International Congress of Mathematicians 2006

Left to right: Nevanlinna Prize winner Jon Kleinberg, Fields Medalist Terence Tao, King Juan Carlos, Fields Medalist Andrei Okounkov, Fields Medalist Wendelin Werner.

John Ball, president of the International Mathematical Union, stood before an audience that included not only a few thousand mathematicians but also close to one hundred fifty representatives of the media and perhaps a dozen television cameras. The date was August 22, 2006, and the occasion was the opening ceremony of the twenty-fifth International Congress of Mathematicians (ICM) in Madrid, the first ever held in Spain. On the stage with Ball was Juan Carlos, the king of Spain, who attended in order to present the Fields Medals. Ball announced the medalists in alphabetical order, the first one going to Andrei Okounkov. On a screen above the stage appeared a photo of Okounkov smiling enthusiastically, and the one-sentence citation of the Fields Medal committee. After Ball had read the citation and the audience began

applauding, Okounkov mounted the stage and accepted his medal from the king.

The screen then switched to the imposing stare of Grigory Perelman, shown in a photo that has since been displayed in countless newspapers, magazines, and websites. As soon as Ball said Perelman's name, the audience broke into loud applause, not waiting for the citation. After the applause died out and he had read the citation, Ball stated, "I regret that Dr. Perelman has declined to accept the medal." Although Perelman had been widely rumored to be a front-runner for a Fields Medal this year and many had anticipated that he might refuse to accept it, a degree of shock nevertheless greeted Ball's announcement. How could someone refuse a Fields Medal, the most illustrious honor in mathematics? A wave of nervous applause flitted through the hall, and then there was silence. After a brief pause, Ball went on to announce the other two Fields Medalists, Terence Tao and Wendelin Werner. They accepted their awards in person, as did Jon Kleinberg, winner of the Nevanlinna Prize. Kiyoshi Itô, the 91-year-old winner of the newly established Gauss Prize, was unable to attend for health reasons. Itô's daughter accepted the prize on his behalf.

Ball, the honorees, and the others who were to speak at the opening ceremony had gone through a rehearsal the day before to ensure everything would go without a hitch, especially regarding royal protocol. One Fields Medalist jokingly asked whether it would be okay if, after receiving the medal from the king, he tore off his shirt and ran around the hall like David Beckham might do in a Real Madrid game. Had he done so, he might have drawn some of the limelight from Perelman, who to the frustration of many, nearly eclipsed the other prizewinners. It was the extraordinary story of Perelman that made the ICM 2006 a historical

event and brought the topic of mathematics into television broadcasts, radio programs, newspapers, magazines, and webpages all over the world.

Why Did Perelman Refuse the Medal?

At a press conference after the opening ceremony, Ball said that in June he had spent two days in St. Petersburg talking to Perelman in an effort to get him to accept the medal. Perelman was unfailingly courteous but steadfast in his refusal. Concerning his reasons, Ball explained that Perelman feels isolated from the mathematical community and therefore does not want to be seen as a figurehead or representative of that group. Ball also said that Perelman believes his own values are not represented in the mathematical community. As to whether this belief arises from particular experiences or events in Perelman's life, Ball declined to say. Is refusal of the medal a snub? Ball was asked. "No, not a snub," he replied. "I wanted him to accept it because it gives the mathematical community the fullest opportunity to express our admiration for what he has done. And I wanted him to accept it for himself so that he could take pleasure from it and so that he could influence others in the future. I was disappointed that he absolutely would not change his mind." But, Ball said, his discussions with Perelman were straightforward, polite, and pleasant. Asked whether he feared for Perelman's mental health, Ball flatly answered no.

Some reasons for Perelman's turning down the Fields Medal are indicated in the article "Manifold Destiny" by Sylvia Nasar and David Gruber. The article appeared in the August 28, 2006, issue of the *New Yorker* magazine; that issue came out in print on August 21, 2006, the day before the ICM opening ceremony. The authors write that Perelman mentioned to them a dispute he had had years earlier with a collaborator over how to credit someone who had obtained a particular result, and he expressed his dismay over the lax ethics in mathematics. "Of course, there are many mathematicians who are more or less honest," the article quotes Perelman as saying. "But almost all of them are conformists. They are more or less honest, but they tolerate those who are not honest."

