SEOUL ICM 2014
INTERNATIONAL CONGRESS OF MATHEMATICIANS

Math&Presso

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Yitang Zhang – Invited Lecture

Optimism and passion for mathematics prevail

Yitang Zhang stepped onto the main stage of mathematics last year with the announcement of his achievement that is hailed as "a landmark theorem in the distribution of prime numbers". The Chinese scholar's work provided a significant lead to proving the twin prime conjecture, one of the oldest problems in number theory. His perseverance and steadiness enabled him to prevail over difficulties where other experts of the field had not. He is now 58, and he stayed virtually unknown before his achievements was made public. The Peking University graduate finished Ph.D. at Purdue University in 1991, and had no steady academic appointments until he found a position as a lecturer at the University of New Hampshire. He is now a professor of the school.

In an interview during the SEOUL ICM 2014, Zhang said his optimistic nature and his love for mathematics have helped him overcome hardship. Minhyong Kim, a professor of mathematics at Oxford University moderated the interview at COEX on Tuesday

Yitang Zhang, who made a significant contribution to the twin prime conjecture, speaks to reporters at COEX, Seoul, on Tuesday.

Q. Tell us about the progress made over the twin prime conjecture since your discovery.

A. It was May of 2013. I got an email from a Princeton magazine, and they asked me whether they could publicize my story, and then everyone in the mathematical society got to know the story. I said then that the prime gap is less than 70 million, and now to my knowledge, it has been reduced for little more than one year, to 252 (he later corrected it to 246).

Many mathematicians, inspired by you, have worked on polymath projects to reduce the gap and made significant progress – What do you think of it?

The final goal of this twin prime conjecture is to reduce the gap to two. When I got the first result last year, I realized that it would be very likely to reduce to less than 70 million. But at the time, without a computer program, I couldn't do much computation. Before I published my paper, I thought it would be good enough. I did not expect it would be reduced like this, but I realized (then) that it could be reduced (further). Reporters of my work said (proving) the existence of any such constant was a remarkable achievement. If we could give a number, (and I did), I think it was enough.

How did you start working on the twin prime conjecture?

I like to watch major progress in mathematics. In 2005, three mathematicians (Goldston, Pintz, and Yildirim) gave a lecture on the significant progress they made toward proving the twin prime conjecture. Although they had not achieved bounded gaps, their result was very close to bounded gaps. In November of 2005, there was a workshop in California Institute of Technology and many experts gathered together to close the final gaps. After a couple of years, they found a very critical difficulty to overcome. I came into the fray, a little later, in maybe 2007 or 2008. I read a paper about the progress, what other people had achieved, and what the major problems that we had to overcome were. Then I started working on it, and kept thinking on in several ways. You might have heard a story about this. In July 2012, I took a vacation in Colorado at a friend's house. As I walked around their backyard, I found this solution. I just tried what I can do, as much as I can do with the knowledge I had accumulated over the years. You would say, it was just an intuition and I knew I could achieve it.

You have been away from mainstream mathematical community for several years. How were you able to pull off such a major feat?

To me, I don't think it was too difficult. Even before I went to the University of New Hampshire, I kept thinking about mathematical problems. Sometimes I went to a university, I went to their library to check out some papers. Even then I always did something in mathematics. So when I came to the University of New Hampshire, I was able to publish a paper very soon. I had not completely quit mathematics. I really love mathematics. This is the most important thing. I know how to persist. This is my major quality.

Do you think it is important to maintain a balance between doing everyday mathematics and taking on a more difficult long term project? What do you think of a harmonious approach?

If I am to give suggestions to other mathematicians, in particular to young mathematicians, it is "do not learn from my example." My case is very special. I love challenging problems. I do not like doing some small problems. But if I need to give a suggestion to other people, I'd say you also need to do some short term problems. You need to publish papers, otherwise you would not be able to get a job, and would not be able to have dates, something like that. But one thing, I would say, is that do short term problems in a regular way, but keep a watch on long term problems; this is very important. At least watch, and pay attention to significant problems.

