

AIMATH

The Newsletter of the American Institute of Mathematics



Morgan Hill site...

...one big step closer

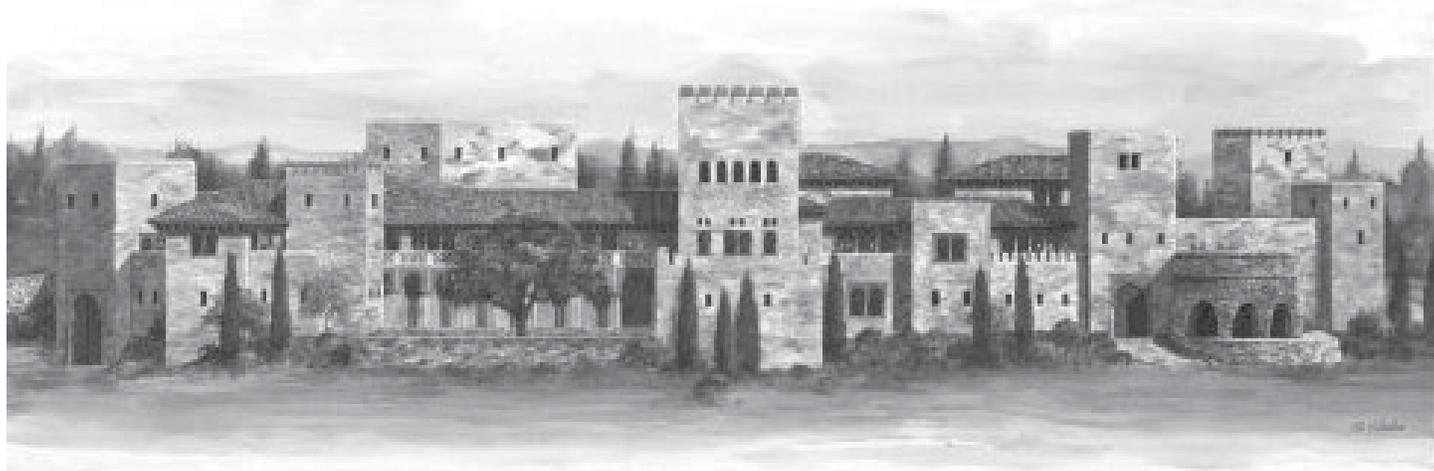
July 19 at 7:00pm was a dramatic moment for the American Institute of Mathematics. That was when the final hurdle to building “the Castle” in Morgan Hill was cleared. A unanimous vote from the Morgan Hill City Council approved the revised plans for the future home of AIM. We are now set to begin construction of our “Alhambra-style” math institute.

AIM Director, Brian Conrey, began the session with an overview of AIM’s mission, its scientific activities, and the broader benefits that AIM has brought, and continues to bring, to the Morgan Hill community. This was followed by an open floor session in which interested parties addressed the Council. Residents and community leaders spoke of AIM’s outreach efforts to their young people and to the local schools and the benefits

that AIM will bring to the community. Their testimonials were interwoven with those of approximately 18 research mathematicians from Stanford, Berkeley, San Jose State, and UC Davis enthusiastically describing the impact that AIM has had on cutting-edge research while fostering an environment that encourages collaboration. One rancher, whose family has raised cattle adjacent to the AIM property for several generations, compared our enterprise to Andrew Carnegie, Bill Gates, and Warren Buffett.

The next step is the demolition of the abandoned building that exists on the proposed site and the production of a detailed set of building plans. It is anticipated that the first programs will be held in the new facility in the fall of 2009.

The future home of AIM.



From the Director



This past year has been a very busy one for AIM. In this, our first newsletter, you can read about the highlights including the appointments of Steven G. Krantz as Deputy Director and Rachel Kuske as Associate Director for Program Diversity; the submission of a proposal to the National Science Foundation to continue our funding as one of the seven NSF Mathematics Institutes in the U.S. (be sure to visit the new Web site www.mathinstitutes.org); and the approval by the city of Morgan Hill of our plans for a beautiful 167,000 square foot conference center modeled after the Alhambra.

