio Lewis Holl Chair in Applied Mathematics and professor of mathematics at ISU, discrete math is a very strong research area for the math department, making the IMA’s annual program a perfect fit. And the short distance between Ames, Iowa and Minneapolis, Minn. made it possible for people to commute home on the weekends.

“The commuting arrangement was ideal for me for several other reasons: I could meet with my some of Ph.D. students when back in Iowa, and I was able to go into my ‘institute’ mode while at the IMA—by this I mean do math, sleep, and eat. This works great for one week, but would not work for three months. But I had two to three normal days at home every week so I could be intense at the IMA,” Hogben said.

In all, five faculty and three graduate students were long-term visitors during the fall semester, with two faculty staying for the full year. Several other faculty, postdocs, and graduate students engaged in short-term visits or attended workshops.

The IMA is known for being a collaborative workplace for established mathematicians, but the institute also strives to provide an engaging environment for graduate students to help train them as the next generation of researchers and educators. Faculty are encouraged to bring their students with them when visiting the IMA for the annual program. While all of the faculty from Iowa State interacted with their graduate students on a regular basis, Hogben says they also encouraged the students to talk with the IMA visitors and postdocs.

“The experience at IMA this semester was amazing,” said Chassidy Bozeman, a third-year Ph.D. student at Iowa State University. “For starters, because the IMA program is thematic, it has provided several opportunities to network with other individuals with similar interests. In particular, the program has allowed me to become more comfortable discussing research with other mathematicians.”

“I feel lucky that I get the chance to be here,” said Jephian Lin, a second-year graduate student at Iowa State University. “In particular, I like the learning seminar about algebraic topology since I feel I’ve really learned something there. Also, instead of talking about teaching and taking courses, the atmosphere in a research institute like IMA is a nice experience.”

Bozeman believes that the IMA offers great exposure to a plethora of research areas and topics. “This is not something that I would have gained during a traditional graduate school experience, and I am confident that these new experiences will guide me in being more of a well-rounded researcher,” she said.

Hogben even brought one of her students, Kevin Palmowski, to the IMA during a non-workshop week. The purpose of bringing a student for a week, she says, is to pull them out of their home environment so they can interact with people, cross-fertilize, and really focus on their research—as well as limit the number of interruptions that occur on a daily basis in their regular office.

And during Hogben’s own long-term visit, she collaborated with Jeanette Janssen (Dalhousie University) and IMA postdoctoral fellow Will Perkins about planted partitions in circulant matrices, started a project on multipartite Nordhaus Gaddum problems with Michael Young (ISU) and Jephian Lin (ISU), and completed a project started earlier on exact crossing numbers with Young and Bernard Lidicky (ISU).

“Although most of my collaborations were with people from Iowa State, taking us away from ISU was critical to getting things done,” she noted.

Collaborations aside, Hogben and her colleague Ryan Martin (ISU) kept busy co-organizing the Annual Program Seminars for the fall semester.

“Ryan and I wanted the talks to be surveys of problems with lots of open questions designed to start research collaborations,” she explained. “I enjoyed the talks and thought the speakers did a great job.”

To round out the annual program year, Hogben is also working on putting together an IMA Volume on Recent Trends in Combinatorics with co-editors Andrew Beveridge (Macalester College), Jerrold Griggs (University of South Carolina), Gregg Musiker (University of Minnesota, Twin Cities), and Prasad Tetali (Georgia Institute of Technology).

“The vision for the volume is to invite people to write surveys of problems with lots of open questions. Most of these surveys came from workshop and seminar talks. We wanted them to be broader than a typical research paper and most are,” Hogben explained. “Working on Recent Trends in Combinatorics has been lots of fun thanks to a great group of co-editors and authors, and I think the volume will contribute to extending the impact of the discrete structures year.”
Diverse Interests Come Together in One Program

Long-term visitor Mokshay Madiman found the 2014-2015 thematic program’s broad range of related, but different, mathematical fields to align closely with his interests.

“My interests are somewhat diverse, so I rarely encounter activities—like this annual program—that span many of them,” said Madiman, an associate professor at the University of Delaware. Madiman visited during the spring semester, participating in workshops, becoming an Annual Program Seminar organizer, and interacting with a variety of visitors.

“And just being at the IMA provided some space for contemplation and writing without the usual distractions at one’s own institution,” he added, as the free time helped him wrap up several older projects.

Madiman also brought two of his Ph.D. students with him to the IMA and worked with them on a number of topics. On occasion, this work also involved discussion with other IMA visitors, such as former IMA associate director Elisabeth Werner (Case Western Reserve University), Eric Carlen (Rutgers University), Larry Goldstein (University of Southern California), and Dmitriy Bilyk (University of Minnesota).

“Most of these discussions were exploratory, but it was certainly enriching for my students and me. My students also benefited from the large number of seminars and the workshops,” Madiman said.

He had a number of discussions with IMA postdocs as well, including Naomi and Ohad Feldheim, Arnaud Marsiglietti, Piotr Nayar, Matthew Wright, and Jing Wang. Madiman felt a particular synergy with Marsiglietti and later joined a rapidly developing project with Marsiglietti, Matthieu Fradelizi (Université Paris-Est Marne-la-Vallée), and Artem Zvavitch (Kent State University) a month after he left the IMA in May.

“We expect to submit a paper on quantitative and qualitative descriptions of the convexification tendencies of Minkowski summation that, among other things, refutes a conjecture made a few years ago by Sergey Bobkov (University of Minnesota), Liyao Wang (Yale University), and myself,” he explained.

A notable collaboration that he began at the IMA was with Werner and Carsten Schuett (Christian-Albrechts-Universität zu Kiel) on a general framework to make sense of the many notions of affine surface area and related functionals, and to do so in a way that provides insight both about convex bodies with smooth boundaries and polytopes, rather than being degenerate for one of these classes.

