

# Highlights of the Seoul ICM 2014

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# Prelude

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Day trip to Gyeongju (GF, KM)

- ▶  $\sim 2\frac{1}{2}$  hours SE of Seoul (fast train + local bus)
- ▶ Tumuli Park
- ▶ Cheongsomdae Observatory



# International Congress of Mathematicians

- ▶ held every four years by the International Mathematical Union
- ▶ attracts thousands of mathematicians
- ▶ participants come from most countries and all branches of mathematics
- ▶ major awards:
  - ▶ Fields Medals
  - ▶ Nevanlinna Prize (mathematical aspects of information sciences)
  - ▶ Gauss Prize (impact outside mathematics)
  - ▶ Chern Medal (lifelong achievement)
  - ▶ Leelavati Award (public outreach)

# International Congress of Mathematicians 2014



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**SEOUL ICM 2014**

INTERNATIONAL  
CONGRESS OF  
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# International Congress of Mathematicians 2014

- ▶ Seoul, South Korea
- ▶ 5,193 participants from 122 countries



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- ▶ 21,227 public programme participants
- ▶ 256 media people
- ▶ 564 staff



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- ▶ 21,227 public programme participants
- ▶ 256 media people
- ▶ 564 staff
  
- ▶ 1,267 presentations, including ...
- ▶ 20 plenary lectures (mornings)
- ▶ 188 invited lectures
- ▶ massively parallel sessions

# International Congress of Mathematicians 2014

	11-Aug (Mon)	12-Aug (Tue)	13-Aug (Wed)	14-Aug (Thu)	15-Aug (Fri)	16-Aug (Sat)	17-Aug (Sun)	18-Aug (Mon)	19-Aug (Tue)	20-Aug (Wed)	21-Aug (Thu)	Venue		
08:00			Registration 07:00-20:30 Exhibition 13:00-18:00	Registration 08:00-18:00 Exhibition 09:00-18:00	Registration 08:00-18:00 Exhibition 09:00-18:00	Registration 08:00-19:00 Exhibition 09:00-18:00		Registration 09:00-18:00 Exhibition 09:00-18:00	Registration 09:00-18:00 Exhibition 09:00-18:00	Registration 09:00-20:30 Exhibition 09:00-18:00	Registration 09:00-15:00			
09:00		ICMI, Emília W. Uivar IMAWO	Opening Ceremony	Ian Agol	James Arthur	Mayam Mirzakhani		Alexei Borodin	Mikhail Lyubich	Alan Frieze	Jonathan Pita			
10:00					Jun-Muk Hwang	Demetrios Christodoulou	Franco Brezzi		Jean- François Le Gall	Ben Green	Takuro Mochizuki	Vojtech Rödl	Hall D	
11:00														
12:00				Lunch	Emmanuel Candes	János Kollár	Manjul Bhargava		Fernando Coda Marques	Benoit Perrhame	Frank Merle	Vera Serganova		
13:00					Lunch	Lunch	Lunch		Lunch	Lunch	Lunch	Lunch	Hall C1+C2	
14:00			Registration	Laudations for Fields 1 Laudations for Fields 2	Fields Medalist 1	Fields Medalist 2	Gauss Prize Lecture		Chern Prize Lecture	Fields Medalist 3	Fields Medalist 4	Invited Lecture (Yitang Zhang)	Hall D	
15:00				Laudations for Fields 3 Laudations for Fields 4 Laudations for Nevenina	Invited Section Lectures & Panel Sessions	Invited Section Lectures & Panel Sessions	Invited Section Lectures & Panel Sessions	Excursion	Invited Section Lectures & Panel Sessions	Invited Section Lectures & Panel Sessions	Invited Section Lectures & Panel Sessions	Closing Ceremony	Invited Section Lecture & ICMI Panels: Hall E1.4, E5.4, 300, 301AB, 307ABC, 308ABC, 317ABC, 318ABC, 327ABC, 402, Hall D1	
16:00				Nevenina Prize Lecture	ICMI (Core) IMU Panel 1	ICMI (Core) IMU Panel 2	ICMI (Core) IMU Panel 3			ICMI (Core) IMU Panel 1	ICMI (Core) IMU Panel 2	ICMI (Core) IMU Panel 3		Short Communications: 300, 310AB, 311AB, 312, 313, 316, 319, 320AB, 321AB, 322, 323, 304AB, 325AB, 326
17:00					Photo Signing 16:00-17:00	Photo Signing 16:00-17:00	Photo Signing 16:00-17:00			Photo Signing 16:00-17:00	Photo Signing 16:00-17:00	Photo Signing 16:00-17:00		Public Book Event & IMU Panel 1
18:00	Registration				Emily Noether Lecture (Georgia Benkart)	Abel Lecture (John M. Eitner)	Casual Performances			IMU Panel 1	IMU Panel 2	IMU Panel 3		Math Movie Screening: Hall D
19:00			Welcome Reception				Conference Dinner							Special Lectures: Hall D
20:00				Public Lecture 1 (James Simons)								Public Lecture 2		IMU Panels: 402 Conference Dinner: Hall D
Thematic Days									Math Education Day	Math History Day	Math Popularization Day		Hall D	

# International Congress of Mathematicians 2014

## Fields Medals

- ▶ Artur Avila (CNRS (France)/IMPA (Brazil))
  - ▶ dynamical systems theory
- ▶ Manjul Bhargava (Princeton)
  - ▶ number theory, rational points on elliptic curves
- ▶ Martin Hairer (Warwick)
  - ▶ stochastic partial differential equations
- ▶ Maryam Mirzakhani (Stanford)
  - ▶ dynamics and geometry of Riemann surfaces