In addition, we held the first ever Math Mardi Gras!

This January will mark AIM's ninth anniversary in the "Math Warehouse" as some fondly call our location next to the Palo Alto Fry's Electronics store. The space was formerly the Fry's corporate headquarters when the electronics giant was in its infancy. This space, together with the innovative way that AIM approaches mathematical research, is particularly fitting for a Silicon Valley start-up.

In June we had our 50th focused workshop. More than 2000 mathematicians have attended one of our 5-day workshops which are AIM's hallmark. Their basic structure is "talks in the morning, work in the afternoon," a model which seems to offer the right balance of activities and is also easy to remember!

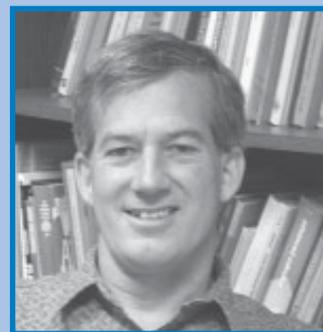
Afternoon workshop activities often include a problem or discussion session (in AIM's distinctive style), tutorials, or, what is one of the most interesting features of an AIM workshop: work in small groups. Our goal is to help new, productive collaborations to emerge from these modest beginnings.

The AIM style of workshop is a decided twist to the conventional mathematical wisdom that "if you gather mathematicians together, then some random interactions will occur and mathematics will happen." The AIM philosophy is more like, "if you gather mathematicians together, then ask them to formulate specific problems, divide them into smallish groups and set them working on the problems, even more mathematics will happen."

We want to preserve this feeling of a start-up as we plan our move to the "math castle" in Morgan Hill a few years from now. One thing that will help is that we have designed a room there that will be laid out much the same as our one large room here in the math warehouse in Palo Alto.

I hope you like our newsletter! Please feel free to send us suggestions of things you would like included in future issues.

—J. Brian Conrey



New AIM Appointments

The American Institute of Mathematics is pleased to announce the appointment of Steven G. Krantz and Rachel A. Kuske to the AIM Research Conference Center (ARCC).

Steven Krantz, an active researcher in several complex variables and distinguished author, has been appointed Deputy Director of ARCC. Having recently served as Chairman of Mathematics and Head of the Division of Natural Sciences at Washington University in St Louis, Krantz has also held academic



Steven G. Krantz, Deputy Director

positions at the University of California, Los Angeles, Princeton University, and Penn State University.

Awarded the Chauvenet Prize and Beckenbach Book Award from the Mathematical Association of America, Krantz has authored over 50 books on topics of complex variables, partial differential equations, geometry, general mathematics, as well as mathematical writing and education. Founder of *The Journal of Geometric Analysis*, Krantz is also a member of several editorial boards.

(Continued on page 3)

New AIM Appointments *(Continued from page 2)*

Rachel Kuske, a Canadian Research Chair in Applied Mathematics at the University of British Columbia, has been appointed Associate Director for Program Diversity at ARCC. Kuske has served on the faculties of Stanford University, Tufts University, and the University of Minnesota, where she was a McKnight Landgrant Professor and Associate Director of the Minnesota Center for Industrial Mathematics. Her research interests extend over a number of areas of applied mathematics including modeling in stochastic dynamics, mathematical finance, and mathematical biology.

Kuske is also on the editorial boards for the *SIAM Review* and the *SIAM Journal on Applied Mathematics* (SIAP) and was the founder and director for the Mentor Network of the Association for Women in Mathematics.



*Rachel A. Kuske,
Associate Director for Program Diversity*

More than Research

The American Institute of Mathematics participates in a variety of outreach activities, both in the Bay area and the Morgan Hill community. Among these programs is the Math Mardi Gras, held for the first time this year. Other programs, including Math Circles, Teachers' Circles, MathCounts, and the AIM public lecture series, will be featured in future issues of the newsletter.