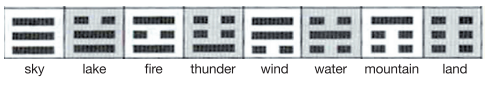
You are a good case study against the notion that mathematics is a young man's game. Are you intentionally trying to defy the notion?

Mathematics is supposed to be done by young people, because they are smart and healthy. But I feel young, although I am old physically. Living conditions nowadays are much better than earlier. In China, there is a poem, saying living up to 70s is difficult; but nowadays, it is not. I say to myself, that I am really still young. If you can stay young, mentally, you can think like young people. Dreaming is not only for young people. This spring, I met (Enrico) Bombieri, who is a very famous mathematician at Institute for Advanced Study. He is already 70 years old, 74 maybe? (Bombieri is 73). Everyday he comes to the office, and keeps working on the Riemann Hypothesis.

Math is Ubiquitous in Seoul

"A new dynasty will after thrive and expand," is the meaning of the name Gyeongbokgung ("gung" is "palace" in Korean). It was the first and the best palace of the Joseon Dynasty, built three years after Taejo Lee Sunggye first established his dynasty in 1392. The beauty of the palace encompasses several mathematic principles. Let's explore Gyeongbokgung and consider its mathematical significance.

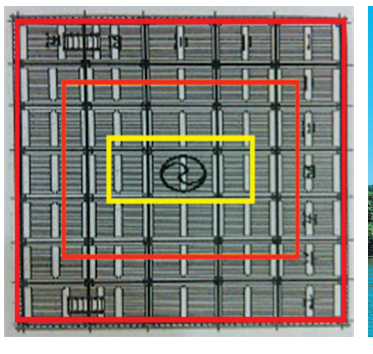
Gwanghwamun

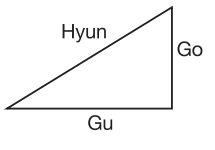


Gwanghwamun, the main gate of Gyeongbok Palace, is surrounded by a low wall called a yeojang with variations in its height to allow the flexible deployment of guns in battle. The yeojang of Gwanghwamun is decorated with the *taeguk* (yin-yang) and other symbols attesting to the sophisticated spiritual world of ancient Koreans.

The roof of Gwanghwamun was also constructed using mathematical principles. Each eave reflects the Theorem of Gugohyun, an early Korean form of the Pythagorean theorem. The theorem was documented in as a publication of the Silla Dynasty (57 BCE–935 CE). This theorem was widely used in Korea for land measurements and major construction projects that could not be directly measured by tools. The roof also was designed using cycloids so that it is visually stable and light.

Gyeonghoeru





Gyeonghoeru in Gyeongbok Palace is a pavilion built on an island in the center of a lake. Joseon architecture was mainly wooden, and so most structures were vulnerable to fire. Gyeonghoeru was built with that danger in mind, as the surrounding lake attests. The units of measure used to design Gyeonghoeru also contain a symbolic protection from fire; it occupies 36 *kan* (a unit of area), which is the square of 6. The sixth of the "eight gwae," trigrams that originated in the "I Ching," is assigned to water. The sum of the digits from 1 to 8, representing the eight trigrams together, also adds up to 36. The number 36 is also the sum of all the individual bars in the eight trigrams comprising the eight gwae.

Sang-Gu Lee (Sungkyunkwan University)

Kyung Chan Min
Yonsei University

The inception of SEOUL ICM 2014 began with the participation of Kyung Chan Min (former president of the KMS) and Hyungju Park (chairman of the SEOUL ICM 2014 Organizing Committee) at the 15th IMU General Assembly in Santiago de Compostela, Spain.

Kyung Chan Min stated that a close interaction with world mathematics communities is imperative for the growth of mathematics in Korea. He cited the speeches of King Juan Carlos I of Spain and of IMU President John Ball at the opening ceremony ICM 2006 in Madrid as the inspiration that incubated the NANUM program. He added that the Korean Mathematical Community should now look forward to taking another step ahead, following the SEOUL ICM 2014.

"We must promote mathematical development as an essential element for the progress that will enable sustainable development for all Humanity."