“While we are still at the early stages of this research, I am excited about this project and would be very surprised if it does not result in published work in a couple of years,” Madiman said.

Besides being exposed to a wide range of research, beginning collaborations, and finishing projects, a highlight of Madiman’s visit was the social aspect of the program.

“It is not always appreciated how important the social fabric of the research community is to the mathematical enterprise, but the trust and friendships so developed strongly increases the likelihood that we will end up collaborating on new research in the future,” he noted.

Gaining New Insights in Combinatorics

Having already visited the University of Minnesota and the IMA numerous times, Patricia Hersh did not turn down the chance to be a long-term visitor for the fall semester of the thematic year.

Hersh, a professor at North Carolina State University, highly valued the opportunity to interact with participants from other parts of combinatorics, such as extremal combinatorics and graph theory, and the “excellent” combinatorics group at the University of Minnesota. According to Hersh, this has been very helpful in her new role as combinatorics editor for the Proceedings of the AMS.

“This was especially opportune timing because I had invested lots of time in large service projects to the math community in the preceding few years,” she added. “It was very helpful to have a semester right after that to really focus on research.”

During her stay, Hersh collaborated with Victor Reiner (University of Minnesota) on combinatorial aspects of representation theoretic stability. This culminated in a joint paper with entitled “Representation stability for cohomology of configuration spaces in Rd.”

“Among other things, this paper improves a stability bound of Thomas Church and Benson Farb from 4i to 3i+1 by using an Sn-equivariant version of the Goresky-MacPherson formula along with results of Sheila Sundaram describing the Whitney homology of the partition lattice,” she explained.

Hersh also organized a learning seminar on the applications of topology and geometry to extremal combinatorics. Her previous visits to the IMA were during the annual programs on Applications of Algebraic Geometry and Scientific and Engineering Applications of Algebraic Topology.

“Different people presented results; generally not their own work but rather classic results of the field,” she noted.

For Hersh, the most valuable part of her experience was being able to talk with several top-notch combinatorialists, including Jacob Fox (Massachusetts Institute of Technology), Joel Spencer (New York University), and Noga Alon (Tel Aviv University), who posed a “fascinating” open question at the Probabilistic and Extremal Combinatorics workshop regarding finding an elementary proof of a result about decomposing a complete graph into a disjoint union of complete bipartite graphs.

“Richard Stanley also gave an excellent talk,” Hersh said. “He was my Ph.D. advisor, so seeing him at the IMA was a valuable opportunity to touch base with him mathematically and get his thoughts on some things I was working on.”
Participating in Thematic Programs on Control Theory More Than 20 Years Apart

Anders Rantzer (Lund University) has the unique perspective of being a postdoc during the 1992-1993 Thematic Program on Control Theory and its Applications and an organizer for the 2015-2016 program of the same name.

Prior to his postdoctoral fellowship, Rantzer had been traveling to conferences and found the idea of a longer stay at the IMA to be appealing. Being a postdoc introduced him to leading researchers of the field and their different viewpoints—something that has shaped his ongoing research career.

“I had a wonderful experience. It was a fantastic opportunity to make connections to other researchers from all over world,” he said.

Being a postdoc helped him get an idea of how his own research fit into the larger context and to know what kind of questions were being asked.

According to Rantzer, the first program year on control theory marked the end of an important period on robust control that dominated the 1980s as period of active interaction between mathematics and control.

As some of the questions in the 1980s were resolved around the first IMA year, the field of control theory shifted its attention in the beginning of the 1990s toward application areas where control methods are currently being used and the needs of those areas.

Ten to 15 years after the first program year, a new wave of theoretical questions were being asked about large scale systems.

“If you look at the current [2015-2016] program year, there is a lot of attention being paid to large scale systems and networks, which is creating a new need to establish contacts between control engineering and mathematics,” Rantzer noted. “That is why I think this new IMA year is very useful. But it’s sort of a different branch of mathematics that we are making connections to now. It’s quite interesting to see this over a longer period. Attention has been shifting from theory to applications and back again to theory.”

Just as the important topics and questions in the field of control theory have changed over time, so too have Rantzer’s own research interests. He received his Ph.D. in 1991 in Optimization and Systems Theory, having an interest in robust control. But gradually his attention shifted to application areas after interacting with both the automotive industry and the energy sector where he saw the need to handle more complex systems. Most recently, he has been involved with the recent growth in control theory for large scale systems and networks.

According to Rantzer, another important trend over the last 20 years has been the strength and relationship between control and optimization theory, which is another branch of applied mathematics.

“Optimization has developed very rapidly, to a large extent, in synergy with control theory. Control theory has been a driving application for the development of optimization theory, and optimization has become more and more important to control. How to use optimization for control purposes has been a recurring theme for my research,” he explained.

Rantzer will spend the entire year at the IMA for the 2015-2016 program, having been chosen as a Taylor Family Distinguished Visiting Professor for his influential contributions and continuous presence in the field of control, originality of ideas, and creativity in seeking new and timely directions that have impacted the science, engineering, and mathematics of control.

“I really look forward to a year devoted to research and to interact with people for more extended periods of time than just seeing them at conferences,” he said.

Rantzer also hopes to contribute to the 2015-2016 year in a way that creates an environment similar to his own postdoc experience for the new generation of researchers visiting the IMA.

“I think the new generation of researchers in our field will, through this annual program, have an opportunity to connect mathematics to engineering, which is the strength of the IMA,” he said. “I’m very happy there is a group of young, talented researchers here that will be able to take advantage of these opportunities.”
Marsiglietti received his Ph.D. from the Université Paris-Est Marne-la-Vallée in France. The theme of the program was closely related to his research in the Brunn-Minkowski theory, and Marsiglietti had studied the publications of program year organizer Sergey Bobkov (University of Minnesota, Twin Cities).