Math Mardi Gras

In April 2006, AIM put on what we hope will become a new Morgan Hill tradition: the Morgan Hill Math Mardi Gras. Over 350 community members participated in this family-oriented event, which featured fun math activities and friendly competitions. The Morgan Hill Community Center was filled with students and their families playing SET, Sudoku and Math Jeopardy. Additionally, local junior high and high school students (hired by AIM) produced and ran booths which taught math concepts. Students enjoyed visiting the various booths, solving math problems, and attempting to become the king or queen of Mardi Gras. It was a fun day for the many involved families that Morgan Hill is fortunate to call its own!



More than 350 community members participated in the first, annual Math Mardi Gras at the Morgan Hill Community Center.

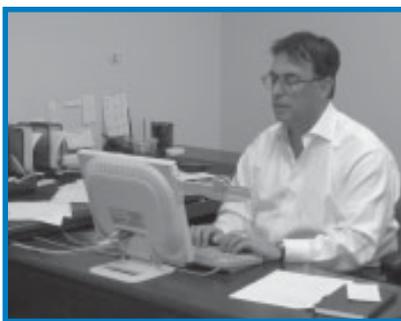


Queen and King of the first Morgan Hill Mardi Gras.

The Mardi Gras ended with a talk by Don Goldston of San Jose State University where he described his recent results about small gaps between primes. This work, together with Janos Pintz and Cem Yildirim, was listed by "Discover" magazine as one of the most important breakthroughs of 2005, putting us closer to solving the elusive "twin primes conjecture."

-Lori Mains

Workshop Snapshot



Deputy Director Steven Krantz provides a summary of recent ARCC workshops. The full text can be found at the AIM Web site www.aimath.org.

Free Analysis (June 19, 2006 - June 23, 2006)

Organized by Dimitri Shlyakhtenko and Dan Voiculescu

The theory of von Neumann algebras is a prominent part of theoretical mathematics and also of mathematical physics. It is the modern language for formulating ideas of quantum mechanics, and it is also the source of important ideas for modern analysis. The group that gathered at AIM this week consisted of a diverse collection of mathematicians—with broad-ranging interests—who wanted to be brought up to speed on fast-breaking new ideas in this subject area.

Of particular interest are techniques, pioneered by organizer Voiculescu, of developing a highly noncommutative parallel to classical probability theory and applying it to important structural problems of von Neumann algebras. (*continued ...*)

Calibrations (June 26, 2006 - June 30, 2006)

Organized by Robert Bryant, Xiaobo Liu, and Pit-Mann Wong

The theory of calibrations finds its genesis in a 1982 *Acta Mathematica* paper of Reese Harvey and Blaine Lawson. Both Harvey and Lawson attended the AIM workshop and both spoke on the morning of the second day. The spirit of calibrated geometry is to understand the structure of a manifold by studying a distinguished family of submanifolds. This approach leads to insights that are unavailable from the more classical points of view using coordinate charts or tensor fields. (*continued ...*)

Generalized Kostka Polynomials (July 24, 2006 - July 27, 2006)

Organized by Jennifer Morse and Anne Schilling

One of the fundamental ideas of modern algebra is that of the “symmetric polynomial”. A polynomial is *symmetric* if it is invariant under permutations of the variables. As an instance, the polynomial $x_1x_2 + x_2x_3 + x_1x_3$ is a symmetric polynomial of three variables. We wish to consider the ring $\Lambda = \Lambda[x_1, x_2, \dots, x_n]$ of symmetric polynomials in infinitely many variables.

There are many different bases for the ring Λ . Perhaps the most important of these is the Schur polynomials. We are interested in the relationship of Schur polynomials to partitions. (*continued ...*)

Effective Randomness (August 7, 2006 - August 11, 2006)

Organized by Denis Hirschfeldt and Joseph Miller

Let $\mathcal{A} = \{a_1, a_2, \dots\}$ be an infinite sequence of 0s and 1s. What does it mean to say that this sequence is random? If we are given two such sequences, then what does it mean to say that one sequence is more random than the other? These are fundamental questions, and are related to questions of computability theory. The connections between these two subject areas are the subject of the present workshop.

The idea of a random sequence finds its germ with A. Kolmogorov. Some say that he invented modern probability theory in order to deal with this problem.