The 4,000 congress participants talked avidly about the *New Yorker* article and about Perelman's refusal of the medal. "It's a sad story, because he is not collecting the fame and recognition he undoubtedly deserves for his work," said Günter Ziegler, who is at the Technische Universität in Berlin and is president of the Deutsche Mathematiker Vereinigung (German Mathematical Society). "On the other hand, I am a little worried that the fact that Perelman turned down the prize...takes away attention from these exciting young mathematicians who did come to collect the prize for fantastic work." Sebastià Xambó of the

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Nevanlinna Prize Selection Committee
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Universitat Politècnica de Catalunya also found Perelman's refusal saddening—and perplexing as well. Can someone go to Perelman and try to get him to express why he seems to prefer being isolated from other mathematicians?, Xambó asked, wondering if Perelman could be drawn back into the community somehow. Many mathematicians expressed admiration for Perelman. "I admire him," stated Salah Bouendi of the University of California at San Diego. "He cares nothing about prizes or fame....He cares only about mathematics. He said 'If you give me recognition, fine, and if you don't, you don't.'" Some had a more cynical interpretation of Perelman's behavior. For example, one mathematician, who asked not to be named, said that in refusing the Fields Medal, Perelman communicated the message that he is more important than the medal. "It's good marketing," the mathematician remarked.

No one has ever turned down a Fields Medal before. It has happened three times that medalists were not present to collect their medals. In 1966 Alexandre Grothendieck refused to travel to the ICM site in Moscow to protest actions of the Soviet government. Serguei Novikov was not permitted to travel from the Soviet Union to the 1970 Congress in Nice to obtain his medal; the reasons can be traced to his support of dissidents during the 1960s and a negative recommendation to the Soviet authorities by officials at the Steklov Institute. In 1978 Gregory Margulis was prevented from traveling from the Soviet Union to Helsinki to

collect his medal because a board of mathematicians recommended to the Soviet government that he be denied a permit to travel. Although they did not personally attend the awards ceremony, Grothendieck, Novikov, and Margulis all accepted the honor. In 1988 Grothendieck famously declined the Crafoord Prize of the Royal Swedish Academy of Sciences, which awarded the approximately US$200,000 prize jointly to him and Pierre Deligne. In Grothendieck's reasons for declining the prize—one of which was the degradation of ethics within the mathematical profession—one hears an echo of what is known of Perelman's reasons for declining the Fields Medal.

The 2006 medals were unusual not only because of Perelman's refusal to accept his. They were also unusual in honoring mathematicians who have done extensive collaborative work. Terence Tao has had over thirty collaborators, which seems an especially large number given his age; he is only thirty-one. He is a member of the so-called "I-team", where "I" stands for various things including "interaction"; the other I-team members are James Colliander, Markus Keel, Gigliola Staffilani, and Hideo Takaoka. The medal for Wendelin Werner honors work done jointly with Gregory Lawler and Oded Schramm; it happens that Werner is the only one of the three who meets the age requirement for the Fields Medal, which says that a medalist must not have turned forty before the start of the year in which the medal is given. (Schramm was considered for a Fields Medal in 2002, but he was already too old by less than a month.) Andrei Okounkov has also had many collaborators, and some of his most spectacular work has been in enumerative geometry in ongoing joint work with Rahul Pandharipande. "Mathematics is changing," said Ball, who served as chair of the Fields Medal committee. "We see a lot more collaborative work now."

The instructions to the Fields Medal committee call for choosing between two and four medalists,

The new logo for the International Mathematical Union, unveiled at ICM2006. The logo was designed by John Sullivan of the Humboldt Universität Berlin.

with a strong preference for four. Ball said this preference is intended to ensure diversity among the areas of the medalists. It also allows for recognition of different kinds of contributions. "There are many different things that are important in mathematics: creating theories, making connections between different subjects," he said. "There has to be mathematical depth—that's essential. In my personal opinion, one has to use methods of evaluation of the importance of people's work that are appropriate for the kind of mathematics that they do." He noted that the increasing trend toward joint work may make it difficult for future Fields Medals committees to figure out who among the collaborators should be honored.

Of Knots and Flows

The Madrid ICM was dominated by talk about the Fields Medals but not overwhelmed by it. There was a full complement of plenary and section lectures, plus several panel discussions and special events. One of the standouts among the plenary lectures was that by Étienne Ghys of the École Normale Supérieure de Lyon, who spoke on "Knots and Dynamics". His talk began with what he called a paradigmatic picture in chaotic dynamics, namely, that of the Lorenz attractor. The periodic orbits of a flow are knots. One can create additional knots associated to a flow by arbitrarily connecting the ends of pieces of flow lines. One can then examine which kinds of knots arise in this way and ask whether a flow can be viewed as a limit of a sequence of knots. The knots that appear in the Lorenz attractor are of a special type, and some knots, like the figure-8 knot, never appear there. Ghys described a thread of ideas starting with the Lorenz attractor and leading up to his recent work on "modular knots", and then came full circle back to the set of knots found in the Lorenz attractor, for they turn out to be the same as modular knots.

