Opening ceremony

Sir John Ball, President of the International Mathematical Union

Your Majesty,
Señor Ruiz Gallardón,
Señora Cabrera,
Señora Aguirre,
Professor Manuel de León,
Distinguished guests,
Ladies and gentlemen,

¡Bienvenidos al ICM dos mil seis! Welcome to ICM 2006, the 25th International Congress of Mathematicians, and the first ICM to be held in Spain. We offer our heartfelt thanks to the Spanish nation, so rich in history and culture, for its invitation to Madrid.

We greatly appreciate that His Majesty King Juan Carlos is honouring mathematics by His presence here today.

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.

Mathematics has a strong record of service, freely given. We see this in the time and care spent in the refereeing of papers and other forms of peer review. We see it in the running of mathematical societies and journals, in the provision of free mathematical software and teaching resources, and in the various projects world-wide to improve electronic access to the mathematical literature, old and new. We see it in the nurturing of students beyond the call of duty.

This service is exemplified by the tremendous efforts made over the last four years by Spanish mathematicians to bring this Congress to fruition. I propose that we formally record our appreciation of their splendid work through electing by acclamation the President of the Local Organizing Committee, Manuel de León, as President of this International Congress.

The Scientific Program of the Congress was in the capable hands of an international Program Committee consisting of Noga Alon (Israel, Chair), Douglas Arnold (USA), Joaquim Bruna (Spain), Kenji Fukaya (Japan), Nigel Hitchin (UK), Vaughan Jones (USA), Pierre-Louis Lions (France), Gregory Margulis (USA), Richard Taylor (USA),

S. R. Srinivasa Varadhan (USA), Claire Voisin (France), Enrique Zuazua (Spain). The International Mathematical Union is most grateful to the members of this committee, and to the many other mathematicians who served on the sectional panels, for their work in putting together a fine program of lectures.

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. The need for an understanding of mathematics, of the mathematical way of thinking, and of the role mathematics can play in society, is no longer confined to scientists and engineers, but is increasingly important for those who work in industry, finance, the social sciences, and in many other walks of life, and thus also for all involved in education, for the media, opinion-formers and politicians. As subjects become better understood, they become more mathematical. Thus in the life sciences, for example, we see a rapid increase in the use of mathematical models, a trend that promises to profoundly influence medicine in the future.

In 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 needs for science and mathematics, its own problems as regards its 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. It has established an office for developing countries at the International Centre for Theoretical Physics in Trieste, and has cooperated with ICTP and the Abel Fund in the founding of the Ramanujan Prize for young mathematicians working in developing countries. At the IMU General Assembly held in Santiago de Compostela last weekend, a new class of Associate Membership was created to encourage more countries to join the Union. The IMU has augmented its developing countries programmes, particularly in Africa, helped by generous support from the following sponsors:

Niels Henrik Abel Memorial Fund (annual grant),

Nuffield Foundation and the Leverhulme Trust (linked grants to support mathematics in sub-Saharan Africa, in conjunction with the London Mathematical Society and the African Mathematics Millennium Science Initiative),

David and Lucile Packard Foundation,

Andrew W. Mellon Foundation,

American Mathematical Society,

London Mathematical Society.

Other sponsors, including those of the ICM itself, have made it possible for some 400 mathematicians from developing and economically disadvantaged countries, particularly younger researchers, to attend this Congress:

ICM sponsors,

American Mathematical Society,

Mathematical Society of Japan,

USA Committee for Mathematics,

London Mathematical Society,

Het Wiskundig Genootschap Netherlands,

Italian Mathematical Union (UMI),

German Mathematical Society (DMV),

European Mathematical Society.

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.

Manuel de León, President of the ICM2006 Organizing Committee

Your Majesty,
President of the Community of Madrid,
Minister of Education and Science,
Mayor of Madrid,
Professors John Ball and Phillip Griffiths,
Dear Colleagues, ladies and gentlemen,

On behalf of the Organizing Committee I would like to welcome you all to the ICM2006, and in particular to this opening ceremony.

First of all, I want to express our gratitude to the King Juan Carlos for His continuous support.

¡Muchas gracias, Majestad!