(*continued ...*)

Call for Workshop Proposals

The American Institute of Mathematics is committed to developing productive collaborations among mathematical scientists. At the heart of what AIM does is to run about twenty-four workshops each year. For us, a workshop is a gathering of about thirty researchers in a particular area of mathematics for a week of intense study.

The AIM model for a workshop is unique. We encourage organizers to schedule relatively few lectures each day, and to set time aside for discussing open problems, new directions, etc. as well as working in smaller groups on particular problems.

The AIM staff, Brian Conrey, Steven Krantz, Rachel Kuske, and David Farmer, works closely with the organizers of each workshop to develop the program of activities for that week. There are three intensive conference calls preceding the workshop. During that time, the underlying goals of the workshop are defined, along with a plan for accomplishing them. The AIM staff also meets with the organizers regularly throughout the week of the workshop. We work with the discussion leaders and the problem-session organizers, and assist the organizers to evaluate the success of their goals. We also help to create a Web site which serves as an ongoing resource on the workshop's subject.

AIM is currently accepting proposals for workshops to be held in Summer 2007 or later. Instructions and an application form are available on the AIM Web site <http://www.aimath.org/ARCC/workshopproposals.html>.

The deadline is November 1.

The morning of Monday July 17, 2006, participants of the AIM workshop on “The Classification Theory for Abstract Elementary Classes” began to gather around a table in a shaded, landscaped patio of the Creekside Inn in Palo Alto, California for danishes and coffee. After the requisite catching-up and chitchat, a participant asked the question that was on the minds of many at the table, “So, Monica, what’s the plan? We didn’t receive a schedule yet.” How was I going to answer this? The truth is that only the two speakers for the first morning had been scheduled. At this point, I was not at all convinced that this minimalist, plan-as-you-go scheduling that the AIM staff suggested in our conference calls would work, so I was not in the position to start defending it. Instead of answering, I excused myself and headed to AIM for the brief meeting of the organizers and the AIM leadership to discuss plans for the day. As I began the short walk to the AIM research center, I couldn’t help but think that this workshop was going to be a disaster. How could a workshop or conference function without a schedule announced weeks in advance?

After receiving notification of the acceptance of our proposal, co-organizer Rami Grossberg and I had several conference calls with the leadership of AIM over the course of a year. The purpose of these calls was to set a date for the workshop to take place, to finalize the list of invited participants and to agree on a structure for the workshop. During each conference call, the AIM staff helped us to clarify the focus and the goals of our workshop. Rami and I proposed to bring together pure and applied logicians to work towards a solution to Shelah’s Categoricity Conjecture. This conjecture is not expected to be solved any time soon. However, hundreds of pages of partial results have accumulated throughout the years. Moreover, certain of these results played a crucial role in Boris Zilber’s model theoretic analysis of the complex numbers with exponentiation, involving also Schanuel’s Conjecture from transcendental number theory. Aside from Zilber’s work, there has been little connection between the abstract model theory of non-elementary classes and applied model theory. As organizers we hoped that by bringing together pure and applied model theorists, reciprocity would be established. The applied model theorists may guide the pure model theorists to cases of the categoricity conjecture of particular interest, and the pure model theorists may acquaint others to some of the new results of non-elementary model theory.

About a year in advance of the workshop, the AIM staff contacted the invited participants and began to advertise the workshop. David Farmer, the Director of Programming, constructed a webpage for the workshop which included an application form for interested participants. One ingredient of an AIM workshop is to welcome a diverse audience. The application process helps

Organizer’s Perspective



*An excerpt of the account of the “The Classification Theory for Abstract Elementary Classes” Workshop at AIM, July 17-21, 2006, by organizer, **Monica VanDieren**, Robert Morris University.*

facilitate this. Here diversity is measured in not only in the traditional metrics, but also in terms of area of expertise and level of experience of the participants. As an organizer (and a participant), I appreciated the application process since it opened up the workshop to interested mathematicians whom the organizers may have overlooked. In fact, the applicant pool expanded the breadth of the participants.