Ghys's masterly use of computer animations not only made for a visually attractive presentation but also got to the heart of the mathematical ideas. The animations were made with Jos Leys (`http://www.josleys.com`), a mechanical engineer who has an interest in mathematics. At the end of his talk Ghys emphasized the importance of mathematicians communicating with nonmathematicians, a theme struck by several speakers at the ICM. He displayed a quotation of David Hilbert that made several appearances in lectures at the Madrid congress: A mathematical theory is not to be considered complete until you have made it so clear that you can explain it to the first person you meet on the street. Ghys went ten minutes over his allotted time, but the rapt audience hardly seemed to care. (Ghys and Leys have written a Web-based article about this work, including many of the animations,
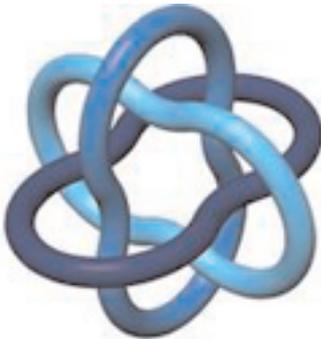
for the November 2006 issue of the AMS Feature Column. See `http://www.ams.org/mathmedia/featurecolumn`.)

Two lectures were greeted with especially keen anticipation: the plenary lecture by Richard Hamilton of Columbia University and the "Special Lecture on the Poincaré Conjecture" by John Morgan, also of Columbia. Hamilton, the originator of the idea of using the Ricci flow to attack the Poincaré and Thurston Geometrization Conjectures, described his thirty years of work on the problem. Hamilton said that the initial inspiration came forty years ago, when he attended the seminar of James Eells, who suggested that one might be able to use evolution equations to attack the Poincaré Conjecture. About ten years later, Hamilton began to think seriously about this possibility and hit upon the idea of using an evolution equation called the Ricci flow. In the lecture, Hamilton described many of the ideas of Perelman and at various points presented some simplifications of his own. He said that he was "thrilled" that Perelman had showed how to carry the Ricci flow program to its final conclusion. "I am enormously grateful to Perelman for this work," he said. In a press conference that was reported on in the *ICM Daily News*, Hamilton again expressed his admiration for what Perelman has done and said he "would be delighted to work with him in the future."

In contrast to Hamilton's lecture, which was aimed at mathematicians, Morgan's lecture could be understood by the general public. He discussed the origin and mystique of the Poincaré Conjecture and how perceptions of it have changed over the decades. In the 1970s, he said, if one had asked topologists whether the conjecture was true, they would probably have been evenly split in their answers. But by 1985, after William Thurston had described his vision of the nature of three-manifolds that has now become known as the Geometrization Conjecture, the vote would have been more like ten to one in favor of Poincaré being true. This is because the Geometrization Conjecture had by then been verified in many cases, and there had been a good deal of development in the field of topology without the emergence of any contradictions to the Poincaré Conjecture. After putting in three years of work to understand Perelman's ideas—work that has led to a 473-page book written with Gang Tian of Princeton University—Morgan could confidently display a slide saying "The Poincaré Conjecture is proved!" "It is a great victory for Perelman and for mathematics," he said.

A Deluge of Coverage

The media coverage for the Madrid ICM greatly surpassed that of any previous congress. The ICM publicity effort was headed by Ignacio Bayo and Monica Salomone, both freelance science reporters

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"… a common language independent of politics, religion, and culture"

Below are excerpts from a speech given by John Ball, president of the International Mathematical Union (IMU), during the ICM 2006 opening ceremony.

John Ball

While celebrating this feast of mathematics, with the many talking-points that it will provide, it is worth reflecting on the ways in which our community functions.

Mathematics is a profession of high standards and integrity. We freely discuss our work with others, without fear of it being stolen, and research is communicated openly prior to formal publication. Editorial procedures are fair and proper, and work gains its reputation through merit and not by how it is promoted. These are the norms operated by the vast majority of mathematicians. The exceptions are rare, and they are noticed....

Mathematicians do not own mathematics. But among the many millions who use mathematics daily, they are distinguished by their constant search for deeper understanding, based on an appreciation of beauty, simplicity, structure, and the power of generalization. Yet the lesson of past centuries is that these vital elements in the development of mathematics require constant invigoration by new questions that come from the world about us.