The ICM is a congress of great importance. Every four years, mathematicians from all over the world meet to celebrate mathematics, to inform each other of our latest results, to honour the most outstanding achievements during this period, to debate the present and future state of the discipline, to discuss how best to transfer new knowledge, and to bring mathematics closer to society and to improve public appreciation.

We Spanish mathematicians feel very honoured to have been entrusted by the IMU with the organization of this ICM. The constant support of the IMU Executive Committee and its president, Professor John Ball, has been essential for this task.

Furthermore, an event of this magnitude requires a great financial commitment, which on this occasion in Madrid has amounted to approximately two and a half million euros. Much of this funding has been provided by the Ministry of Education and Science, the Ministry of Foreign Affairs, the Ministry of Culture, the Community and the City of Madrid, and many others that you can see listed below; we are grateful for that support.

In addition to the scientific activities, an interesting series of round-table discussions has been organized, as well as an extensive programme of cultural and parallel activities. The fact that the entire process of registration and communication has been carried out electronically is also worthy of mention. Both this opening ceremony

and all the plenary lectures will be transmitted online throughout the world, and the congress records will be available on the website. This is a reflection of the importance of mathematics in today's Information Society.

The logo deserves a special mention because it is an essential part of every ICM, and on this occasion in Madrid it is the basis on which we have built the image of the Congress. It depicts a sunflower consisting of optimum growth mathematics and the golden mean representing a Spain of sunlight and optimism.

Our wish and our aim is for this ICM2006 to provide a platform for making the presence of mathematics felt in society, a process in which the media must inevitably play its part. To this end, the ICM2006 set up a Press Office that has worked together with the IMU to issue a weekly bulletin in English and Spanish aimed at both the media and the public at large.

Allow me also to explain how Spain has prepared itself for this day. Ten years ago, Spanish mathematicians set about reorganizing the social structure of our community, and in particular the Committee that liaises with the International Mathematical Union. At the same time, we began working on the organization of the World Mathematical Year in Spain. This collective project has had one important consequence: Spanish mathematicians came to the realization that we are a community, a community which, perhaps more than any other scientific discipline in this country, has subjected its strengths and weaknesses to an ongoing process of examination.

We have learned that mathematical research in Spain has made great progress in recent years. We now need to raise the standard of quality and encourage the interdisciplinary nature of mathematics, and are presently taking steps to achieve these aims.

We all agree on the vital role of mathematics in education, but it still remains to convince everyone of its equally important role as key technology for development. The new schemes for mathematical research currently being set up in Spain will undoubtedly help to increase qualitative and quantitatively the presence of Mathematics in science, technology and innovation. For a country like ours, this is the basis for a prosperous future.

The celebration of the ICM2006 in Madrid constitutes a landmark on this road. It also underlines our sense of belonging to an international community to whose organization and activities we are eager to make a contribution, continuing the process of internationalization that is already under way in Spain.

On behalf of the Organizing Committee, I would like to thank all the participants for coming to Madrid, some of them from very distant places, and I apologize if at any time we have been unable to meet all their demands. We would like you to know that in these coming days we are about to share, we are at your complete disposal.

Welcome to the ICM2006, welcome to Madrid! We wish you a successful conference and a very pleasant stay. Thank you all very much!

Alberto Ruiz Gallardón, Mayor of Madrid

Your Majesty,

Under the auspices of the Crown, and in keeping with the scientific and cultural progress that this Institution has enabled in Spain, Madrid bears today the honour and the responsibility of being the world capital of mathematical science. This has been made possible by the International Mathematical Union's choice of our city to host its twenty-fifth Congress, responding not only to the efforts made by Madrid City Council during its candidacy for the most prestigious mathematical event of our age, but also to the very nature of the capital of Spain as a crossroads of knowledge.

Over the next few days, the Congress promoters will witness this city's unquestionable capability regarding the organisation of significant events, with international impact, in the fields of science, culture, sports or economics. Madrid's excellent infrastructures for the staging of fairs and exhibitions and the wide range of services it offers are factors which explain the city's increasingly consolidated position at the forefront in terms of the hosting of conferences and congresses. However, the hospitality of the inhabitants of Madrid – on whose behalf I take this opportunity to extend a warm welcome to the participants of the Congress – and their interest in the intellectual progress of this century, are elements that have proved even more decisive in choosing Madrid for a gathering of the brightest minds of our age.