Up until a month before the workshop, we had only discussed the structure of the workshop. The organizers agreed not to deviate from the typical AIM workshop which involves at most two talks in the morning, followed by group activities in the afternoon. At this point we identified several topics that should be presented or discussed over the course of the workshop. Since our participant list included researchers from a variety of backgrounds, we decided to spend the first morning outlining the big picture and providing some background material. Aside from the first day, Rami and I did not set a schedule for the other topics. We took the advice to heart, agreeing that the flow of the workshop would govern the schedule for the remainder of the week. After choosing the topics of the talks, we then asked speakers to lead discussions and to lecture on these topics.

While comfortable with the lecture component of the workshop, my nervousness the morning of the first day was fueled by the uncertainty surrounding the problem session slated for the afternoon. In our morning organizational meeting, the AIM staff outlined the process. We would select one person to moderate the afternoon problem session. In this session the participants were asked to pose questions related to the goals of the workshop. The purpose was to identify problems that the participants could work on throughout the week. In practice, our afternoon session, while very productive in listing major open problems, did not provide the right level of focus to break up into groups and begin working on problems. It was tempting, especially for the experts including the organizers, to lose track of the goal of generating a list of questions and instead to engage in a debate

(Continued on Page 8)

“How could a workshop function without a schedule announced weeks in advance?”

AIM Fellows

Each year, AIM chooses a finishing graduate student to receive our Five-Year Fellowship. This year Elizabeth Meckes of Stanford University was selected as our ninth Five-Year Fellow. Elizabeth was a student of Persi Diaconis studying Probability.

The idea of having a Five-Year Fellow originated at the very first AIM event: the 1996 Seattle conference with the unwieldy title, “In celebration of the centenary of the proof of the prime number theorem, a symposium on the Riemann Hypothesis.” At that event there was a very unusual gathering: a round table discussion brainstorming about how the newly formed AIM might have an impact on mathematics. Sir Michael Berry suggested that supporting a brand new outstanding PhD in mathematics for 5 years of full time research would be valuable. He argued that England had such fellowships, that they were widely viewed as successful, and that AIM would do well to institute one. And so the AIM Five-Year Fellowship was born.

Soundararajan, now a Professor at Stanford, was the first Five-Year Fellow. The other three Fellows who have completed their terms are Henry Cohn, Microsoft Research, Vadim Kaloshin, Caltech, and Lenhard Ng, Duke University.

Current fellows, in addition to Meckes, are Frank Calegari, Mike Develin, Jacob Lurie, and Joel Kamnitzer.

In a total of 30 Fellowship years, our nine Fellows have written more than 60 papers!



*Elizabeth Meckes
AIM Fellow
2006*



A small part of the AIM Reprint Library near one of the sitting areas at the American Institute of Mathematics.

The Reprint Collection at AIM

The Reprint Library is one of AIM’s more interesting collections. More than 100,000 reprints can be found on AIM’s bookshelves assembled into the “Collected Works” of more than 5000 mathematicians. These volumes of “collected works” are housed in black, 3-ring binders; the author’s name is displayed on the spine, with the individual reprints placed in separate plastic protectors inside, much as an individual might sort a reprint collection in his or her private office.

These binders make for a nice browsing experience for AIM visitors. One can see the natural progression of ideas through an author’s sequential publications. Our reprint holdings can be found on our Web site: <http://www.aimath.org/library.html>

Many of our reprints are the result of generous donations. For example, AIM has received the entire reprint collection from the personal libraries of Gian-Carlo Rota, Samuel Eilenberg, S. Chowla, Emil Grosswald, Franklin Peterson, Abraham Robinson, Alfred Tarski, Paul Bateman, and Armand Borel. As you might imagine, we found some very exciting original reprints within these works.

AIM plans to build the most comprehensive reprint library in the world, and is constantly looking to enhance its collection. Please consider sending us reprints of your papers and updating your collections folder as you write new papers. Also, we would warmly welcome the donation of entire reprint collections to our library.

WANTED

* **Reprints** *

* **single authors** *

OR

* **collections** *

The Joint Math Meeting

Each January, more than 4000 mathematicians gather at the annual meeting of the American Mathematical Society and the Mathematical Association of America. In 2007, the Joint Meeting will be held in New Orleans. AIM uses this opportunity to spread the word about its activities and to generate interest in ARCC's workshops.