“I really wanted to meet him and work with him, so this annual program was the opportunity for this to happen,” he said, which led to Bobkov becoming Marsiglietti’s mentor at the IMA.

Feldheim and her husband Ohad, also an IMA postdoc, obtained their Ph.D.s from Tel-Aviv University in Israel, but had a two body-problem as both are mathematicians but with different interests. His falls more in combinatorics and the discrete side of mathematics, while hers are in probability and analysis.

“Somehow the year combined these two subjects, so it was a good solution,” she said.

“It was really exciting for me because it was a combination of things that I had worked on and wanted to learn. And there were many visitors I knew by name because I read their papers and knew they were coming to give some talks.”

Nayar’s (Ph.D., University of Warsaw in Poland) main scientific interest in concentration of measure theory was one of the main topics of the annual program.

“The IMA provides a great environment for meeting experts working in the field. The number of visitors during this year was impressive, and this motivated me to come. Also, the chance of working with my IMA mentor, Sergey Bobkov, influenced my decision,” he said.

The IMA facilitated the many collaborations undertaken by these postdocs—not only with their mentors and long-term visitors, but with each other. Feldheim, Nayar, and Marsiglietti collaborated with Jing Wang, another IMA postdoc, on concentration inequalities for product measures, as related to the concentration of measure phenomenon.

“We first learned a bit of concentration during several informal seminar talks and then started working on a particular problem,” Nayar noted. “I learned this problem from Rafal Latala, who was one of my mentors in Poland during my Ph.D. studies.”

“Usually, to obtain concentration, one proves certain functional inequalities, such as the so-called Poincaré inequality or the logarithmic Sobolev inequality,” Marsiglietti explained. “In this paper, we investigated another functional inequality that implies concentration, the so-called infimum convolution inequality, also called the property tau of Maurey. We proved that for a certain class of measure, the convex infimum convolution holds true for any convex functions. This allowed us to derive concentration for convex functions and convex sets.”

Collaborating with peers was a new experience for some of the postdocs.

“It’s a different feeling, and I enjoyed working with peers,” Wang said. “Maybe we are not as fast as the other professors who has been working in this area for 20 or 30 years, but this process is very nice. We learn from each other, and we exchange ideas. Because we work with peers, we feel free to share some idea or comments. We don’t really hesitate because we know each other. There’s no pressure.”

“This is the first time I really tried to collaborate since doing my thesis, where I worked more or less alone or with my advisor. So I’d say this program experience works on how to collaborate,” Feldheim said.

Feldheim’s other collaborative research projects include working with her IMA mentor, Dmitriy Bilyk (University of Minnesota, Twin Cities) on fair questions in approximations of functions, or trying to numerically integrate some complex functions.

“The main contribution from me that I succeeded in doing this year is three moderate projects, maybe not very big ones, but moderate projects in different mathematical areas, so I was learning a lot,” she noted.

Nayar and Marsiglietti came together again to collaborate with Artem Zvavitch (Kent State University) and his then Ph.D. student Galyna Livshyts, who was an IMA visitor in April.

“It concerned the conjectured Gaussian Brunn-Minkowski inequality,” Nayar said.

“In February, I visited Artem at Kent and we [made some] progress towards proving this conjecture. Later, Galyna, who was also working on this question before, and Arnaud joined us, and after some discussions, we proved the Brunn-Minkowski inequality for unconditional sets and unconditional log-concave measures.”

While meeting experts in the field and starting new collaborations were highlights of the year for all the postdocs, Feldheim also included Minnesota as one of her highlights.

“I’m in love with the lakes. This is something that is unique to this area—at least it is for me,” she said. “Nature is so close to the city. In Israel, there are the rural places and there is the city. You can drive for a while to get to some interesting places. But here, [nature] is incorporated into the city.”

Next for Feldheim is an NSF postdoctoral fellowship at Stanford University in fall 2015, working with Amir Dembo. Nayar will begin a postdoctoral position at the University of Pennsylvania in January 2016, working with Elchanan Mossel. Marsiglietti will stay at the IMA for the second year of his postdoctoral fellowship.
Jonathan Weare Awarded the 2015 IMA Prize in Mathematics and its Applications

In September 2015, the IMA Prize in Mathematics and its Applications was awarded to Jonathan Weare, an assistant professor in the Department of Statistics and The James Franck Institute at the University of Chicago.

Weare received this recognition for his innovative contributions to the theory and practice of stochastic sampling methods, in particular rare event and Markov chain Monte Carlo algorithms for accelerating molecular simulations. His mathematical insights are revolutionizing the way simulations are being done by researchers in disciplines ranging from chemistry to geophysics.

“My core research interest is in stochastic processes and, in particular, their simulation on a computer,” he noted. “Stochastic processes are often used to describe the evolution of a system perturbed by its environment. For example, the evolution of a large collection of interacting atoms is typically modeled by a stochastic process.”

Often, the most interesting feature of the system is something that it does only rarely. “For example, the small jiggles of a large biomolecule may only very occasionally be interrupted by a dramatic rearrangement of the atoms in the molecule, and those rearrangements may be responsible for the function of the molecule in the body,” Weare explained. “Interrogation of these ‘rare events’ through computer simulation can be very difficult, but it is crucial to improving our understanding important issues in areas ranging from biology to climate science.”

Prior to the University of Chicago, Weare was a Courant Instructor at New York University’s Courant Institute of Mathematical Sciences, where he credits Jonathan Goodman, Robert Kohn, and Eric Vanden-Eijnden for providing valuable mentorship.