Madrid's long-standing relationship with mathematics can be traced back to at least 1582, when Phillip II founded the Royal Academy of Mathematics. Madrid also provided the stage upon which Agustín de Pedrayes, one of Spain's most celebrated mathematicians, who achieved fame in the International Congress of 1799 in Paris via his crucial contribution to the creation of the decimal metric system, carried out his professional activity between the 18th and 19th centuries. Nevertheless, Madrid's confidence in the success of this Congress is focused more on the future than on the past.

In a world where political systems appear faced with terrible challenges, where technology is hampered by uncompromising materialism, where the humanities seem overwhelmed by the challenge of providing an answer, you, as mathematicians, have the great privilege of speaking a different and eternally youthful language, wherein conjectures can be tested or refuted, whilst the language itself remains untainted by despair and its universality undiminished by disagreement. Laymen have difficulty

understanding the terms of the debate centred around Fermat's Last Theorem or those used to describe the essential humility of the mathematical possibilities surrounding Gödel's Theorem. Nevertheless, we believe that certain equations are as beautiful as the Iliad, as stated by the philosopher Edgar Quinet, and therefore we can find motives for consolation and hope. Indeed, beyond the specific applications of mathematical science, this discipline provides proof that the human need for understanding and for creativity remain intact. In these turbulent and yet complacent times, the inherent difficulty of mathematics – where, in the words of Plato, beauty and truth coincide – constitutes an intellectual stimulus, an invitation to better ourselves and a bastion of purity. The thinker George Steiner quoted Kepler to explain this phenomenon: "amidst massacres [and war], the laws of elliptical motion belong to no man and to no principality".

Therefore, Sire, perhaps it is not only mathematicians who need to come closer to society, by descending to the details of everyday life and explaining the usefulness of their science to the people, but it is all of us who are obliged to make the ethical and aesthetical effort to reach the same level of excellence, rigour and beauty that they inhabit.

In this two-fold hope and trust, it is a great pleasure for me to welcome the world's best mathematicians to Madrid.

Mercedes Cabrera, Minister for Education and Science

Your Majesty,

When the International Mathematical Union chose the City of Madrid to host the 25th International Congress of Mathematicians and for the presentation of the prestigious Fields Medals, the Spanish Government Ministry of Education and Science understood that it had to give its full support to the Organizing Committee of the event. In this way, our support for the Congress became an important part of the Scientific Policy Programme of Complementary Measures.

Given that more than 8,000 Spanish mathematicians are represented at the International Mathematical Union, we feel that at this time and together with them all the citizens of Spain are likewise represented, since we recognize the importance of mathematics in the development of thought, in the shaping and management of reality, and in the progress of Culture.

This Congress will serve to pave the way to new avenues of research, and to the exchange of new advances and opinions among all the different fields of knowledge, whether related directly or indirectly with mathematics. Furthermore, it will assist in advising public bodies, the Ministry of Education and Science among them, on the means of support it should adopt in the future.

We therefore celebrate this meeting as a great event of concern to everyone, and with our best wishes for its success we greet the members of the International Mathematical Union; the Organizing Committee of the Congress; the scientists who will be honoured for their achievements, and all the participants, especially all our guests from abroad.

We do not know what some of the pioneers in the history of mathematical research in Spain would have said if they had known about the congress we inaugurate today.

However, we know what we, as scientists, teachers or holders of public office, are obliged to offer both for them and for society in the matter of teaching and research. For them, in recognition and in tribute to their work and their memory; for society at large, because it is the proper task of public bodies, and in particular of the Ministry I represent, to make scientific achievement and discovery available to all in the interests of progress. That is why the Spanish Ministry of Education and Science is currently developing different projects in support of research in the fields of Mathematical Science.

As a basic policy, it is our aim to improve the role of mathematics in Education. To that end, the restructuring of the Spanish educational system as laid out in the new Organic Law of Education will enable us establish specific areas in which the acquisition of logic-mathematical skills and the development of mathematical learning at school level will accorded the status of basic abilities.

