ICM 2002 in Beijing

The 2002 International Congress of Mathematicians (ICM), held in Beijing, China, August 20–29, 2002, was full of firsts. It was the first time an ICM was held in a developing country. It was the first time the top governmental official of the host country came to the ICM opening ceremonies. And for many of the mathematicians attending the congress, it was their first trip to China; even for those who had been to China before, the tremendous changes the country has gone through in recent years made it seem like a new place. The warmth and enthusiasm of the Chinese organizers reflected not only the country's long-standing reverence for learning and knowledge but also its recognition that strengthening China's scientific research capacity is critical to the country's future development. "This was a very special and indeed unique ICM," said Jacob Palis, president of the International Mathematical Union.

With 4,260 registered participants, this was the largest ICM ever held. A total of forty-six satellite conferences—also a record number—drew about 4,000 participants, half of whom also attended the congress. The satellite conferences were held all over Asia, including in Shanghai, Tianjin, Hanoi, Kyoto, Lhasa, Macau, and Taipei; one was even held in Moscow. About half the ICM participants were from developing countries, including about 1,700 Chinese mathematicians. Around US$126,000 collected through donations by AMS members went toward travel grants that allowed about eighty young mathematicians from developing countries to attend the ICM. The congress was held at the Beijing International Convention Center, located in the northern part of the city near the sports complex built for the Asian Games that were held in Beijing in 1990.

Throughout the congress there were clear signs of the significance China attached to the ICM. One example was the opening ceremonies, held in the Great Hall of the People in Tiananmen Square; were Washington, DC, the host city, this would be equivalent to holding the opening ceremonies in the Capitol building. A convoy of about one hundred buses ferried participants and accompanying guests from the convention center to the Great Hall. Hundreds of police officers stationed on streets and highways, sometimes in locations that put their personal safety at risk, held back the city's teeming traffic to let the convoy through on the approximately 30-minute drive to the Great Hall.

Security in the Great Hall was tight, and all visitors had to pass through metal detectors; items like pocket knives were discovered and confiscated, to be returned at the end of the ceremonies. Participants were given assigned seats in the auditorium, which can hold 10,000 people. In the balcony the crowd was filled out by a horde of Chinese school kids in T-shirts bearing the words "I want to be a mathematician". On the stage in the auditorium were various IMU dignitaries, a number of Fields Medalists, Nobel laureate John Nash, and members of the local organizing committees, as well as the congress president, Wenjun Wu of the Chinese Academy of Sciences, and honorary president, Shiing Shen Chern of the Nankai Institute of Mathematics. The crowd erupted in applause when Jiang Zemin, president of China, came

Left to right: Fields Medalist Vladimir Voevodsky, President of China Jiang Zemin, IMU President Jacob Palis, and Fields Medalist Laurent Lafforgue.

onto the stage and took his seat between Chern and Palis.

Jiang was originally trained as an electrical engineer and is said to have a keen appreciation of mathematics. Unlike what one might expect from a politician, he did not rush in to give a speech and rush out again. Rather, he sat and listened for ninety minutes. He stirred from his seat only to present the Fields Medals to Laurent Lafforgue of the Institut des Hautes Études Scientifiques and Vladimir Voevodsky of the Institute for Advanced Study in Princeton. At that moment, triumphal music played on the public address system as a crowd of photographers and camera operators surrounded the Fields Medalists and the president, making it impossible for the audience to see. The Nevanlinna Prize was treated as a lesser honor; it was presented to Madhu Sudan of the Massachusetts Institute of Technology not by the Chinese president, but by IMU secretary Phillip Griffiths without any accompanying music and without such a large phalanx of photographers.

In his speech at the opening ceremonies, Palis pointed out the significance of holding the ICM in a country that is home to one-quarter of all humanity. "This makes the ICM more inclusive, and inclusiveness is a basic principle of the IMU," he said. Others spoke of the need to improve the level of mathematics research in China as the country modernizes. In a speech on behalf of the Chinese government, vice premier Lanqing Li stated the government's aim to make the country into a world-class mathematical power in the early twenty-first century. Other speakers included the president of the China Association of Science and Technology and the mayor of Beijing. After a break, brief talks on the work of the Fields Medalists and the Nevanlinna Prize winner were presented: Gérard Laumon (Université de Paris-Sud) spoke about the work of Lafforgue, Christoph Soulé (Institut des Hautes Études Scientifiques) about the work of Voevodsky, and Shafi Goldwasser (Weizmann Institute of Science) about the work of Sudan. A "reception" after the opening ceremonies turned out to be an elaborate multicourse sit-down banquet for 5,000 people. For the bus trip back to the convention center, the police once again stopped traffic as night fell on the city.