“I don’t think I could have been more fortunate in the group of people that have been my mentors,” he said. “They have all reinforced the idea that an applied mathematician should be useful. By that I mean my goal should be to focus on problems or algorithms that have a real chance of [someday] having a measurable impact on an application area.”

A collaboration with Goodman produced a family of Markov chain Monte Carlo (MCMC) methods called affine-invariant ensemble samplers whose performance is unaffected by affine transformations of space. These algorithms are particularly useful for sampling badly-scaled distributions because they are faster than standard MCMC methods. Their paper was later used to code a software package called emcee: The MCMC Hammer that is now widely used in astrophysics. Weare and collaborators have also studied the performance of this method by applying it to the orbital parameters of exoplanets.

While his work brings new ideas to fundamental problems that are important in diverse application areas, Weare wasn’t always interested in the physical sciences, chemistry in particular.

“My parents are both chemists, but I managed to avoid learning chemistry for a very long time!” he said.

It wasn’t until his thesis advisor at the University of California, Berkeley, Alexandre Chorin, suggested Weare look at problems in computational chemistry.

“When I first saw a message from Professor Santosa, I would not have guessed that he was contacting me about the IMA Prize. I’m very honored.”

Willard Miller (left), Prize Committee Chair, and Jonathan Weare

“I’m very glad he did. Among the other benefits, it has allowed me to collaborate with my father,” Weare noted.

Weare will continue to work on several long-term projects in computational chemistry, climate science, and power systems engineering.

“There’s more than enough for me to learn,” he said. “Looking farther out, I’m sure there will be new application areas that will catch my eye.”

The IMA Prize in Mathematics and its Applications is awarded annually to a mathematical scientist who is within 10 years of having received his or her Ph.D. degree. The award recognizes an individual who has made a transformative impact on the mathematical sciences and their applications. The prize can recognize either a single notable achievement or acknowledge a body of work. The prize consists of a certificate and a cash award of $3,000. Funding for the IMA Prize in Mathematics and its Applications is made possible by generous donations of friends of the IMA.
A Mathematical Celebration of Yakov G. Sinai

The IMA’s fourth annual Abel Conference was held in honor of Yakov G. Sinai from October 31 to November 2, 2014.

Sinai received the 2014 Abel Prize for his fundamental contributions to dynamical systems, ergodic theory, and mathematical physics. He has been a professor of mathematics at Princeton University since 1993 and a senior researcher at the Landau Institute of Theoretical Physics of the Russian Academy of Sciences since 1971.

Originally from Russia, Sinai began his career at Moscow State University as a scientific researcher before becoming a professor in 1971. During the past half-century, he has written more than 250 research papers and has supervised more than 50 Ph.D. students.

According to the Abel committee, Sinai is one of the most influential mathematicians of the twentieth century, and he has achieved numerous groundbreaking results with many of those results named after him, including Kolmogorov-Sinai entropy, Sinai’s billiards, Sinai’s random walk, Sinai-Ruelle-Bowen measures, and Pirogov-Sinai theory.

Helge Holden, then chair of the Abel board, opened the conference and was followed by Sinai, who gave introductory remarks about the early years of his mathematical activity in Moscow. He also shared stories about the people he worked with or who influenced his research.

Svetlana Jitomirskaya (University of California, Irvine), a former student of Sinai’s when he was a professor at Moscow State University, gave the first talk on “Quasiperiodic Operators with Monotone Potentials: Sharp Arithmetic Spectral Transitions and Small Coupling Localization.”

Participants considered the conference a success, finding the talks to be “outstanding,” “excellent,” and of “high quality.” One participant deemed the conference “excellent because of the selection of speakers whose survey talks covered a wide part of the mathematics [produced by Sinai]. Of course, the great part the success is due to Sinai’s attractive personality: he formulated challenging problems for his gifted students on different fields of mathematics.” Overall, the conference demonstrated the “width of Sinai’s interests and influence,” as stated by another participant.

The Abel Conference series honors the Abel Prize Laureates and is a collaboration between the Norwegian Academy of Sciences and Letters and the IMA. Videos from the conference can be seen at ima.umn.edu/2014-2015/SW10.31-11.2.14.

The IMA gratefully acknowledges the generous support of Schlumberger-Doll Research, Microsoft Research, and the University of Minnesota for this annual conference series.
Cédric Villani on the Living Art of Mathematics

Wearing his usual three-piece suit, splashy cravat, and spider-shaped brooch, French mathematician Cédric Villani looks like he has just stepped in from the 19th century.

Yet this unique sense of style becomes authentic when Villani says that mathematicians, obsessed with the notion of elegance, consider themselves as artists and poets in a form of art that is more alive than ever. Thus, it is hardly surprising to know that he is also a polymath with a broad range of interests that run the gamut from music and politics to Japanese manga.

Villani has built a distinguished career as a mathematician, taking over directorship of the Institut Henri Poincaré in Paris, one of France’s most prestigious research institutions, when he was still in his thirties. He is also a professor of mathematics at the University of Lyon, and his work on partial differential equations and mathematical physics has earned him numerous awards, including the Fields Medal in 2010 for his proof on nonlinear Landau damping and work on the Boltzmann equation.

Presenting the sixth annual Arnold Family Lecture in April, Villani talked about how the intuition and creative genius of mathematicians has been inspiring artists for years, going as far back as the ancient Greeks. The Greeks were the first to consider mathematics as a logical way of viewing the world, and they integrated this logic by constructing a formal proof as a means to convince someone that something is true.

"Mathematics is not just science," Villani noted. "It is a way to train your spirit in the art of reasoning, and this is also one reason why it’s important to teach it."