It is also our aim to pursue a new teaching methodology, encouraging practical experience in the classroom and furthering ongoing teacher training to meet our educational goals.

With regard to the situation of research in our country, Spain occupies the 9th position in the world in terms of scientific production in mathematics. This constitutes a considerable improvement over the last twenty-five years, and we expect the plans that are now being developed to improve this performance even further, by consolidating quality research teams and strengthening relations with researchers working on projects in other fields connected with technological innovation and development.

To achieve these goals, the National Programme for Mathematics has been set up within the framework of the R+D+I National Plan. In addition, the Consolider Mathematica Programme is being carried out as part of the broader Consolider Ingenio 2010, which will enable us to fund research work by top level groups in the field of Mathematics. In fact, the Consolider Mathematica programme has been chosen by the relevant Scientific Committee as a worthy recipient of immediate support.

We trust that these and other complementary measures, aimed at the training and mobility of research personnel and the creation of research institutions, will strengthen

Mathematical Science, both at an international level and in the Spanish System of Science, Technology and Business.

But today we are also here to celebrate the presentation of the Fields Medals and the Nevanlinna and Gauss Prizes. The Ministry of Education and Science of the Spanish Government congratulates the award-winners and expresses its gratitude for their generous contribution to society through Science. They are an example to us all, and especially to the many young people who are laying the foundations for their future professional careers.

Finally, I would like to express our gratitude to the members of Executive Committee of the Congress for all their efforts, and to all those involved in the organization of the many accompanying events and activities, as well as the scientists who by their work will enrich discussion and extend common understanding.

Your Majesty, we are aware of Your interest in seeing Spain occupy an important place in the society of knowledge and in the International Scientific Community, and of Your wish that all citizens acquire a solid education and training in preparation for the modern world. The Ministry of Education and Science is currently working on numerous schemes and projects to achieve this aim. If we are successful, we will have fulfilled one of the main purposes of our existence. Support for this International Congress of Mathematicians constitutes a further step along this road.

Many thanks and welcome to you all.

Esperanza Aguirre, President of the Community of Madrid

Your Majesty,

It is an honour and a source of great satisfaction for Madrid to welcome from today over 4,000 of the best mathematicians from all over the world who have gathered here to share their latest studies and discoveries, to explain the state of their researches, and to reward the most outstanding achievements of their colleagues with the Fields Medals and the Rolf Nevanlinna and Carl Friedrich Gauss Prizes.

In the 19th century, the German mathematician Gustav Jacobi stated that those who devoted themselves to study and research in Mathematics did so above all to "honour the human spirit"". This is how it has always been since the origins of mathematical thought, and the greatest achievements in this Science figure among the finest creations of humanity as a whole.

This is a good opportunity to recall that mathematical thought dates back to classical Greece, and lies at the source of all Western thought and civilization. From these brilliant beginnings, the essence of mathematical thought has consisted in finding an exact formulation for what we see, what we experience and what we perceive. That is why, whether we realize it or not, we are all descendants of Pythagoras.

To these words of greeting and welcome to Madrid I would also like to add my sincere congratulations to all the Congress participants for their efforts, for their researches, and for the knowledge they impart to their students, initiating them into the mysteries of their science. The intrinsic difficulties of their studies sometimes deprive them of recognition by society at large. That is why, with my congratulations, I would like to encourage them to continue with their fine work.

In the mid-19th century, the leading Spanish mathematician of the period, José Echegaray, stated that unfortunately there were few Spaniards of world status in mathematical research at that time. Happily today that is no longer the case, and the presence of the most outstanding mathematicians here in Madrid is the best demonstration of what I mean. I am sure that the celebration of this Congress in Madrid will act as a stimulus to all those young people in Spain who have discovered the pleasures of studying mathematics, and have begun to appreciate the beauty of its reasoning and its proofs. I likewise trust that the choice of Madrid as host city for this Congress will also be a source of pride and encouragement for all the Faculties of Mathematics at Madrid Universities.