Awash in Publicity

Because of the appearance of the president, the opening ceremonies were heavily covered by the Chinese media. But the media's interest did not stop there; according to Zhiming Ma of the Chinese Academy of Sciences, who served as chair of the ICM local organizing committee, Chinese television and newspapers began carrying mathematics-related stories when the satellite conferences began on August 10 and continued coverage throughout the congress. "They were very enthusiastic to report on the ICM," he noted. "The main purpose [of the ICM publicity effort] was to make the public aware that mathematics is important and has many applications in society. In this we were successful." There were several airings of television programs about Chern and about S.-T. Yau of Harvard University, who is the only Chinese Fields Medalist. Also appearing on television were the Chinese mathematician Gang Tian, who holds the J. Simons professorship at the Massachusetts Institute of Technology, and John Nash.

In fact, Nash's arrival at the congress headquarters hotel was a media event. Hours before, the hotel had laid down a red carpet stretching from the lobby to the elevators. To prevent it from getting dirty, the carpet was taped over with old tattered pieces of cloth, which were whisked away before Nash and his wife, Alicia, arrived. When they arrived bearing several bouquets of flowers that apparently had been presented to them at the airport, they were immediately besieged by photographers, camera operators, and technicians with klieg lights. Later on during the meeting Nash gave an evening lecture aimed at the general public, for which students began lining up an hour early in order to get good seats.

The esteem in which mathematicians were held was extraordinary. One ICM speaker, Gregory Lawler of Cornell University, did some tourism in Wuhan before arriving in Beijing. The tour guide had heard about the congress, and when she found out Lawler was one of the speakers, he recalled, "She apologized to me for not having treated me with more respect." Stephen Hawking, who came to China for a satellite conference, gave a public lecture in Beijing before the ICM and also met with President Jiang. News of Hawking's lecture spread widely: When he was in Taiyuan before the ICM, Tian chatted with a

car driver hired by the university there. The driver said he had given his son 1,000 yuan to travel to Beijing to hear Hawking's lecture. One thousand yuan, about US$125, could be a month's wages for this driver. "That kind of thing is not organized," Tian noted, but rather is a spontaneous reaction on the part of ordinary people. But are people simply dazzled by the fame and celebrity of someone like Hawking? "That is not the basic reason," Tian replied. "The basic reason is that people here pay a lot of respect" to those who have made great achievements in science.

As Tian pointed out, the Cultural Revolution of the 1960s and 1970s sought to destroy the Confucian tradition but did not succeed in eliminating it. The Confucian view that "study is above all else" remains strong in China today and is the source of the country's profound respect for intellectuals. Also, China has come to recognize that building its science and technology base is crucial for the country's future development. The government has selected a number of scientific areas to emphasize, one of them being mathematics. Part of the reason for choosing mathematics is the low cost of funding mathematics research, and part is the enabling role mathematics plays in science and technology. One sign the government is serious about this goal is the recent doubling of funding for mathematics research by the main Chinese science funding agency.

There are other indications in China of this new emphasis on mathematics. One is the governmental support for the ICM, which came to US$1.2 million, more than the organizers were originally promised (an ICM host country is expected to raise about $1 million). Through a program organized by the education ministry, Chinese scientists who work abroad are brought back to China for a few months a year to organize courses and to stimulate research; Tian participates in this program through Peking University. International mathematics institutes are growing: in addition to the Morningside Institute for Mathematics, which is part of the Chinese Academy of Sciences in Beijing, there is the Nankai Institute in Tianjin, where a new building is under construction and will be completed in fall 2004.

But the level of mathematics research in China is "still far from the top," Tian said. "We need a lot of time to catch up." One of the reasons is that many good young mathematicians have gone abroad to work. Indeed, it is still common for good Chinese students in mathematics to leave the country to get Ph.D.'s, because the opportunities abroad are so much better. Nevertheless, the outlook is improving, and the ICM is a bright spot. "The ICM will have a very positive impact on Chinese mathematics," Tian said. "For example, it will attract a lot more young people into mathematics. Then the problem is how we make them into first-rate mathematicians."

Speech by Shing Shen Chern

At the opening ceremonies of ICM 2002, Shiing Shen Chern presented the following speech.