Villani attributes his ability to construct a proof to a book called the Geometry of Triangles, and how it was easier to start with something as simple as a triangle and a circle before launching into a 100-page proof.

“All of science starts from something, which is amazing, [and you can] replace the beautiful mystery with a beautiful explanation. If you do it right, the explanation will never be less beautiful than the mystery,” he said.

The word “beauty” comes up a lot as Villani talks about mathematics. When all the mathematical arguments fit together to make a beautiful proof, he says, it can be described as the harmonious order of the parts, like when instruments in an orchestra fit together to make music.

But, he argues, mathematics is also a form of art, not just a form of science. One example is when Pythagoras discovered the mathematical ratios between octaves, fifths, fourths and string length, which is the basis of modern day music scales. Another is the idea of the golden ratio, a mathematical relationship that creates symmetry from asymmetrical parts, and its use in paintings and design.

But according to Villani, we can find mathematics in the description of the world, even if it’s not about precise ratios, as many examples in nature, like plants and reflections in water droplets, exhibit stunning
shapes and arrangements. Villani is more concerned with the fact that “mathematics gives you all the tools to describe some of the most harmonious, inspiring shapes around.”

“Mathematics as we know it is behind every aspect of nature,” he continued, while showing a cartoon from the math-themed comic strip Abstruse Goose depicting scientists as viewing the world in equations. “It’s like there is an extra world made of equations, and there is beauty in the way equations come together.”

Architecture also relies on math as models must first be constructed to know that an idea is structurally sound before it can be built in the physical world. And mathematics is very present these days in Hollywood industry. According to Villani, Gravity, starring Sandra Bullock, was the most mathematical movie ever made, as the math formulas used to create the simulated world in space took years to do.

Villani also talked about the poetic nature of mathematics, and how creativity and imagination play such an important part in making math a form of art. While poetry has rules that guide the use of syllables, rhymes, lines, verses, and so on, there is still creativity to be seen in how words and sounds are brought together.

“Likewise, in mathematics, the science in which we are the most rigorous, not leaving anything to persuasion, we have to prove every single thing,” Villani said. “This is a crazy constraint which is one of the explanations why mathematics needs so much creativity.”

In this way, art is inspired by rules, and turning mathematics into art is done by following the rules. An example Villani gives is hyperbolic geometry and pseudo-spheres, and its appearance in sculptures and crochet. These examples produce beautiful art objects that look different, but the geometry is the same—there is a constant negative curvature in the mathematical sense.

The image that accompanies this article, called “Still Life: Five Glass Surfaces on a Tabletop,” is a collaboration between mathematician Richard Palais and graphic artist Luc Bénard, created using 3D-XplorMath software. These visualizations were also rendered following mathematical rules; the surfaces are known as (starting from lower left and moving clockwise): the Klein Bottle, the Symmetric 4-Noid, the Breather Surface, the Boy Surface, and the Sievert-Enneper Surface. It was awarded first place in the illustration category of the National Science Foundation/Science Magazine 2006 Visualization Challenge.

Villani discussed how his own memoir, Birth of a Theorem: A Mathematical Adventure, displays the creativity and discovery of math. It accounts for the months of collaborative work and thought that led to his mathematical proof of nonlinear Landau damping, a mysterious phenomenon in plasma physics.

“There is artistic value in the formulas, representations, and words that we use to communicate from mathematician to mathematician [because we can] find some truth from the equations,” he said.

The mathematical communications Villani shares in the book include the breakthroughs, setbacks, email exchanges, and conversations. He describes the book as “written like an adventure novel” and “what happens when we are trying to prove a theorem.”

The lecture ended with a video from French artist Jean-Michel Alberola showing Villani’s hand writing out equations on a blackboard. Villani points out that even with all the technology available to us, there is still beauty in writing on the blackboard because of its capability to effectively communicate what is in the mind of the mathematician. When the video looks at the final blackboard from a distance to see all the equations, the result is nothing short of a work of art.

Recorded public lectures are available on the IMA website at ima.umn.edu/public-lecture.
Bringing Research Communities Together

The IMA hosted several hot topics workshops that brought together mathematicians and scientists with diverse backgrounds to foster synergy and strengthen interdisciplinary connections.

Three workshops addressed important issues facing society: natural disasters caused by waves, the use of hydraulic fracturing to recover oil and gas, and drug design.

Impact of Waves Along Coastlines

This workshop, held in October 2014, gathered scientists and mathematicians from academia and industry to increase forecasting and prediction ability of coastal hazards, such as earthquakes, tsunamis, and hurricanes, in the hopes of anticipating and mitigating the risks associated with these phenomena.

According to workshop organizer Natasha Flyer, a scientist with the National Center for Atmospheric Research, the worldwide damage in both property and lives from coastal hazards has been staggering in the last decade. Heightened awareness of these threats has generated an increased concern for public safety and preparedness.

“Realistic prediction entails the synthesis of real-world observations into mathematical-computational models of the physical processes involved, with quantification of the uncertainties in both,” Flyer explained. “When forecasting coastal hazards, the predictions need to be available with sufficient lead times and be expressed with high enough geographic accuracy to determine effective evacuation strategies and sustainable land-use practices.”

To achieve these goals, improvement is needed in both prediction of the coastal hazard and in probabilistic hazard assessment.

According to workshop organizer David George, a scientist with the U.S. Geological Survey, the workshop promoted integration of probabilistic approaches in research performed by those traditionally focused on single deterministic models.

“This will hopefully lead to an increased focus on and incorporation of uncertainty quantification and validation for flow modeling, ideally in a more uniform and systematic fashion,” he noted.

Researchers have made significant progress developing models and software to simulate coastal hazards in the last few decades. However, since this research topic is inherently interdisciplinary, the community is scattered among different fields.