With my very best wishes for the success of the Congress, and for the personal future and professional scientific career of all those concerned, I once again most cordially welcome you all to Madrid.

Many thanks.

Presentation of the new IMU logo by Phillip Griffiths, Secretary of IMU

The International Mathematical Union (IMU) has adopted a new logo. It was the winner of an international open competition announced by the IMU in 2004 that attracted over 80 submissions. The final selection was made by the Executive Committee of IMU.

The logo was designed by John Sullivan, Professor of Mathematical Visualization at the Technical University of Berlin (TU Berlin) and at the DFG Research Center MATHEON, and adjunct professor at the University of Illinois, Urbana (UIUC), with help from Prof. Nancy Wrinkle of Northeastern Illinois University.

The logo design is based on the Borromean rings, a famous topological link of three components. The rings have the surprising property that if any one component is removed, the other two can fall apart (while all three together remain linked). This so-called Brunnian property has led the rings to be used over many centuries in many cultures as a symbol of interconnectedness, or of strength in unity.

Although the Borromean rings are most often drawn as if made from three round circles, such a construction is mathematically impossible.

The IMU logo instead uses the tight shape of the Borromean rings, as would be obtained by tying them in rope pulled as tight as possible. Mathematically, this is the length-minimizing configuration of the link subject to the constraint that unit-diameter tubes around the three components stay disjoint. This problem and its solution are described in the paper *Criticality for the Gehring Link Problem* by J. Cantarella, J. Fu, R. Kusner, J. Sullivan, N. Wrinkle, Geometry and Topology 10 (2006), pp. 2055–2115, also available at arXiv.org/math/0402212.

Although this critical configuration is quite close to one made of convex and concave circular arcs, its actual geometry is surprisingly intricate. Each component is planar and piecewise smooth, with the shapes of many of the 14 pieces described by elliptic integrals. The improvement over the similar piecewise circular configuration leads to a savings of length of less than one tenth of one percent!

(The paper cited above first noticed a similar surprise in the simple clasp: one rope attached to the floor clasped around another attached to the ceiling. There as well, the minimizing shapes for the ropes are quite complicated, leaving a small gap between the thick tubes right at the tip.)

The tight configuration of the Borromean rings has pyritohedral symmetry (3*2 in the Conway/Thurston orbifold notation), and the IMU logo uses a view along a three-fold axis of rotation symmetry. Instead of the thick tubes, which would touch one another all along their lengths, thinner tubes are drawn, allowing a better view of the link.

Sullivan says the new logo "represents the interconnectedness not only of the various fields of mathematics, but also of the mathematical community around the world." Together with Charles Gunn of TU Berlin, he has made a 5-minute computer-graphics video The Borromean Rings: a new logo for the IMU that was shown at the ICM opening ceremony.
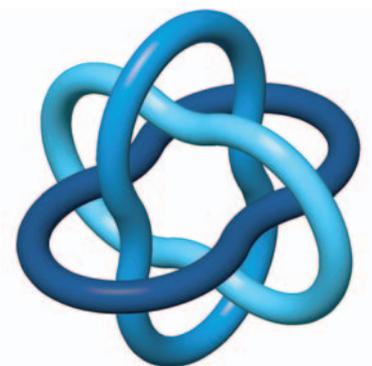
Presentation of the Fields Medals by John Ball, Chairman of the Fields Medal Committee

The 2006 Fields Medal Committee consisted of:

- Enrico Arbarello (Italy)
- John Ball (UK, Chair)
- Jeff Cheeger (USA)
- Donald Dawson (Canada)
- Gerhard Huisken (Germany)
- Curtis McMullen (USA)
- Alexey Parshin (Russia)
- Tom Spencer (USA)
- Michèle Vergne (France)

The instructions to the Committee are: to choose at least two, with a strong preference for four, Fields Medallists, to have regard in its choice to representing a diversity of mathematical fields, and to respect the age limit that a candidate's 40th birthday must not occur before January 1st of the year of the Congress at which the Fields Medals are awarded.

The Committee was privileged to consider a number of remarkable young mathematicians. Although the choice was a difficult one, the Committee was unanimous in selecting four medallists whose wonderful work demonstrates the breadth and richness of the subject. I will announce the names of the winners in alphabetical order.