It is my great pleasure to welcome you to this gathering. We are in an ancient country that is very different from Western Europe, where modern mathematics started. In 2000 we had a mathematics year, an effort to attract more people to math. We now have a vast field and a large number of professional mathematicians whose major work is mathematics. Mathematics used to be individual work. But now we have a public. In such a situation a prime duty seems to be to make our progress available to the people. There is clearly considerable room for popular expositions. I also wonder if it is possible for research articles to be preceded by a historical and popular introduction.

The net phenomenon could be described as a globalization. It is more than geographical. In recent studies different fields were not only found to have contacts but were merging. We might even foresee a unification of mathematics, including both pure and applied, and even the possibility of the emergence of a new Gauss.

China has a long way to go in modern mathematics. In recent contests of the international mathematical Olympiad, China has consistently done very well. Thus China has begun from the roots and China has the advantage of "number" (of people). Hopefully this congress will be a critical point in the development of modern math in China.

The great Confucius guided China spiritually for over 2,000 years. The main doctrine is "仁"pronounced "ren", meaning two people, i.e., human relationship. Modern science has been highly competitive. I think an injection of the human element will make our subject more healthy and enjoyable. Let us wish that this congress will open a new era in the future development of math.

Human Rights Issues

The human rights record of the Chinese government drew some attention before and during the ICM. Joel Lebowitz of Rutgers University is chair of the AMS Committee on Human Rights of Mathematicians and a cochair of the Committee of Concerned Scientists (CCS), which addresses issues of human rights and scientific freedom. Before the congress Lebowitz sent an email message to all ICM speakers suggesting ways of registering human rights protests, such as putting up a transparency listing names of Chinese scientists whom the CCS believes have been unfairly imprisoned. This email was also signed by Joan Birman of Columbia University and Louis Nirenberg of the Courant Institute at New York University.

Closing Remarks by Edward Witten

Edward Witten of the Institute for Advanced Study presented the last lecture of ICM 2002. At the end of his lecture he made the following remarks.

All of us here at ICM 2002 love mathematics and science for their beauty and because we love to understand things. Mathematics and science are also important in society for many reasons. They are the basis for the technology that is so important in the modern world. Mathematics and science also require and help to develop the sort of independent, critical thinking without which the emergence of the modern world would scarcely have been possible.

As the largest country and the most rapidly developing country in the world, China can play a very important role in the development of mathematics and science. Thus, it is fitting that ICM 2002 was held here. All of us foreign guests at ICM 2002 are grateful to our Chinese hosts for arranging this wonderful conference and for giving us the opportunity to visit this wonderful country, to see so many of the historic monuments, and to witness some of the rapid development and progress occurring in this country, which even for those who have read about it before is extremely eye-opening to see. Many of us leave with a feeling of regret that our visits are coming to a close and a hope that we have a chance to come back soon and to witness further progress in this country. I'm sure you will all want to join me in wishing our Chinese hosts and all guests from around the world all health, prosperity, and success in science and a future of peace, democracy, and freedom.

When asked whether they planned to follow these suggestions, some speakers indicated they would not, partly out of a desire not to be rude to their Chinese hosts and partly because they did not believe they knew enough about the human rights cases. One speaker in the differential geometry section, Hubert Bray of the Massachusetts Institute of Technology, explained why he opted not to register a human rights protest: "The situation in China is very complex, so I defer to my Chinese mathematician friends as to what should be done regarding the peaceful promotion of democracy and human rights."

Paul Biran of Tel Aviv University, who also spoke in the differential geometry section, said that he had seriously considered whether to make a protest and spent some time looking into the human rights cases the CCS had identified. In the end he decided not to make a protest because he thought it would be ineffectual and could end up causing difficulties for the ICM organizers, who are not at fault. Still, he was uncomfortable. "My concern is that [the Chinese government] might be using us for propaganda," he said. By playing host to a large mathematics conference, China may be hoping to burnish its image abroad. "Why should we play into this?" Biran asked.

From what could be gleaned by querying speakers and participants, it appears that the only speaker to make a direct protest in a lecture was Harry Kesten of Cornell University, who gave a plenary talk. At the end of his lecture he put up a transparency listing the names of some Chinese people who are either scientists or associated with science (one, for example, was identified as a webmaster) and whom he said had "received long jail sentences for peaceful activities." Later Kesten said that he had encountered little reaction to his statement, though he heard secondhand that a Chinese friend had confessed to being shocked. "Of course it is a bit rude," Kesten said, "But I wanted to say it, for myself."

