LONDON MATHEMATICAL SOCIETY

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Highest honour for UK mathematician

Professor Martin Hairer FRS, University of Warwick becomes the ninth UK based mathematician to win the prestigious Fields Medal over its 80 year history. The medal recipients were announced today in a ceremony at the four yearly International Congress for Mathematicians, which on this occasion is being held in Seoul, South Korea.

The president of South Korea, Geun-hye Park, was present for the announcements and presented Professor Hairer with the medal. The Fields Medal has an equivalent standing within mathematics as the Nobel Prize has within other areas of science and is awarded every four years to at most four of the most outstanding mathematicians under 40 years of age at the beginning of the year.

Martin Hairer works in an area of mathematics known as stochastic analysis; it provides conceptual and computational toolkits for rigorously modelling the interactions within high dimensional random systems.

A smouldering rag is a difficult system to think about mathematically. There is an interaction between highly non-uniform heat pattern, heat dependent and heat producing chemical reactions, and the ever changing state of the underlying rag as more of it turns to ash. It is an example of an important class of problems around modelling randomly evolving interfaces. Although common in nature and important, they have challenged mathematicians for decades. The combination of randomness, singularity, and nonlinearity simply do not fit well together with existing mathematical tools (*eg* partial differential equations).

Martin Hairer works on this interface between probability theory and partial differential equations; and has created a body of work that is widely recognised as having revolutionised an entire field of research.

Hairer was able to give, for the first time, a rigorous intrinsic mathematical meaning to a number of different classes of random interface arising in physics. These problems have been a focus of attention for decades.

Terry Lyons, President of the London Mathematical Society, commented, 'We are all very excited that Martin Hairer's incredible and ground shaping achievements have been recognised by the international community through the award of a Fields Medal. The Fields Medal has, for many years, been recognised as being at the highest level; the Nobel Prize for mathematics. As a result of Martin Hairer's spectacular work and precise definitions, a new field is effectively opened up and validated through a range of deep, distinctive, and challenging applications. In addition to his great science, Martin Hairer is a major contributor to the wider mathematical community. On behalf of the LMS, I congratulate Martin and I am confident this congratulatory message is shared across the whole UK community and beyond'.

Professor Hairer, said, 'The award of a Fields Medal is of course an extraordinary recognition of the work in analysing singular stochastic partial differential equations, which goes well beyond anything I ever dared to imagine. It also provides recognition to this very broad interface between probability theory and analysis, sometimes collectively referred to as "stochastic analysis", as a very active area of modern mathematics with a fascinating range of deep open problems still waiting to be explored. This is also an opportunity to thank my wife Xue-Mei, my parents, and the many friends and colleagues on both sides of the Atlantic who provided continuous inspiration, encouragement and support over the years'.

Three other outstanding young mathematicians also received the Fields Medal. Maryam Mirzakhani (Stanford University), Artur Avila (Centre national de la recherche scientifique, France) and Manjul Bhargava (Princeton University).

Mirzakhani was cited for her 'outstanding contributions to the dynamics and geometry of Riemann surfaces and their moduli spaces' and made history as the first woman to win a Fields Medal.

Artur Avila received the award for his profound contributions to dynamical systems theory, which have changed the face of the field, using the powerful idea of renormalization as a unifying principle'.

Manjul Bhargava was awarded a Fields Medal 'for developing powerful new methods in the geometry of numbers, which he applied to count rings of small rank and to bound the average rank of elliptic curves'.

Notes for Editors

1. The **London Mathematical Society (LMS)** is the UK's learned society for mathematics. Founded in 1865 for the promotion and extension of mathematical knowledge, the Society is concerned with all branches of mathematics and its applications. It is an independent and self-financing charity, with a membership of over 2600 drawn from all parts of the UK and overseas. Its principal activities are the organisation of meetings and conferences, the publication of periodicals and books, the provision of financial support for mathematical activities, and the contribution to public debates on issues related to mathematics research and education. It works collaboratively with other mathematical bodies worldwide. It is the UK adhering body to the International Mathematical Union.

2. The **Fields Medal** was founded at the behest of the Canadian mathematician John Charles Fields and was first awarded in 1936. Its aim is to recognise and support the major contributions of younger mathematicians - those under 40 years old. The award includes a gold medal, and a nominal monetary award of US$15,000 (€10,000). It is awarded after the most stringent refereeing process organised by the International Mathematical Union (IMU). Usually chaired by the President of the IMU, the composition of the Fields medal committee is only announced at the time the prize recipients are announced.

3. The Fields medal ceremony **is streamed live** on YouTube (“Seoul ICM 2014”) from 9am-11.35am local Seoul time. A three minute video account of the work of each recipient will be shown at the ceremony.

4. **Professor Hairer’s work in more detail**. It is important throughout science to understand the influence of noise on differential equations, and on the long-time behaviour of the solutions. A milestone came with the seminal work of Itô in the 1940s, whose work linking differential equations with Brownian noise has had a transformative effect that spreads from engineering through finance, to biology. In the past 20 years there have been substantial further advances. However, none of these developments have satisfactorily captured the behaviour of systems with complex spatial interaction. For partial differential equations, a comprehensive and rich enough theory has proved to be more elusive, and only particular cases (linear equations, tame nonlinearities *etc*) had been treated satisfactorily.

   Hairer's work addresses two central aspects of the theory. Together with Mattingly he employed the Malliavin calculus along with new methods to establish the ergodicity of the two-dimensional stochastic Navier-Stokes equation. Building on the rough-path approach of Lyons for stochastic ordinary differential equations, Hairer then created an abstract theory of regularity structures for stochastic partial differential equations (SPDEs). This allows Taylor-like expansions around any point in space and time. The new theory allowed him to construct systematically solutions to singular non-linear and vector valued SPDEs as fixed points of a renormalisation procedure.

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