King Juan Carlos I

Volunteers in SEOUL ICM 2014

Aspiring students volunteer for ICM

With a paper in his hand, a mathematician at the SEOUL ICM 2014 looked at a loss when he bolted out of a room on Friday. But he smiled when he saw a young man in a red T-shirt. "Could you do me a favor?" the mathematician asked, and gave him the paper to deliver to another person in a distant room.

The young man, Keunwoo Lim, a Seoul National University freshman with a smile. The 19-year-old mathematics major finished the errand and then said, "I'm happy that I could do something for mathematicians."

The International Congress of Mathematicians set the stage for mathematicians to shine, but other people helped them shine more brightly. About 300 college students have been working as volunteers during the SEOUL ICM 2014.

Hosting an event of this magnitude is a lot of work. The volunteers have made sure the organizing committee missed nothing in running the event-packed nine-day congress smoothly. They provided translation services and checked attendance. Some guided visitors puzzled by the meandering COEX corridors.

Around 300 college students in Korea have volunteered to help mathematicians gathering during the Seoul ICM 2014.

Some carried heavy luggage and equipment.

Many live in the Seoul metropolitan area, but a third are from other provinces all over Korea or from abroad. About 760 young people applied for the job; 331, from 80 colleges, were selected. Among them, 290 volunteers devoted a significant portion of their summer vacation to the congress.

Since the launch ceremony for the volunteer group on July 9, the students have been coached about how to prepare for the event, including by Jun-muk Hwang, who researches complex geometry at the Korea Institute for Advanced Study. Hwang described for them the ICMs that he had attended earlier.

Dowan Koo, a junior at Yonsei University, is the student leader of the group. The 22-year-old math major said the congress has him to study harder.

"My dream is to attend an ICM," he added, "and I am excited and happy to meet the people who have already achieved what I dream of."

2010 Fields Medalist – Cédric Villani

Something beautiful and useful in everyday lives

Cédric Villani, a professor at the École Normale Supérieure de Lyon in France and the head of the Institut Henri Poincaré, has been often referred to as the icon of mathematical popularization. He has appeared in television shows and documentary films and has written books in his effort to popularize the field which he says is "beautiful but also useful."

Villani cuts a stylish path wherever he goes, often wearing a silk scarf and a spider brooch, and retains a youthful enthusiasm for his discipline, gladly appearing in a movie, for example, to promote the beauty of mathematics. Popularizing mathematics, says Villani, is promoting your own field and his raison d'être.

"Why am I a mathematician and why am I paid to do mathematics?" Villani asked rhetorically of reporters on Monday at COEX. "We as mathematicians have to justify our use of taxpayers' money – as is the case for most mathematicians – for something that's beautiful and very useful in many areas of our everyday lives."

"It's about making young generations aware that they can have a bright future in this field and be proud of going into it," he continued. "In the end, it's also to feel good about yourself as you better understand your role." As part of Villani's activities, he appeared at a screening of a French documentary in which he is featured, called "How I Came to Hate Maths." Directed by Olivier Peyon, the film was shown Tuesday evening at COEX.

"Enjoying [mathematics] with the public is a huge joy and reward for me," said Villani. "I expect that the ICM will trigger new desires among schoolchildren to become mathematicians."

He was interviewed by email by the JoongAng Ilbo, before the congress began.

Q. How would you explain your research in terms that the general public can understand?

A. Kinetic theory and transport theory describe the evolution and prediction of gas statistics, taking into account the statistical nature of a gas and the fact that particles are subject to motion and interaction. These equations are used also to describe the evolution of galaxies and plasmas, among other things.

The most famous equations in kinetic theory are the Boltzmann equation, which describes the phenomenon known as entropy, or increasing disorder in a system; and the Vlasov equation, which describes the "more ideal" world of plasmas and stars in which collisions are negligible.

Mathematicians are often stereotyped as inflexible and single-minded, but your personal website shows a quite different image. Do you enjoy interacting with the general public?

Since [receiving] the Fields Medal, I have given hundreds of public lectures, interacted with artists (including Patti Smith, David Lynch and some other heroes of mine) and appeared in a movie.

Cédric Villani
Institut Henri Poincaré

All of these events were received very positively by the public, which shows that there is a huge appetite on their part to better understand the role of mathematics in their lives, the role of mathematics as part of the human culture, the role of the mathematician as a creator and innovator, and the art and efficiency that there is in mathematics.