Edward Witten of the Institute for Advanced Study made remarks at the end of his plenary lecture that some saw as an indirect statement about human rights in China. Mixed in with gracious thanks for the hospitality of the Chinese, he pointed to the "independent, critical thinking" that is needed in mathematics and science. He ended his remarks by asking the audience to join him in wishing everyone "a future of peace, democracy, and freedom." (The complete text of Witten's remarks appears in a sidebar.) Witten's lecture was the last of the congress, and his closing statement was greeted by great applause. One participant called the diplomacy and elegance of the statement "very Chinese."

A different kind of protest was presented by Lafforgue, who gave the first plenary lecture of the congress. He began his lecture by saying that he would prefer to speak in French, his "beloved language," which has played a great role in all fields of human culture, including mathematics. "The present domination of the whole world by a single country—whatever its merits—by a single culture and by a single language can be very destructive of diversity of thought," he said. But because most Chinese mathematicians do not understand French, Lafforgue struck a compromise: he spoke in English, with two sets of transparencies, one in French and one in Chinese. He then went on to present, in terms accessible to a general mathematical audience, the quite technical work that won him his Fields Medal, namely, the solution of the global Langlands correspondence for function fields.

Connections in Mathematics

By and large the plenary lecturers at the ICM succeeded in their efforts to communicate to an audience of nonspecialists. As is to be expected, the level in the section lectures was much more variable. Although they were admonished by the ICM organizers to present talks for a general audience, the section lecturers faced a dilemma. Part of the

audience for a section talk is made up of nonspecialists, but part consists of other section speakers in closely related areas—in other words, some of the top mathematicians in the world in that particular branch of mathematics. Devising a talk suitable for both components of the audience is a formidable task, and many of the talks appealed only to specialists. But there were exceptions. For example, Stephen Bigelow of the University of Melbourne in Australia (now at the University of California, Santa Barbara) presented a very clear explanation of his elementary proof that braid groups are linear. In his doctoral thesis two years ago, Bigelow gave a proof of this result using homological topology. Now he has boiled the proof down to one that uses only basic combinatorial arguments in topology. That such an elementary proof was not found earlier is surprising, for it had been suspected for a long time that braid groups are linear.

In keeping with ICM tradition, the prizewinners who had not been invited to speak on the regular program—in this case Voevodsky and Sudan—were asked to speak in sessions arranged on-site. Both had spoken at the 1998 ICM in Berlin: Voevodsky as a plenary lecturer and Sudan as a section speaker. At the Beijing congress, the room for Voevodsky's talk was overflowing with people who were treated to an exceptionally clear account of his highly technical work on cohomology theories. That Sudan's Nevanlinna Prize-winning work stands at the center of theoretical computer science could be seen in the topics of the talks in the section on mathematical aspects of computer science, where probabilistically checkable proofs, combinatorial optimization problems, and the question of whether P equals NP were prominent themes.

Kesten's lecture on critical points in percolation theory was among the most accessible of the plenary talks. Given a graph on which vertices are colored black or white with a certain probability, percolation theory studies connected clusters of same-colored vertices. This kind of model has been used to simulate, for example, the spread of disease, but the most important uses have come in statistical physics. Percolation models are the simplest ones to exhibit phase transitions, which have been intensively studied for a long time. Kesten commented that the hunt for the so-called critical probability, which marks the exact point of the phase transition for a percolation model, slowed the field down for twenty years and yielded few results, mostly pertaining to symmetric graphs. Kesten surveyed some of most important work in the field, leading up to the recent ground-breaking results in 2001 by Stanislav Smirnov, who proved what physicists had surmised through nonrigorous arguments: that the scaling limit of critical percolation on the triangular lattice is conformally invariant (and, in particular, limits of crossing probabilities are conformally invariant). Other recent work by Gregory Lawler (who spoke in the probability and statistics section), Oded Schramm, and Wendelin Werner has led to important new insights.

Noga Alon of Tel Aviv University gave an exceptionally clear lecture surveying some results in discrete mathematics. Many early results in this area were found by ingenuity and clever tricks, but as the area has matured, more sophisticated tools have come into play. Alon described two of these: namely, algebraic techniques and probabilistic methods. He also discussed the close connections between discrete mathematics and computer science and the use of computers to solve mathematical problems, such as the four-color theorem. He predicted that computers will be used more and more in proving results in discrete mathematics and said that care is needed to integrate the use of computers so that this area of mathematics does not lose its "special beauty."