A Fields Medal is awarded to Andrei Okounkov, of the Department of Mathematics, Princeton University, for his contributions bridging probability, representation theory and algebraic geometry.

A Fields Medal is awarded to Grigory Perelman, of St Petersburg, for his contributions to geometry and his revolutionary insights into the analytical and geometric structure of the Ricci flow. I regret that Dr. Perelman has declined to accept the medal.

A Fields Medal is awarded to Terence Tao, of the Department of Mathematics, University of California at Los Angeles (UCLA), for his contributions to partial differential equations, combinatorics, harmonic analysis and additive number theory.

A Fields Medal is awarded to Wendelin Werner, of the Laboratoire de Mathématiques, Université Paris-Sud, for his contributions to the development of stochastic Loewner evolution, the geometry of two-dimensional Brownian motion, and conformal field theory.

Presentation of the Nevanlinna Prize by Margaret H. Wright, Chair of the 2006 Nevanlinna Prize Committee

It is a privilege to announce the winner of the 2006 Rolf Nevanlinna Prize, which is awarded by the International Mathematical Union for outstanding contributions in mathematical aspects of information sciences.

The Nevanlinna Prize was first awarded in 1982. A requirement is that the winner's 40th birthday must occur on or after January 1 of the year in which the award is made.

The members of the 2006 Nevanlinna Prize Committee are:

– Samson Abramsky (United Kingdom)

– Franco Brezzi (Italy)

– Gert-Martin Greuel (Germany)

– Johan Håstad (Sweden)

– Margaret Wright, Chair (United States).

The International Mathematical Union awards the 2006 Nevanlinna Prize to Professor Jon M. Kleinberg of the Computer Science Department, Cornell University, Ithaca, New York, USA. Professor Kleinberg's date of birth is October 1971.

The Nevanlinna Prize citation for Jon Kleinberg is:
For deep, creative and insightful contributions to the mathematical theory of the global information environment, including

the influential "hubs and authorities" algorithm;

methods for discovering short chains in large social networks;

techniques for modeling, identifying and analyzing bursts in data streams;

theoretical models of community growth in social networks; and

contributions to the mathematical theory of clustering.

Jon Kleinberg's combination of mathematical ability, superb taste in interesting problems, breadth of interests and sense of strategy is both dazzling and unmatched. His work has had a fundamental impact on the effectiveness of today's most advanced Web search engines, and his mathematical insights have had applications to Internet routing, data mining, discrete optimization, and the sociology of the World Wide Web.

Presentation of the Gauss Prize by Martin Grötschel, Chair of the Gauss Prize Committee

Today we celebrate the first award of the Carl Friedrich Gauss Prize for applications of mathematics. Since this is a new IMU distinction, it is appropriate to say a few words about the scope of the prize in the beginning.

The Gauss Prize is awarded jointly by the Deutsche Mathematiker-Vereinigung (DMV, the German Mathematical Society) and the International Mathematical Union (IMU), and is administered by the DMV. The prize consists of a medal and a monetary award (currently EUR 10,000). The source of the prize fund is a small surplus from the International Congress of Mathematicians (ICM'98) held in Berlin eight years ago.

The statutes stipulate that the Gauss Prize is awarded for outstanding mathematical contributions that have found significant practical applications outside of mathematics, or for achievements that made the application of mathematical methods to areas outside of mathematics possible in an innovative way, e.g., via new modelling techniques or the design and implementation of algorithms. In a nutshell, the Carl Friedrich Gauss Prize is given for the impact the work of the prize winner has had in practice.

Since the practical usefulness of mathematical results is often not immediately visible, and as their applicability and importance for practice may only be realized after a long time lag – in contrast to the Fields Medal and the Rolf Nevanlinna Prize – no age limit restricts the choice of a prize winner.

Scientific awards gain reputation through the choice of outstanding winners. The Fields Medal, e.g., is a prime example for this fact. The Gauss Prize jury hopes to mark the beginning of a similar tradition today by presenting an awardee whose research has influenced the world at large and whose contributions are highly respected by the mathematical community.