Brian Conrey, Steven Krantz, and David Farmer can be found at the AIM booth in the exhibit area, and are happy to talk with people about AIM and its programs.

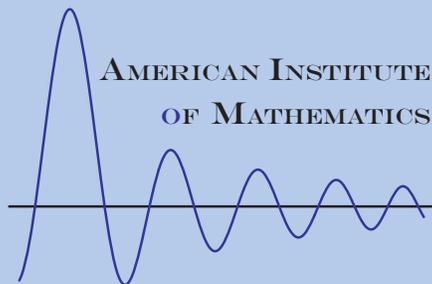
AIM also joins in hosting the Mathematics Institute Open House reception. This event is open to all conference participants and provides another venue to learn about each institute's programs and to meet with institute members. Please join us at the Institutes' Reception, 5:30 - 8:00 p.m., Friday January 5 at the Sheraton New Orleans.

Please join us at the
*Mathematical Institutes'
Open House Reception*



*Friday, January 5, 2007
5:30 P.M. - 8:00 P.M.*

Sheraton New Orleans



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OF MATHEMATICS

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Conference Center Renewal

AIM is one of seven federally funded mathematics institutes across the country. Others are MSRI in Berkeley, IPAM in Los Angeles, SAMSI in North Carolina, IAS in Princeton, MBI in Columbus, Ohio, and IMA in Minneapolis, Minnesota.

Like all other institutes, AIM is funded by the National Science Foundation (NSF) for a period of five years at a time. The summer of 2007 will mark the end of AIM's first funding cycle, and as such, a proposal for a further five years of support was submitted in late spring this year.

The proposal highlighted the unique style of AIM workshops in the context of fos-

tering long-term collaborations. In addition to requesting continued support for its workshop program, the new SQuaREs initiative was proposed. This exciting new program brings together small groups of 4 to 8 researchers for intensive periods of work over the course of several years. These more focused collaborative efforts are a natural extension of AIM's workshop approach, and introduce the next phase in AIM's vision of collaborative research.

AIM's renewal proposal has since been reviewed with the recommendation for a site visit by a team of external reviewers. The site visit will occur in early September, after which the NSF will make its final decision.

ARCC's first workshop: The Perfect Graph Conjecture. November, 2002



“Until the workshop, examples of non-trivial abstract elementary classes were sparse...”

about the history, motivation, practicality and solvability of major open problems. After a half hour of intense discussion, but with only one problem on the board, I decided to call a time-out on the debate about the failure of the amalgamation property. A new problem was posed and several others followed. Although the problems discussed on Monday afternoon were not appropriate for group work throughout the week, the afternoon session provided the big picture of the field. A graduate student took notes on this session and distributed them the next day. A final copy will soon be available on the workshop website.

The AIM staff observed our problem session and made suggestions for the following day on how to conduct an afternoon session targeted at identifying problems for the working groups. In part because of AIM's recommendations and in part because the participants now had the big picture and had time overnight to think of interesting short term directions of research, Tuesday's problem session produced eight problems suitable for working groups. In the end, four were chosen and the participants divided into groups to work on these problems for the remainder of the afternoon.

By happy hour on Tuesday, I was more relaxed about the outcome of the conference. The hour buzzed with word that two of the working groups had identified several examples of fields and groups and had initiated a model theoretic classification of these examples. Up until the workshop, examples of non-trivial abstract elementary classes were sparse, but after only two days at AIM, there was new excite-

ment and a promise that a substantial body of examples exists. It had also become clear to the organizers what the best topics for the morning lectures were, and we began to create a schedule for the remainder of the week. Another wave of chatter over happy hour surrounded work of Alexei Kolesnikov. There was sufficient interest and a connection to one of the working groups for Alexei to present his work in detail. Although not originally part of the workshop plan, it was very manageable to add an additional talk by Alexei on Thursday afternoon because of the flexible scheduling. After the two Thursday morning talks, participants interested in Alexei's work headed over to Fry's Electronics next door for a quick lunch at noon and returned to AIM for Alexei's discussion. Afternoon working group activities were uninterrupted.

