Hacon and McKernan Awarded 2018 Breakthrough Prize

Christopher Hacon of the University of Utah and James McKernan of the University of California San Diego have been awarded the 2018 Breakthrough Prize "for transformational contributions to birational algebraic geometry, especially to the minimal model program in all dimensions."

Christopher Hacon

James McKernan

The prize committee summarizes their work: "'Projective spaces' are a field of algebraic geometry. They are related to the concept of perspective in art: perspective is a way of 'projecting' a 3-dimensional scene onto a 2-dimensional canvas. There are certain rules for doing this: for example, parallel lines on a 2D surface never meet; but to show the parallel lines of our 3D world—such as train tracks—on a 2D canvas, they should appear to converge on a 'vanishing point' in the distance. The human mind can only visualize 3 dimensions. But mathematicians can use algebra to explore far higher dimensions—in fact, indefinitely high. Through their collaboration, Hacon and McKernan worked out the 'rules' for projecting objects in multi-dimensional spaces onto lower-dimensional spaces."

The *Notices* thanks Antonella Grassi of the University of Pennsylvania for providing the following short description of their work: "In 2006 Hacon and McKernan, in collaboration with C. Birkar and P. Cascini, proved the finite generation of the canonical ring for a smooth variety of general type of any dimension. (A variety of general type is the higher dimensional analogue of a Riemann surface of genus $g \geq 2$.) The result is a crucial ingredient in the classification of algebraic varieties.

"In the case of curves, there is a unique smooth projective curve in each birational equivalence class, and the canonical ring is finitely generated. For surfaces, the Castelnuovo-Enriques-Kodaira classification gives minimal models; the finite generation of the canonical ring was proved by Mumford in the second half of the last century. It is in higher dimension that minimal models, canonical models, and finite generation get intertwined. The case of threefolds was solved in the 1980s, and it relies on the explicit classification of the possible singularities involved. Already in dimension four such a classification becomes highly complex.

"Hacon and McKernan's proof is a wonderful roundabout induction on the dimension of the variety, using their proof of existence of minimal models for varieties of general type.

"Since the 2006 results, many other important advances have been made, some by Hacon and McKernan, with many applications."

Biographical Sketch: Christopher Hacon

Christopher Hacon was born in Manchester, United Kingdom, and grew up in Italy. He received his PhD from the University of California Los Angeles in 1998 under the direction of Robert Lazarsfeld. He was a Wylie Assistant Professor at the University of Utah in 1998 and assistant professor at the University of California Riverside from 2000 to 2002. He joined the faculty at Utah in 2002. He says, "Salt Lake City is a mecca for math, after famed mathematician and avid mountaineer János Kollár moved there to do research." Hacon's father was a mathematician, and his first math memory dates to age eight, when he meticulously counted all the books in the house. He believes that most mathematicians are about 100 years ahead of their time because many of the proofs that they unravel are only much later usable in advancing technologies such as cryptography, computer graphics, GPS, MRIs, and others. He speculates that his and McKernan's work may someday be used in advancing string theory.

Hacon received a Clay Research Award in 2007 and has been awarded the Frank Nelson Cole Prize in Algebra (with James McKernan) in 2009, the Antonio Feltrinelli Prize in Mathematics, Mechanics, and Applications (2011), and the E. H. Moore Research Article Prize of the AMS (with James McKernan, 2016). He was an AMS Centennial Fellow in 2006–2007 and a Simons Foundation Investigator in 2012. He was an invited speaker at the International Congress of Mathematicians in 2010, was elected a Fellow of the AMS in 2012, and was elected to the American Academy of Arts and Sciences in 2017. He and his wife, Aleksandra Jovanovic-Hacon, have six children between six and eighteen years old. The family enjoys spending time together outdoors, hiking, skiing, and rock climbing.

Biographical Sketch: James McKernan

James McKernan was born in London and received his PhD in 1991 from Harvard University. He taught at the University of California Santa Barbara from 1995 to 2007 and at the Massachuetts Institute of Technology from 2007 to 2013 before joining the University of California San Diego. His father was an electrical engineer who taught calculus in the evenings at a school for working adults. He says his father encouraged him—he was quite slow but stubborn and had what they now call "grit." Of his work, McKernan says, "What I studied goes all the way back to the Greeks—who first analyzed sections of cones—and now, 2000 years later, a version of the conic sections turns up in string theory!"

McKernan has been the recipient of a Clay Research Award (2007) and the 2009 Cole Prize in Algebra (with Christopher Hacon). He was named a Simons Foundation Investigator in 2016. With Christopher Hacon, he was awarded the 2016 E. H. Moore Research Article Prize. He gave an invited lecture at the ICM in 2010. He was elected to the Royal Society of London in 2011.

About the Award

The Breakthrough Prize in Mathematics was created by Mark Zuckerberg and Yuri Milner in 2013. It recognizes major advances in the field, honors the world's best mathematicians and supports their future endeavors, and aims to communicate the excitement of mathematics to the general public. The prize is accompanied by a cash award of US$3 million. Previous winners of the Breakthrough Prizes are:

2015 Simon Donaldson, Maxim Kontsevich, Jacob Lurie, Terence Tao, and Richard Taylor
2016 Ian Agol
2017 Jean Bourgain

Naber, Viazovska, and Zhang Awarded New Horizons in Mathematics Prizes

The New Horizons in Mathematics Prizes are awarded to promising early-career researchers who have already produced important work in mathematics. The recipients this year are:

Aaron Naber of Northwestern University "for work in geometric analysis and Riemannian geometry, introducing powerful new techniques to solve outstanding problems, particularly for manifolds with Ricci curvature bounds."

Maryna Viazovska of Ecole Polytechnique Fédérale de Lausanne "for remarkable application of the theory of modular forms to the sphere packing problem in special dimensions."

Wei Zhang of the Massachusetts Institute of Technology and Columbia University and Zhiwei Yun of Yale University "for deep work on the global Gan-Gross-Prasad conjecture and their discovery of geometric interpretations for the higher derivatives of L-functions in the function field case."

Naber and Viazovska will receive a cash award of US$100,000 each; Yun and Zhang will share a cash award of US$100,000.

—Elaine Kehoe, from Breakthrough Prize Committee and University of Utah announcements

NOTE. See Henry Cohn's Conant Prize-winning cover story on Maryna Viazovska, "A Conceptual Breakthrough in Sphere Packing," in the February 2017 *Notices*. `www.ams.org/publications/journals/notices/201702/rnoti-p102.pdf`.