“A primary goal behind the workshop was to foster integration and communication amongst researchers from somewhat diverse settings,” George said. “This communication will ideally lead to a more standardized approach to model development, application, and validation. And much of the research and model development could potentially be integrated.”

Both George and Flyer agree that the workshop helped connect researchers who previously did not collaborate, thus promoting an increased level of organization in the community and a basis for future workshops in the field of prediction and probabilistic hazard assessment.

Hydraulic Fracturing: From Modeling and Simulation to Reconstruction and Characterization

The IMA brought together two research communities in May that have had limited interaction: the inverse problems community and the hydraulic fracturing community. One of the major and unresolved challenges in hydraulic fracturing design remains the limited capacity for monitoring fractures as they progress.

According to workshop organizers Emmanuel Detournay (University of Minnesota, Twin Cities) and Bojan Guzina (University of Minnesota, Twin Cities), the objective was to update the respective communities on the state-of-the-art in each field, as new numerical methods to simulate hydraulic fracturing have recently been established and new imaging techniques are being developed that could potentially impact the technology and implementation of fracturing.

Although hydraulic fracturing is being successfully and more safely implemented, it is highly desirable to better monitor and intelligently stir fractures for higher efficiency, more productivity, and less environmental impact.

“From an inverse problem perspective, this means that there is a great need for the development of feasible subsurface imaging techniques that are fast, provide reasonable resolution at high depth, and account for background uncertainties,” Detournay said.

Besides monitoring the progress of propagating fractures, other challenges include modeling hydraulic fractures in heterogeneous rock that already has an extensive network of pre-existing natural fractures. And in order to be useful, Guzina says, industry requires models that will be able to execute rapidly—from seconds to minutes.

The workshop helped define the progress and techniques currently being developed
by the inverse problem community, and these researchers were introduced to realistic settings and specific open problems in hydraulic fracturing by industry experts. The open problems related to mathematical and computational investigations of propagation breakages, imaging of fractures in solids, and imaging through uncertain backgrounds.

“I had the chance to see that researchers outside of my usual community make use of the tools that I study and develop in order to solve problems arising from actual engineering applications,” said a workshop participant. “And I also had the opportunity to visualize the areas of my research that haven’t been applied yet and could potentially be adapted to meet the needs of engineers.”

Motivating new applications of existing mathematical and computational knowledge in inverse problems and imaging was exactly what workshop organizers had hoped to achieve.

Mathematics of Biological Charge Transport: Molecules and Beyond

In July, the IMA helped bridge the research gap between molecular biologists and mathematical scientists by facilitating the sharing of knowledge on molecular biology and modern mathematical tools and techniques.

The workshop, organized by Chun Liu (The Pennsylvania State University), Yoichiro Mori (University of Minnesota, Twin Cities), and Guowei Wei (Michigan State University), focused on charge transport, as organizers noted that “almost all biological activities involve transport of charged particles in complicated biological environments. This has long been recognized as a central issue in molecular biology and physiology, but it is only in the last few decades that mathematical and computational techniques together with sophisticated experimental data have allowed the field to transition from the descriptive and qualitative toward the predictive and quantitative.”

From a biologist’s point of view, an important goal is to link structures of biomolecules, such as ion channels, to function—which in the example of ion channels would be ion selectivity, current-voltage relationship, and gating properties. Genomic sequencing and advances in structural biology are starting to give a detailed view of what biomolecules look like, but it is still challenging to infer functional characteristics from structural data.

From a mathematician’s point of view, it remains a challenge to pursue the dimensionality reduction and construct computationally feasible multiscale models for charge transport in complex living systems so as to achieve critical predictive power for molecular-based observations.

“The workshop brought in leading experts in the field and has led to a better understanding of existing problems in charge transport,” Mori said.

The organizers were also pleased to see participation from young and international researchers, noting that interacting with chemists and biologists who are outside the immediate sphere of contact for mathematicians was a highlight of the workshop. They hope this will entice more junior researchers to work in the field and create more partnerships and concrete projects between mathematicians and biologists.

“Many interesting mathematical approaches were discussed, pointing to a number of new directions in the fields,” Mori added. “The workshop has helped identify crucial issues for mathematicians to work on.”

Wei believes this workshop will have a tremendous impact on human health as voltage-gated potassium and sodium channels are key targets for local anesthetics, antiepileptics, and therapeutics for a range of disorders, such as epilepsy, cardio arrhythmias, hyperalgesia, and myotonia.

The IMA is pleased to serve as a stimulating and productive hub for collaboration between industrial and academic researchers.

I noticed that this is one of a few workshops that emphasized math and molecular biophysics. I am quite sure that this workshop will lead to more attention in this new field. Additionally, there were many young researchers who attended this workshop. Therefore, this workshop will have a significant impact to future generation of mathematicians.”

— WORKSHOP PARTICIPANT
IMA Hosts Celebratory Workshops for Douglas Arnold and Ruth Williams

The IMA is pleased to celebrate the long and fruitful careers of established mathematicians.

Structure-Preserving Discretizations of Partial Differential Equations

In October, more than 100 researchers attended a special workshop to celebrate the contributions of mathematician Douglas Arnold, a professor at the University of Minnesota and former IMA director from 2001 to 2008, on the occasion of his 60th birthday.

The workshop focused on the progress that has occurred since the 2004 IMA Hot Topics workshop on Compatible Spatial Discretizations for PDEs and related conferences held later at the Centre of Mathematics for Applications at the University of Oslo.

“Mathematical modeling of physical and biological processes using PDEs has become a standard approach to studying many important problems,” said workshop organizer Richard Falk, Rutgers University. “The development of reliable and efficient numerical approximation schemes makes this a practical approach and is therefore central to progress in many areas of science and engineering.”