Not every working group was a complete success. In fact one group, shortly after forming on the first day, dissolved after it was apparent that the question for this group was already solved. A quick conversation with Brian Conrey (Director) established a plan to form one new working group the following day. On Wednesday afternoon, after short progress reports of the Tuesday group activities, one new problem was identified and most participants reengaged in their working group activities from Tuesday.

A total of four working groups ranging from two to six participants each gave detailed progress reports on the last day of the workshop. Summaries of the results from each working group were commissioned and are currently in the process of being composed and distributed to all the

workshop participants as well as being placed posted on the workshop's Web site. There was enough enthusiasm on the last day to continue the collaborations of two of the four problems. David Farmer joined the crowd as suggestions were made for technical methods to accommodate ongoing collaborations in and among the groups beyond the workshop and to disseminate the results of the workshop to the mathematics community.

In retrospect, on that Monday morning on my way to AIM, I had many reasons not to worry. Foremost was the experience of the AIM leadership that had overseen over sixty workshops, many of which have been acknowledged as instrumental in promoting new and constructive collaborations and facilitating solutions to open problems. As I look back on my week in Palo Alto, I attribute the success and productivity of our workshop to the guidance of the AIM staff, to the small but diverse group of passionate participants and to the flexibility that came from a minimalist schedule with two semi-formal talks per day. This shouldn't be too surprising; after all, do we really stick to a rigid schedule throughout a typical workweek as we conduct our own research? Can we get much research done if our schedule is booked with back-to-back seminars and teaching? In much the same way, little research takes place at typical conferences and workshops structured around rigid, dense schedules with too many participants and lack of focus. I am grateful of the opportunity and guidance that AIM provided to me and to the logic community with this rewarding workshop, and I look forward to continuing the collaborative research initiated at this workshop.

“...but after two days at AIM, there was new excitement and a promise that a substantial body of examples exists.”



**The American Institute of Mathematics
thanks
Fry's Electronics
for its continued support of our vision.**

American
Institute of
Mathematics

invites applications for the

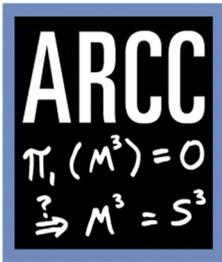
AIM Five-Year Fellowship

The Fellowship will support an outstanding new PhD pursuing research in an area of pure mathematics. It will cover 60 months full-time research as well as funds for travel and equipment. Mail applications to:

AIM Five-Year Fellowship
American Institute of Mathematics
360 Portage Avenue
Palo Alto, CA 94306

All materials should be received by December 31, 2006 for consideration of an award to be made by January 31, 2007. This Fellowship is for new PhDs: candidates expecting to receive a PhD in the year 2007 are eligible to apply. An application consists of a cover letter, a vita, 3 letters of recommendation, and a research plan.

For more information visit **www.aimath.org**



American Institute of Mathematics Research Conference Center

The AIM Research Conference Center (ARCC) hosts week-long focused workshops in all areas of the mathematical sciences. ARCC focused workshops are distinguished by their emphasis on a specific mathematical goal, such as making progress on a significant unsolved problem or examining the convergence of two distinct areas of mathematics. Workshops are small in size, up to 32 people, to allow for close collaboration among the participants.

Call for Proposals

Proposals are sought for workshops which will take place in 2007 - 2008.

Proposals require:

- a list of organizers
- a list of potential participants
- a description of the workshop goals
- an outline of how these goals will be met

Proposals will be accepted until November 1, 2006.