Connections between different areas of mathematics formed a theme running through many of the talks at the congress. Michael J. Hopkins of the Massachusetts Institute of Technology presented new results on "topological" modular forms, which are a topological version of the usual notion of modular forms and which bring closer together ideas from topology and algebra. Hopkins discussed how topological modular forms have provided new insights into the homotopy groups of spheres. Douglas Arnold, director of the Institute for Mathematics and its Applications at the University of Minnesota, described how the use of differential complexes, such as the de Rham complex, has unexpectedly provided new insights into the stability of numerical methods for solving partial differential equations. It turns out that differential complexes provide hints about the geometric structures underlying these methods. As the closing talk of the congress, Witten's plenary lecture described some of the exciting connections between physics and mathematics that have stimulated so much research in recent decades. He discussed singularities in string theory, combining a broad-brush conceptual picture that everyone could appreciate with more technical asides aimed at specialists.

In addition to Nash's evening lecture, there was another lecture for the general public, given by Mary Poovey, Samuel Rudin University Professor of the Humanities and director, Institute for the History of the Production of Knowledge, New York University. In her talk "Can Numbers Ensure Honesty? Unrealistic Expectations and the U.S. Accounting Scandal" she described ways in which mathematics, through accounting schemes and financial modeling, has been used to lend an aura of

objectivity and precision to representations of financial instruments. Her lecture, containing as it did some cautionary tales for the developing financial markets of China, was greeted with great interest and enthusiasm. (Poovey's lecture appears in this issue of the *Notices,* pages 27–35.)

The scientific program of the congress ran from 8:30 a.m. until 6:00 p.m. for eight days. When brain cells gave out, there were plenty of other things to do. Many participated in tours to sites in and around Beijing, such as the Forbidden City and the Great Wall. An excursion to the Peking Opera was arranged for one night, and on another night there was a variety show featuring acrobats. For the ICM party, held midway through the congress, a huge buffet of Chinese specialties was set up on a couple of acres of lawn across the street from the convention center. Other events at the congress included an international symposium on the history of Chinese mathematics, held at the China Science and Technology Museum. The museum also hosted a special exhibit of ancient Chinese mathematical toys. A panel discussion on electronic publishing, sponsored by the IMU Committee on Electronic Information and Communication, drew some lively exchanges, reflecting the struggles within the international mathematical community to come to grips with how new technologies are influencing the archiving and distribution of the mathematics literature. An event called the Juvenile Mathematics Forum was organized by the Chinese Mathematical Society, the Chinese Education Society, and the China Juvenile Science Academy. The forum brought about three hundred middle and high school students from all over China to the ICM for the opening ceremonies and three days of activities.

Two ICM volunteers, Chen Dawei and Yu Pin, undergraduate students at Peking University.

ICM Student Volunteers

One aspect of the congress organization that contributed greatly to the special warmth and hospitality of the Beijing ICM was the contingent of approximately three hundred student volunteers. They fulfilled myriad roles. For three days preceding the congress they were stationed at the Beijing airport to greet arriving participants and bring the participants to special buses going to the convention center. They worked at the registration desk and administered the couple of hundred workstations set up to provide ICM participants with access to email. And throughout the congress they were at hand to answer any kind of question and to provide translations between Chinese and English.

The majority of the student volunteers were undergraduate mathematics students from Peking University, and some also came from outside of Beijing. For many of the students the congress provided a good chance to practice speaking and understanding English, as well as an opportunity to attend talks and to meet mathematicians from all over the world. Chen Dawei and Yu Pin, both undergraduates at Peking University, were two typical volunteers. Dawei said that it was hard for him to understand most of the mathematics talks, but he liked to "feel the atmosphere" of a big international mathematics meeting. "I listened to some talks and couldn't understand them," Pin agreed. "But after this I really have a desire to study more math." This year he will begin graduate work in Paris, at the École Polytechnique. Dawei said he plans to apply to universities in the United States.

The volunteers realize that attending the ICM "will influence their future," Ma remarked. "They are very proud" to work at the congress. The volunteers' heartfelt enthusiasm and respectfulness provided a window on some of the contrasts between Chinese young people and young people in the West. Jean-Michel Bismut of Université Paris-Sud, who is a member of the IMU executive committee, commented that China knows its future depends on developing its knowledge base. "They have real needs," he said. "We in the West are trying to create needs." As a result, young Chinese have a drive and ambition that young people in the West seem to lack. What does this mean for the future of mathematics? Referring to China, Bismut said, "Maybe our future is here."

—Allyn Jackson