Arnold has made fundamental contributions in many areas. These include the phenomena of superconvergence, boundary integral methods, collocation methods, finite element methods for the equations of elasticity, numerical methods for the Stokes equations, finite element methods for beams, plates, and shells, fast solution methods for the linear systems of equations that arise from finite element discretization schemes, and numerical issues arising in general relativity.

In 2002, Arnold initiated the finite element exterior calculus, a new approach to the stability of finite element methods based on geometric and topological structure underlying the relevant PDEs.

Reflected Brownian Motions, Stochastic Networks, and their Applications

In June, this special workshop brought together over 70 mathematicians and applied researchers who share an interest in stochastic network models to highlight areas of current activity, like new applications in molecular biology, and to honor Ruth J. Williams, Distinguished Professor in the mathematics department at the University of California, San Diego, as one of the most important contributors to this research area.

Stochastic network models are the subject of a rich and varied mathematical theory, with a long tradition and a vibrant body of applications. The stochastic networks that Williams studies typically have entities, such as customers, packets, or molecules, that move along paths or routes in a network, wait in buffers, receive processing from various resources, and that are subject to the effects of stochastic variability through uncertainty in arrival times, processing times, and routing.

Modern networks, such as the Internet, are highly complex and heterogeneous, presenting substantial mathematical challenges for their analysis and control. In recent work, Williams has analyzed models of the Internet to understand the entrainment effects of using fair bandwidth-sharing policies and has used insights from queueing theory to study coupled enzymatic processing in protein networks, in collaboration with researchers in synthetic biology.

Williams has also made deep and lasting contributions to the theory of reflecting diffusion processes. She has been instrumental in the development of techniques to prove heavy traffic limit theorems for queueing networks and has pioneered the use of fluid and diffusion approximations to analyze and control general stochastic networks.

Williams has a long relationship with the IMA, beginning as a postdoc in the spring of 1986 during the Annual Thematic Program on Stochastic Differential Equations and their Applications, and has returned numerous times since for workshops pertaining to networks, as well as serving as a member of the Board of Governors (2003-2006).
IMA Holds Workshop for Underrepresented Groups in Math

Last held in 2010, the IMA hosted another “Careers in Mathematical Sciences: Workshop for Underrepresented Groups,” from March 26 to 28, 2015.

The workshop gathered together faculty members, industrial mathematicians, post-docs, and students to discuss careers and professional development for underrepresented minorities.

The keynote speech featured 2012 Blackwell-Tapia Prize recipient Ricardo Cortez (Tulane University) on the “Good Practices for a Marketable Future in the Mathematical Sciences,” in which he discussed opportunities to develop skills and experiences that are transferrable to a wider set of projects.

Cortez, along with Karen Ríos-Soto (University of Puerto Rico), also discussed the expectations leading to tenure evaluations in a workshop session and shared strategies and recommendations for achieving tenure.

“[But] if you don’t get a job in academia, there is still life after academia with jobs available in government or labs,” said organizer Cheri Shakiban, University of St. Thomas and former IMA associate director for diversity. These opportunities were discussed by a panel that included mathematicians from the National Security Agency, LMI Government Consulting, and Argonne National Laboratory.

Many participants expressed appreciation for the panel on the negotiation process, given by Ulrica Wilson (Morehouse College). Some speakers not only shared their research, but their past and how they got to their current position.

The workshop had ample time for participants to share personal experiences and suggestions, including an icebreaker dinner, table discussions during lunch, and a session on tips for success.

“I truly valued the networking opportunity, especially with those that have gone before us and understand the culture of the mathematical sciences,” said a workshop participant.


“I really enjoyed Ricardo Cortez’s keynote speech since he outlined a certain disposition for a career in the mathematical sciences that I think has never been addressed in the many conferences that I have attended.”

— WORKSHOP PARTICIPANT
Introduction to Uncertainty Quantification

The IMA held a two-week New Directions Short Course on Uncertainty Quantification (UQ) from June 15 to June 26, 2015.

According to organizers Luis Tenorio (Colorado School of Mines) and Youssef Marzouk (Massachusetts Institute of Technology), UQ lies at the confluence of many fields, including probability, statistics, data analysis, computational mathematics, and mathematical modeling. It touches upon almost any field that involves models, whether of natural or engineered systems, and data.

The objective of the course was to help participants from different backgrounds obtain the basic understanding and tools needed to use UQ in their fields of interest. In addition, the course presented snapshots of current research and examples of UQ in different application areas, so that the participants would be aware of methods that are in current use.

"Information gathered from data and interpreted through the 'lens' of a mathematical model is inevitably subject to uncertainties," Tenorio said. "Uncertainties result from the assumptions underlying almost any model, such as which interactions to include, how well physical processes can be resolved, what parameter values to use, and the fact that data are typically incomplete, noisy, and indirect. Prediction and decision-making based on such information then has to account for these uncertainties."

As someone on the applications side, this short course helped me know ways in which I can evaluate the shortcomings of the models that I create, where previously I only had an intuition that there were shortcomings in my models.” – WORKSHOP PARTICIPANT

A concrete (and extremely challenging) example is the impact of the Greenland and Antarctic ice sheets on sea level rise.

“One would very much like to predict how this process will affect the world’s oceans decades into the future, but making a reliable prediction requires assessing a host of uncertainties, associated with both current models and available data,” Marzouk said.

While UQ alone certainly cannot provide all the answers to such a complex question, assessing the reliability of such predictions is one of the larger goals of UQ.