Workshops will be held at AIM in Palo Alto. More details, and an online application, are available at:

<http://www.aimath.org/ARCC>

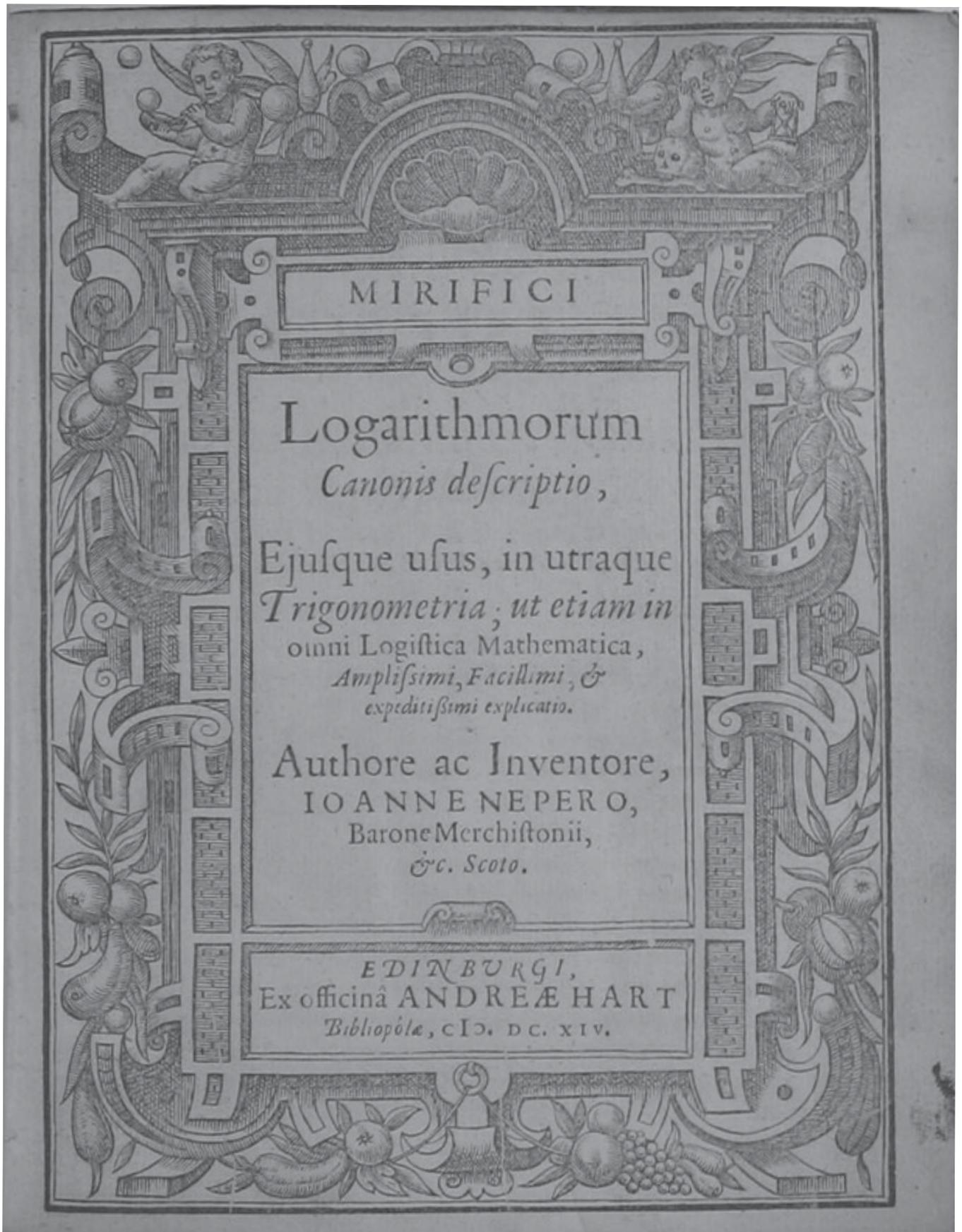
ARCC seeks to promote diversity in the research mathematics community. We encourage proposals which include significant participation of women, underrepresented minorities, junior mathematicians, and researchers from primarily undergraduate institutions.



The future home of ARCC in Morgan Hill, California

Major funding for ARCC is provided by a grant from the National Science Foundation.

Collection Highlights



Napier, John. *Mirifici logarithmorum canonis descriptio*... Edinburgh: 1614

First edition of Napier's invention of logarithms, bound in a contemporary vellum binding