## Nevanlinna Prize

- ▶ Subhash Khot (NYU)
  - ▶ approximability in combinatorial optimisation problems

## Gauss Prize

- ▶ Stanley Osher (UCLA): applied mathematics

## Chern Medal

- ▶ Philip Griffiths (Princeton): geometry

## Leelavati Prize

- ▶ Adrián Paenza (Buenos Aires)

# International Congress of Mathematicians 2014

- ▶ opening ceremony: prize announcements, presentations of (almost all) awards
- ▶ closing ceremony: presentation of Leelavati Prize
- ▶ laudations: Fields Medals, Nevanlinna Prize
- ▶ lectures by prizewinners
- ▶ lecture by John Milnor (Abel Prize 2011)
- ▶ International Congress of Women Mathematicians (ICWM) (12, 14 Aug)
- ▶ Emmy Noether lecture by Georgia Benkart (Wisconsin)
- ▶ public lectures:
  - ▶ James H Simons
  - ▶ Adrián Paenza (Leelavati Prize)
- ▶ panels
- ▶ exhibition
- ▶ DonAuction
- ▶ conference dinner
- ▶ Baduk (a.k.a. Go or Weiqi)

## Some mathematics

**Yitang Zhang** (special invited lecture)

- ▶ **Theorem** (2013).  $\exists$  constant  $k$  such that  $\exists$  infinitely many pairs of consecutive primes differing by exactly  $k$
- ▶ initially showed  $k < 70,000,000$
- ▶ since his first proof,  $k$  has been reduced to 246
- ▶ *Twin Prime Conjecture*:  $k = 2$

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### Ben Green (plenary lecture) on Approximate Algebraic Structure

- ▶ announced new result (Ford, Green, Konyagin, Tao)  
<http://arxiv.org/abs/1408.4505>
- ▶ Put  $G(x) := \max$  gap between consecutive primes  $\leq x$ .
- ▶ **Theorem.** For some (slowly) growing function  $f$ ,

$$G(x) \geq f(x) \frac{\log x \log \log x \log \log \log \log x}{(\log \log \log x)^3}.$$

- ▶ answered affirmatively a question of Erdős (for which he had offered \$10,000, the largest of all his rewards)

## Some mathematics

**Marc Noy** (invited lecture): Random planar graphs and beyond

- ▶ Giménez (2005):

# planar graphs on  $n$  vertices  $\sim c \cdot n^{-7/2} \gamma^n n!$  ( $\gamma \simeq 27.29$ )

- ▶ Chapuy, Fusy, Giménez, Mohar, Noy (2011) (+ Bender & Gao):

# graphs of genus  $g$  on  $n$  vertices  $\sim c \cdot n^{5(g-1)/2-1} \gamma^n n!$

- ▶ “A random graph of genus  $g$  has the same global properties as one of genus 0.”

- ▶ Let  $\mathcal{G}$  be a minor-closed class of graphs.

Consider a *random* member of  $\mathcal{G}$ .

**Conjecture.**

If  $\mathcal{G}$  has bounded tree-width, then largest block has size  $o(n)$ .

- ▶ tree-width 1  $\implies$  size of largest block = 2
- ▶ tree-width 2  $\implies$  size of largest block =  $O(\log n)$
- ▶ tree-width 3: first open case
- ▶ planar  $\implies$  size of largest block =  $\Theta(n)$ .

## Some mathematics

Unique Games Conjecture (UGC) pertains to ...

E2LIN mod  $p$

INPUT: a set of linear equations of the form

$$x_i - x_j = c_{ij} \pmod{p}$$

OUTPUT: an  $\mathbf{x}$  that satisfies the most equations.

Unique Games Conjecture (UGC):

The following *promise problem* is NP-hard:

INPUT: as for E2LIN mod  $p$ .

PROMISE: at least a fraction  $1 - \varepsilon$  of the equations are satisfiable.

OUTPUT: a solution to at least a fraction  $\varepsilon$  of the equations.

There are many inapproximability results conditional on UGC.

Opinion seems divided on whether it's true.



## Some mathematics

Tommy Jensen (Kyungpook NU) (contributed talk):

On some unsolved graph colouring problems

- ▶ Adaptive chromatic number

$\chi_{\text{ad}}(G) :=$  minimum  $k$  such that

$\forall f : E(G) \rightarrow \{1, \dots, n\} \quad \exists \varphi : V \rightarrow \{1, \dots, k\}$  such that  
 $\forall uv \in E(G), \quad \{\varphi(u), \varphi(v)\} \neq \{f(uv)\}.$

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- ▶ Can you bound  $\chi(G)$  as a function of  $\chi_{\text{ad}}(K_n)$ ?
- ▶ Hell & Zhu (2008)

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  - ▶ **Theorem** (Kawarabayashi & Reed, 2009). For all  $k$  there exists  $N$  such that any counterexample to the  $k$ -case of Hadwiger's conjecture has  $< N$  vertices.

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  - ▶ **Question:** Is there a *short* argument to show that any counterexample to the Four Colour Theorem has  $\leq N$  vertices?

## Further information

- ▶ Seoul ICM 2014 webpage:  
<http://www.icm2014.org/>
- ▶ Seoul ICM 2014 on YouTube:  
<https://www.youtube.com/user/ICM2014SEOUL>
- ▶ ICM 2018 in Rio de Janeiro, Brazil, 7–15 August 2018:  
<http://www.icm2014.org/>