Will you briefly explain to us what "How I Came to Hate Maths" is about?

This is a documentary film, a road movie, showing what mathematicians really are – not fictitional heroes, but real ones. The movie shows how we behave, how we talk to each other, and so on, but also what subjects make us tremble: Where are the engineering applications, where are the important and sometimes serious consequences? It is the first time that a movie presented mathematicians in such a realistic way.

As the title of the film implies, many people find mathematics difficult and distant. Why is that?

Mathematics is tricky. There is no way around it. It requires rigor, but also tenacity and imagination. It is not obvious to understand its relation to our world. One has to be patient, curious, and able to accept mistakes and improve. It is really learning to think differently.

What is mathematics to you? What personal meanings does it have, and what about it attracts you?

Mathematics has been my professional love and life, a way to explore the world and to understand other sciences, but also to understand many things beyond science that are valuable.

Mathematics has been my way to exert creativity and do works of art, as I consider some of my proofs to be. Mathematics has been the opportunity for me to write huge books, which I treasure as enormous achievements. Mathematics has also been the way by which I have explored the geographical world, having traveled to more than 40 countries to talk about mathematics. It has also been my way into the brains and souls of other people.

I can't isolate the precise features of what in there attracts me. You can't explain the love of your life.

Movie Screening: "Comment J'ai Détesté Les Maths" (How I Came to Hate Maths)

On Tuesday, a group of curious (and perhaps hostile because of the title?) people gathered in Hall D of COEX to watch a French movie, "Comment J'ai Détesté Les Maths" (How I Came to Hate Maths).

As the title suggests, the movie began with ordinary people's negative perceptions of mathematics, which seem to be similar all over the globe. People in the film associated mathematics with boredom, hatred, curses, frustration, fury, uselessness and similar epithets. Their reaction was summed up in one question, "Why should we care about these stupid things?"

Scenes from the movie, "Comment J'ai Détesté Les Maths" (How I Came to Hate Maths).

The French filmmaker Olivier Peyon tried to find answers to this question by interviewing front-runners in the field such as Cédric Villani (2010 Fields Medalist), Bernd Strumfels (Professor of UC Berkeley), Jean-Pierre Bourguignon (President of the European Research Council), Gert-Martin Greuel (Scientific Advisor of IMAGINARY), and James Simons (Chairman of Simons Foundation). The film also included the opinions of ordinary math-loving people like François Sauvageot, a high-school math teacher.

In the movie, Villani gives an capsule description of the charms of mathematics by saying, "Mathematics is rigorous but also creative. It is abstract but universal. It's inegalitarian and democratic. It's ancient yet always evolving."

But certainly the Seoul ICM 2014 Organizing Committee did not arrange this program so that viewers could go home with reasons to hate math. It was quite the opposite.

Although the elite mathematicians described mathematics with exalted terms like "passion," "beauty," and "application" in the film, somewhat softer voices from ordinary people gave the audience additional reasons not to hate math.

In the film, the director attempts to change ordinary people's negative perceptions towards mathematics to perceptions that it is humane, friendly and very close to our everyday lives.

ICM 2018, Rio de Janeiro – 'Sowing Seeds'

The General Assembly of the International Mathematical Union in Gyeongju announced on Aug. 11 that Rio de Janeiro would be the the site of ICM 2018. Not only is this a great honor to the Brazilian mathematical community, it is also a humbling experience. In our country, advanced mathematics started very late, but it developed quickly and vigorously through the efforts of a few talented and energetic pioneers. Fortunately, many of those individuals are still alive to bask in this achievement and experience our gratitude for making it possible.

Brazilian mathematics is indeed very young. Pioneer efforts can be traced back to the mid-19th century, but sustained research activities began only in the 1950s, when Brazil joined the International Mathematical Union, the Brazilian Mathematical Colloquium was first held, and a number of important institutions were founded.