Why has the prize been given Gauss' name? Carl Friedrich Gauss (1777–1855) was one of the greatest mathematicians of all time. Gauss combined scientific theory and practice like no other before him or since. His *Disquisitiones Arithmeticae*, published in 1801, stand to this day as a true masterpiece of scientific investigation. In the same year, Gauss gained fame in wider circles for his prediction, using very few observations, of when and where the asteroid Ceres would next appear. The method of least squares, developed by Gauss as an aid in his mapping of the state of Hannover, is still an indispensable tool for analyzing data. His sextant is pictured on the last series of the German 10-Mark bills, honoring his considerable contributions to surveying.

On the front side of the bill, one also finds a bell curve, which is the graphical representation of the Gaussian normal distribution in probability. Together with Wilhelm Weber, Gauss invented the first electric telegraph. In recognition of his contributions to the theory of electromagnetism, the international unit of magnetic induction is the gauss. These few examples show that the impact of Gauss' mathematics can be experienced every day everywhere. With this new prize, IMU and DMV would like the world to recognize the importance of mathematics for our society; and Carl Friedrich Gauss is a prime example for the role mathematicians can play in this respect.

The medal, designed by Jan Arnold, that comes along with the award is displayed below. It shows on the front a familiar Gauss portrait dissolved into a linear pattern, the least squares method as well as the discovery of Ceres' orbit are symbolized on the back.

Following the prize statutes, the IMU Executive Committee appointed a Gauss Prize Committee for the 2006 award. The members were Bob Bixby, Martin Grötschel (chair), Frank den Hollander, Stéphane Mallat, and Ian Sloan. The establishment of the Gauss Prize was announced on April 30, 2002, Gauss' 225th birthday, and at the same time, nominations were invited. About thirty highly deserving mathematicians from all over the world were suggested for this prize by colleagues from pure and applied mathematics.

And now, I would like to announce the winner and read the citation.

The International Mathematical Union and the Deutsche Mathematiker-Vereinigung jointly award the Carl Friedrich Gauss Prize for Applications of Mathematics to Professor Kiyosi Itô for laying the foundations of the theory of stochastic differential equations and stochastic analysis. Itô's work has emerged as one of the major mathematical innovations of the 20th century and has found a wide range of applications outside of mathematics. Itô calculus has become a key tool in areas such as engineering (e.g., filtering, stability, and control in the presence of noise), physics (e.g., turbulence and conformal field theory), and biology (e.g., population dynamics). It is at present of particular importance in economics and finance with option pricing as a prime example.

The document is signed by John Ball, President of IMU, and Günter M. Ziegler, President of DMV.

A side remark, at this moment in time, a new application-oriented research institute called Quantitative Products Laboratory, is being founded in Berlin. It will be sponsored by a big German bank donating at least three million Euros annually. This new institute would not have been founded without the foundations laid by Kiyosi Itô.

The details of Itô's work will be explained tomorrow, August 23, in the Gauss Prize lecture presented by Hans Föllmer.

Kiyosi Itô was born in Japan in 1915. He received his Doctor of Science degree from the Imperial University in Tokyo and is now professor emeritus at Kyoto University. He has honorary doctoral degrees from Université Paris VI, ETH Zürich, and the University of Warwick. Itô is a member of the Académie des Sciences, France,

the Japan Academy, and the National Academy of Sciences, USA, to mention just a few of his many honors and distinctions.

For health reasons, Kiyosi Itô is unfortunately unable to be present at today's award ceremony.

The IMU President, John Ball, will personally take the Gauss Medal to Kyoto after this meeting and present it to Professor Itô in a special ceremony[1]. I am very happy to be able to announce that the Itô family has decided to send a representative to Madrid. Kiyosi Itô's youngest daughter, Junko Itô, who is professor and chair of linguistics at the University of California in Santa Cruz, is here to accept the Gauss Prize on behalf of her father.

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[1] Photograph by Armin Mester. It shows John Ball and Kiyosi Itô on September 14, 2007 in Kyoto during the presentation of the Gauss Medal.

