Faltings and Iwaniec Awarded Shaw Prize


Max Planck Institute for Mathematics, Bonn, Germany.

Gerd Faltings


Nick Romanenko, Rutgers University.

Henryk Iwaniec

On June 1, 2015, the Shaw Foundation announced the awarding of the 2015 Shaw Prize in Mathematical Sciences to Gerd Faltings of the Max Planck Institute for Mathematics in Bonn, Germany, and Henryk Iwaniec of Rutgers University "for their introduction and development of fundamental tools in number theory, allowing them as well as others to resolve some long-standing classical problems." The prize carries a cash award of US$1 million.

The Shaw Prize in Mathematical Sciences Committee released the following statement about the prizewinners' work.

"Number theory concerns whole numbers, prime numbers, and polynomial equations involving them. The central problems are often easy to state but extraordinarily difficult to resolve. Success, when it is achieved, relies on tools from many fields of mathematics. This is no coincidence since some of these fields were introduced in attempts to resolve classical problems in number theory. Faltings and Iwaniec have developed many of the most powerful modern tools in algebra, analysis, algebraic and arithmetic geometry, automorphic forms, and the theory of zeta functions. They and others have used these tools to resolve long-standing problems in number theory."

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The Work of Gerd Faltings

"A polynomial equation of degree n in one variable with coefficients which are rational numbers has just n complex numbers as solutions. Such an equation has a symmetry group, its Galois group, that describes how these complex solutions are related to each other.

"A polynomial equation in two variables with rational coefficients has infinitely many complex solutions, forming an algebraic curve. In most cases (that is, when the curve has genus 2 or more) only finitely many of these solutions are pairs of rational numbers. This well-known conjecture of Mordell had defied resolution for sixty years before Faltings proved it. His unexpected proof provided fundamental new tools in Arakelov and arithmetic geometry, as well as a proof of another fundamental finiteness theorem—the Shafarevich and Tate Conjecture—concerning polynomial equations in many variables. Later, developing a quite different method of Vojta, Faltings established a far-reaching higher dimensional finiteness theorem for rational solutions to systems of equations on Abelian varieties (the Lang Conjectures). In order to study rational solutions of polynomial equations by geometry, one needs arithmetic versions of the tools of complex geometry. One such tool is Hodge theory. Faltings's foundational contributions to Hodge theory over the p-adic numbers, as well as his introduction of other related novel and powerful techniques, are at the core of some of the recent advances connecting Galois groups (from polynomial equations in one or more variables) and the modern theory of automorphic forms (a vast generalization of the theory of periodic functions). The recent striking work of Peter Scholze concerning Galois representations is a good example of the power of these techniques."

The Work of Henryk Iwaniec

"Iwaniec's work concerns the analytic side of diophantine analysis, where the goal is usually to prove that equations do have integral or prime solutions, and ideally to estimate how many there are up to a given size.

"One of the oldest techniques for finding primes is sieve theory, originating in Eratosthenes's description of how to list the prime numbers. Iwaniec's foundational works and breakthroughs in sieve theory and its applications form a large part of this active area of mathematics. His proof (with John Friedlander) that there are infinitely many primes of the form $X^2 + Y^4$ is one of the most striking results about prime numbers known; the techniques introduced to prove it are the basis of many further works. The theory of Riemann's zeta function—and more generally of L-functions associated with automorphic forms—plays a central role in the study of prime numbers and diophantine equations. Iwaniec invented many of the powerful techniques for studying L-functions of automorphic forms, which are used widely today. Specifically, his techniques to estimate the Fourier coefficients of modular forms of half-integral weight and for estimating L-functions on their critical lines (the latter jointly with William Duke and John Friedlander) have led to the solution of a number of long-standing problems in number theory, including one of Hilbert's problems: that quadratic equations in integers (in three or more variables) can always be solved unless there is an 'obvious' reason that they cannot.

"In a series of papers remarkable both in terms of its concept and novel techniques, Iwaniec together with different authors (Étienne Fouvry and then Enrico Bombieri and John Friedlander) established results about the distribution of primes in arithmetic progressions which go beyond the notorious Riemann hypothesis. This opened the door to some potentially very striking applications. Yitang Zhang's much celebrated recent result on bounded gaps between primes relies heavily on the works of Iwaniec et al. Iwaniec's work mentioned above, together with his many other technically brilliant works, have a central position in modern analytic number theory."

Biographical Sketches

Gerd Faltings was born in 1954 in Gelsenkirchen-Buer, West Germany. He obtained his PhD in mathematics from the University of Münster in 1978. He then spent a year doing postdoctoral work as a research fellow at Harvard University from 1978 to 1979. He was an assistant professor at the University of Münster from 1979 to 1982. From 1982 to 1984, he was professor at the University of Wuppertal. He was professor at Princeton University from 1985 to 1994. Since 1995 he has been a director of the Max Planck Institute for Mathematics. He was awarded the Fields Medal in 1986. He held a Guggenheim Fellowship in 1988 and is also the recipient of the Gottfried Wilhelm Leibniz Prize (1996) and the King Faisal International Prize for Science (2014).

Henryk Iwaniec was born in 1947 in Elblag, Poland. He received his PhD from the University of Warsaw in 1972. He held positions at the Institute of Mathematics of the Polish Academy of Sciences until 1983, when he left Poland. He held visiting positions at the Institute for Advanced Study in Princeton, at the University of Michigan, and the University of Colorado at Boulder. He became professor of mathematics at Rutgers in 1989, where he is currently New Jersey Professor of Mathematics. He has been honored with the Ostrowski Prize (2001), the Frank Nelson Cole Prize in Number Theory (2002), and the Leroy P. Steele Prize for Mathematical Exposition (2011). He was a member of the inaugural class of AMS Fellows (2012).

About the Prize

The Shaw Prize is an international award established to honor individuals who are currently active in their respective fields and who have achieved distinguished and significant advances, who have made outstanding contributions in culture and the arts, or who have achieved excellence in other domains. The award is dedicated to furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilization. Preference is given to individuals whose significant work was recently achieved.

The Shaw Prize consists of three annual awards: the Prize in Astronomy, the Prize in Science and Medicine, and the Prize in Mathematical Sciences. Established under the auspices of Run Run Shaw in November 2002, the prize is managed and administered by the Shaw Prize Foundation based in Hong Kong.

Previous recipients of the Shaw Prize in Mathematical Sciences are George Lusztig (2014), David L. Donoho (2013), Maxim Kontsevich (2012), Demetrios Christodoulou and Richard S. Hamilton (2011), Jean Bourgain (2010), Simon K. Donaldson and Clifford H. Taubes (2009), Vladimir Arnold and Ludwig Faddeev (2008), Robert Langlands and Richard Taylor (2007), David Mumford and Wen-Tsun Wu (2006), Andrew Wiles (2005), and Shiing-Shen Chern (2004).

—From Shaw Foundation announcements