In about six decades, the number of Brazilian mathematicians has increased to about 2,000 active researchers and professors. Research activity covers most areas of mathematics and many of its applications, with regular publications in the best journals, and the work has been spreading to the entire country. Three plenary lectures and 15 invited addresses have been given at ICMs by Brazilian mathematicians, including one plenary lecture and three invited addresses at ICM 2014 in Seoul.

There are now more than 50 graduate programs in mathematics and statistics in Brazil, from the Amazon region to the southern border, training an increasing number of Brazilians and a substantial number of foreign students, especially from Latin America but increasingly from Asia, Europe and North America.

The first graduate programs in mathematics began in the 1930s, with the creation of the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, and the National Faculty of Philosophy of the University of Brazil in Rio de Janeiro. Among the generation trained at the latter school were Mauricio Matos Peixoto and Leopoldo Nachbin, who helped create the Instituto de Matemática Pura e Aplicada (IMPA) in 1952 and were also the first Brazilian mathematicians to give invited addresses at an ICM (in 1962 and 1974 respectively).

Another landmark was the organization of the first Brazilian Mathematical Colloquium in 1957. Several important books in the national mathematical literature, both elementary and advanced, started out as lecture notes for those colloquiums.

In the 1950s and 1960s, a new generation of mathematicians emerged, thanks in large part to training abroad. Regular graduate programs in mathematics were initiated in the 1960s, radiating from IMPA and the University of São Paulo.

The Brazilian Mathematical Society was founded in 1969 and became the country's adhering organization to the IMU. Development accelerated in the 1970s, when definite policies for expansion and consolidation of the national scientific system, including a strategic plan for graduate studies, were put in place by the federal government. The importance of mathematics for the development of science and technology in the country earned it special treatment at that stage.

Other mathematical societies were then created, including the Brazilian Society for Applied and Computational Mathematics, the Brazilian Statistics Association, the Brazilian Society for Mathematical Education, and the Brazilian Society for the History of Mathematics.

Since 2002, the Brazilian Mathematical Society has organized the Bienal da Matemática, devoted to the teaching and popularization of mathematics at all levels and drawing over 2,000 participants at every session.

A scene at the "Brazil Bressan" night on Aug. 19 at the Grand Ballroom of COEX. The Brazilian Mathematical Society hosted the reception; Brazil will be the host of the next International Congress of Mathematicians, meeting in Rio de Janeiro 2018.

Marcelo Viana

Chairman of the ICM 2018 Organizing Committee
President of the Brazilian Mathematical Society

Education, especially in mathematics, has been a consistent top priority for the Brazilian government for many years. Programs now include support for graduate studies both in Brazil and abroad and exchange programs to foster a two-way flow of mathematical talent between Brazil and the rest of the world.

The organization of the ICM 2018 in Rio de Janeiro is an initiative of the Brazilian Mathematical Society, in partnership with IMPA and the Brazilian Academy of Sciences, on behalf of the national mathematical community and with the support of all levels of government.

The first ICMs came at a critical historical juncture, where the very foundations of the mathematical edifice were being put to the test. More than one hundred years later, as we look ahead to the first ICM in the southern hemisphere, we face different challenges: how to make mathematics more global, more accessible, more widespread, and better known throughout the planet.

As the first ICM to take place in Latin America, the Rio de Janeiro ICM will also provide opportunities to expand the region's great progress in mathematical research and outreach.

See you in Rio!

Article by Marcelo Viana

Members of the Math&Presso team and volunteer students pose for a photo yesterday, the penultimate day of the 2014 Seoul International Congress of Mathematicians.

Daily Math Puzzle

Q. (Careful – answer is below.)
In a 6/45 lottery, players select six numbers from 1 to 45, trying to match as many as possible with the six numbers randomly drawn from the same pool. What is the least number of lottery tickets you must purchase in order to guarantee a ticket with two correct numbers?

Answer to today's Daily Math Puzzle

15 tickets
See details in Rio~

The Closing Ceremony of SEOUL ICM 2014 will be held from 3 p.m. to 4:30 p.m. in Hall D1.

14:00 - 15:00 Invited Lecture by Yitang Zhang will be held from 2 p.m. to 3 p.m. in Hall D1.
Chair: Myung-Hwan Kim, Seoul National University, Korea