His Majesty the King of Spain, Juan Carlos

I am greatly pleased to preside over the opening of this Twenty-Fifth International Congress of Mathematicians, an outstanding scientific event which, in addition to its tradition of over a century, enjoys unquestionable prestige and significance on a global scale.

I extend my greetings to all the participants, my warm welcome to Spain to those from other countries, and my most heartfelt congratulations to the organizers of this Congress in Madrid.

You will understand that it is a very special pleasure for me that this Congress, which has brought together nearly four thousand scientists from over one hundred countries, is being held for the first time in our country.

Therefore, I wish to convey my greatest recognition and appreciation to the Spanish mathematical community, whose well-deserved prestige, proven effort and cohesion, have made Spain – and more specifically Madrid – the focus of attention of the international mathematical community this year.

This Congress enables us to learn about the main progress made by research in this discipline, and to highlight and promote in our respective societies the enormous importance of Mathematics. Importance because it is a basic instrument to understand the world, because it constitutes an unquestionable pillar of education, and because it is an indispensable tool to ensure progress for the benefit of Humanity.

Galileo told us that the world is written in mathematical language; to understand it, nothing can rival this discipline that has brought us together today in Madrid.

Improved understanding of the world we live in, by using the universality of Mathematics, is, in addition, a task which reinforces cooperation between diverse countries, societies and cultures.

It is equally evident that the high value of Mathematics in education requires our attention and dedication.

Mathematics is rightly considered the key technology. This is stated in the Declaration made public in 2000 by the International Mathematical Union and UNESCO, on the occasion of the World Mathematical Year.

We depend on, and we will increasingly depend on, the indispensable foundation that research, technology and innovation constitute for the future of our economic development and our social well-being.

For this reason, we must promote mathematical development as an essential element for progress that will enable sustainable development for all Humanity.

The business world must also join, with increasing efforts, a discipline which has been essential to our development, as it is, for example, the basic foundation to achieve the Information Society we currently enjoy.

Spain has been making a particular effort, and will continue to do so in the future, to promote its technological development.

Projects such as the Ingenio 2010 Programme are aimed at such a goal. We are pleased to see that Spanish mathematicians have not missed the opportunity to participate in such an ambitious R+D+I programme.

But this Congress also includes other aspects that I would like to highlight. With 108 countries represented, the largest number in its history, it aims to achieve universal representation and participation.

This has been made possible thanks to grant programmes for the participation of mathematicians from economically disadvantaged countries, following a long-standing tradition of the International Mathematical Union to which Spain is especially sensitive.

Furthermore, this Congress has made an enormous effort to bring Mathematics closer to society, striving to make it more wide-spread and well-known in public opinion.

All of this is being done through exhibitions, various cultural events and by reinforcing its presence in the media.

This effort to make Mathematics more well-known is particularly significant, as it is fundamental to encourage new scientific vocations all over the world.

In addition, these Congresses enable the mathematical community to award, every four years, and with well-deserved solemnity, its most highly prized and valued distinctions.

I am referring to the Fields Medal, the Rolf Nevanlinna Prize and the Carl Friedrich Gauss Prize, all of which are indisputably prestigious awards which have just been granted to this year's winners.

The Fields Medal has been awarded for 70 years to mathematicians under the age of 40 for outstanding achievement in the basic aspects of the discipline; the Rolf Nevanlinna Prize has been awarded since 1982 for the best mathematical contributions to the Information Society; and the Carl Friedrich Gauss Prize, awarded for the first time this year in Madrid, aims to honour outstanding achievement in contributing to improve our everyday lives.

I extend my most enthusiastic congratulations to all this year's winners.

Their work, professional career and scientific merits, as well as their contribution to our societies' development and well-being, deserve everyone's recognition and constitute an example and encouragement for the whole of the international mathematical

community.

To conclude, I would like to reiterate my most sincere support for the significant work done by the International Mathematical Union. I wish you every success for the next Congress to be held in India, just as I trust this one in Madrid will be successful.

I declare open the 25th International Congress of Mathematicians of 2006.

Thank you very much.

The King of Spain, Juan Carlos. On his left, Jon Kleinberg and Terence Tao;
on his right Andrei Okounkov and Wendelin Werner.