The course was suitable for anyone involved in science and engineering applications and information-based decision making, and it brought together researchers from a wide range of disciplines, including applied mathematics, statistics, physics, computer science, and all fields of engineering. Nearly half of the workshop participants were graduate students and postdocs.

"This meeting has also provided good opportunities for collaborations," Tenorio added. "I have already been in post-workshop communication with two participants and hope to start collaborations with them."


Joint work between Matthew Parino (MIT) and Youssef Marzouk (MIT)
Math Modeling Provides Students with Experience in Industrial Research

In keeping with its mission to train the next generation of researchers for careers in industrial mathematics, the IMA offered two summer workshops specially designed to introduce math students to problems in applied and industrial mathematics.

In collaboration with the UMN Math Center for Educational Programs (MathCEP), the IMA reached out to the younger set in high school through its week-long math modeling camp. Sixty high school students participated in the camp that took place in July 2015. The camp joins the trend of showing K-12 students the practical power of math by having them apply it to real-world problems. The camp also serves to increase students’ confidence in science projects and classes, as well as understanding better how math and science are connected.

Now in its second year, the camp had twice as many students, all from Minnesota high schools. These students chose five projects to analyze: factors affecting bad air quality in Minnesota (as inspired by the smoke from Canadian forest fires that surrounded the Twin Cities in early July), light rail expansion in the southwest corridor of the Twin Cities metro area, placement of a new middle school in Wayzata, Minn., Minnesota’s ability to convert to 100 percent renewable energy, and size and placement of a stadium for Minnesota’s new Major League Soccer team that was awarded in March 2015.

“We had 15 groups present their work at the end of the camp, and while many students focused on small pieces of the broad questions we broached, they tried a variety of methods and learned a lot,” said organizer Daniel Schultheis, a postdoctoral fellow with MathCEP. “My favorite moment was talking with one group about the recommendations of their model. When asked why certain coefficients had been fixed in their model, they noted that they actually varied those coefficients significantly and always received the same result. The realization that their answer was only one solution but that it was broadly applicable is a big leap, and a huge success for a camp that’s only one week long.”

According to Schultheis, the students now feel like they have a much better grasp of how someone uses math to tackle difficult questions outside of a classroom.

The IMA was also pleased to host 40 graduate students for the 10-day Math Modeling in Industry workshop in August. This long-running workshop involves teams of graduate students led by industry mentors to analyze and attempt a solution to a real-world problem. Now holding its 19th such workshop in the last 23 years, the IMA has provided hundreds of graduate students with first-hand experience in industrial research. By the end of the workshop, participants express a marked increase in appreciation for interdisciplinary mathematics.

The workshop featured mentors from seven companies: Corning, CyberOptics, Hilti, IBM, Target, CGG, and IQB Information Technologies. Problems included deducing rock properties from spectral seismic data, detecting anomalies in digital photographs, analyzing design in the development of high-performance tools, and other engaging challenges. The workshop often features new and returning mentors.

“I have participated as a mentor in the IMA Math Modeling workshop several times in the past, and each time it has been such a rewarding experience that I look forward to returning to the IMA as a mentor. This year’s team is no exception,” said Chai Wah Wu, a researcher at IBM. “The team members are hard working with diverse expertise, and it has always been a learning experience—not just for the students, but for me as well. The students are exposed to problems, tools, and techniques researchers in industry are used to, and I get a chance to get a fresh perspective on a specific problem. I have been quite surprised by the novel ideas that get generated by the team.”

For first-time mentor Vera Nübel (Hilti), being an engineer and working with math students meant having to “translate languages,” or how to look at the same thing from a mathematical and an engineering perspective.

“For the students, it seems to be very interesting to discover how to apply their mathematical knowledge to ‘real life problems.’ Furthermore, they realize that they have a strong theoretical education and a comprehensive basis, which enables them to understand complex phenomena that arise in technical disciplines,” she said.

Math modeling is but one avenue that the IMA utilizes in addressing the scientific and technological challenges of the world and solving them with new and transformative mathematics.
The IMA Remembers Donald Kahn

The IMA was saddened by the passing of good friend and strong supporter Donald Kahn, a professor emeritus of mathematics at the University of Minnesota, on Friday, January 16, 2015.

Kahn was an early advocate and member of the committee that put together the 1979 National Science Foundation proposal that launched the IMA. The committee also worked on logistical issues and was responsible for securing the fourth floor of Lind Hall as dedicated space for the IMA.

Kahn’s research was in pure mathematics and algebraic topology. Even after retiring in May 2010, he remained engaged at the IMA and was particularly pleased when the IMA organized a year-long program on Scientific and Engineering Applications of Algebraic Topology in 2013-2014. He also regularly attended the Abel Conferences and the IMA Public Lectures, often carrying his Leica camera with him and taking photographs of mathematicians in action.

Most recently, Kahn served on the IMA’s Community Relations Committee. He believed so much in the IMAs mission that he single-handedly started the Eugene Fabes Directorship Fund in 2009.

“The IMA has played a major role in putting Minnesota and the School of Mathematics on the map worldwide, all the way from financial mathematics to category theory. I think that the IMA deserves to have endowment funds so that it may continue, regardless of the vicissitudes of politics and the economy,” Kahn said at the time.

His intention was for the fund to eventually pay for part of the director’s salary. For the past two years, Kahn also donated to the IMA in support of its K-12 outreach efforts.

“His wisdom and humor will be sorely missed at the IMA. Don was a mensch. Our thoughts are with Phyllis and the rest of his family,” said IMA Director Fadil Santosa.

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This publication/material is available in alternative formats upon request. Direct requests to Georgia Kroll, workshop coordinator, at kroll@ima.umn.edu.

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Mathematics and Optics
September 2016–June 2017

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Mathematical and Physical Models of Nonlinear Optics
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