There is no object, large or small, and almost no aspect of human existence to which mathematics cannot contribute understanding. In particular, the great questions facing the planet, such as how to model and manage the climate, pose profound mathematical challenges....When contemplating the importance of mathematics *for* the world, we see the importance of supporting the development of mathematics *throughout* the world. Mathematical talent does not respect geographical boundaries, but the opportunities, working conditions, and tradition necessary for such talent to flourish depend heavily on geography, economic conditions, and politics. Each country and region has its own need for science and mathematics, its own problems with regard to mathematical development.

It is for these reasons that the IMU has made a special effort over the last four years to increase its support for mathematicians in developing countries....Despite these initiatives, a dramatic increase in both funding and scientific interchange is required to address the global imbalances in mathematical education and research. In sharing mathematical knowledge and experience with those who work around the world, it is the whole mathematical community that benefits, and we make our own contribution to peace and stability through the binding together of peoples by a common language independent of politics, religion, and culture.

I wish you all a rewarding and exciting Congress.

King Juan Carlos (right) greets Manuel de Léon, president of the ICM Executive Committee.

who frequently write for the main Spanish newpaper, *El País*. The ICM organizers initially estimated that perhaps twenty media representatives would attend the opening ceremony; when the day came, around one hundred fifty were registered. The Spanish media came out in force, partly because of the presence of the king; there were also reporters from media in Russia, Japan, Italy, Germany, Switzerland, and the United Kingdom. Many reporters who could not attend in person followed the ceremony on a Web broadcast. As the news of Perelman's declination spread, telephone calls poured in from all continents, and the press office staff valiantly struggled to meet the deluge.

Although media interest tapered off after the opening ceremony, the Spanish news agencies continued to send reporters to the meeting, and several television stations did extensive coverage with an eye to creating educational programs about mathematics and the congress. Apart from Bayo and Salomone, the press office team consisted of three senior journalists, a translator, a photographer, a layout and graphics editor, and three mathematician volunteers. The team organized several press conferences and handled all kinds of media queries. It also produced the *ICM Daily News*, which was filled with a variety of snappy and appealing articles about the mathematicians in attendance and the lectures given. The *Daily News* covered the unfolding Perelman saga with interviews with Hamilton and Morgan, as well as with James Carlson, president of the Clay Mathematics Institute, and Huai-Dong Cao of Lehigh University. Cao wrote an article with Xi-Ping Zhu of the University of Xhongshan that provides a detailed account of the work of Hamilton and Perelman leading to a proof of the Poincaré and Geometrization Conjectures. (Two other mathematicians who have produced an exposition of Perelman's work—John Lott of the University of Michigan and Bruce Kleiner of Yale University—both spoke at the congress.) (Issues of the *ICM Daily News* are available at `http://www.icm2006.org/dailynews/`.)

Popular press articles about the Fields Medals began to appear in advance of the congress, when rumors were circulating about whether Perelman would be awarded a medal and if so, whether he might turn it down. Unlike in 2002, when most coverage of the medals was concentrated in the home countries of the winners, there was extensive coverage of the 2006 medals worldwide. In 2002 the *New York Times* ignored the Fields Medals, but this year the *Times* carried two articles about them, as well as a piece beforehand discussing Perelman's story. The interest in Perelman persisted after the congress ended. An editorial by Evgeny Morozov, a Russian newspaper columnist, appeared in the August 31, 2006, issue of the *International Herald Tribune* and described the fascination that Perelman had ignited in Russia. "Russian blogs are already buzzing with poems, songs and jokes about Perelman," Morozov writes. (For more information on media coverage about the Fields Medals, visit the Math Digest on the AMS website; go to `http://www.ams.org/mathmedia/mathdigest` and look for articles appearing in August 2006.)

Spanish mathematicians were thrilled with the success of the congress. "This is a historic event for Spanish mathematics," said Enrique Zuazua of the Universidad Autónoma de Madrid. As soon as the king agreed to attend, Zuazua noted, many doors opened to the congress organizers that had been closed before. Carlos Andradas of Universidad Complutense de Madrid, who served as vice president general of the congress, said that the support from the Spanish authorities carries recognition of the strength of Spanish mathematics and is a statement of support for the future of science in Spain. The congress drew participants from 118 countries and over 1,000 mathematicians from all across Spain. With the unprecedented international media coverage putting the spotlight on mathematics and Spain, Andradas believes that this congress could mark a new breakthrough for Spanish mathematics. He said, "I hope that the Spanish mathematical community continues seeing the prosperity of mathematics as a common and collective task."

—*Allyn Jackson*