Donaldson and Eliashberg Awarded 2020 Wolf Prize

Sir Simon Donaldson of Imperial College London and the Simons Center, Stony Brook University, and **Yakov Eliashberg** of Stanford University have been awarded the Wolf Foundation Prize for Mathematics for 2020 by the Wolf Foundation "for their contributions to differential geometry and topology."


Sir Simon Donaldson


Yakov Eliashberg

Citation: Donaldson

Simon Donaldson is awarded the Wolf Prize for his leadership in geometry in the last thirty-five years. His work has been a unique combination of novel ideas in global nonlinear analysis, topology, algebraic geometry, and theoretical physics, following his fundamental work on four-manifolds and gauge theory. Especially remarkable is his recent work on symplectic and Kähler geometry.

As a graduate student, Donaldson made a spectacular discovery on the nature of four-dimensional geometry and topology which is considered one of the great events of twentieth-century mathematics. He showed there are phenomena in four dimensions which have no counterpart in any other dimension. This was totally unexpected, running against the perceived wisdom of the time. Not only did Donaldson make this discovery, but he also produced new tools with which to study it, involving deep new ideas in global nonlinear analysis, topology, and algebraic geometry.

A trademark of Donaldson's work is to use geometric ideas in infinite dimensions and deep nonlinear analysis to give new ways to solve partial differential equations (PDE). In this way, he used the Yang–Mills equations, which [have their] origin in quantum field theory, to solve problems in pure mathematics (Kähler manifolds) and changed our understanding of symplectic manifolds. These are the phase spaces of classical mechanics, and he has shown that large parts of the powerful theory of algebraic geometry can be extended to them.

Applying physics to problems of pure mathematics was a stunning reversal of the usual interaction between the subjects and has helped develop a new unification of the subjects over the last twenty years, resulting in great progress in both. His use of moduli (or parameter) spaces of solutions of physical equations—and the interpretation of this technique as a form of quantum field theory—is now pervasive throughout many branches of modern mathematics and physics as a way to produce "Donaldson-type invariants" of geometries of all types. In the last five years he has been making great progress with special geometries crucial to string theory in dimensions six ("Donaldson–Thomas theory"), seven, and eight.

Citation: Eliashberg

Yakov Eliashberg is awarded the Wolf Prize for his foundational work on symplectic and contact topology, changing the face of these fields, and for his groundbreaking contribution to homotopy principles for partial differential relations and to topological foundations of multidimensional complex analysis.

Eliashberg is one of the founders of symplectic and contact topology, a discipline [that] originated as mathematical language for qualitative problems of classical mechanics

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and having deep connections with modern physics. The emergence of symplectic and contact topology has been one of the most striking long-term advances in mathematical research over the past four decades. Eliashberg is among the main exponents of this development.

In the 1980s Eliashberg developed a highly ingenious and very visual combinatorial technique that led him to the first manifestation of symplectic rigidity: the group of symplectomorphisms is closed in the group of all diffeomorphisms in the uniform topology. This fundamental result, proved in a different way also by Gromov and called nowadays the Eliashberg–Gromov theorem, is considered as one of the wonders and cornerstones of symplectic topology. In a series of papers (1989–1992), Eliashberg introduced and explored a fundamental dichotomy "tight vs. overtwisted" contact structure that shaped the face of modern contact topology. Using this dichotomy, he gave the complete classification of contact structures on the three-sphere (1992). In these papers, Eliashberg laid the foundations of modern contact topology and introduced mathematical language which is widely used by researchers in this rapidly developing field.

In a seminal 2000 paper, Eliashberg (with Givental and Hofer) pioneered foundations of symplectic field theory, a powerful, rich, and notoriously sophisticated algebraic structure behind Gromov's pseudoholomorphic curves. It had a huge impact and became one of the most central and exciting directions in symplectic and contact topology. It has led to a significant progress on numerous areas, including topology of Lagrangian submanifolds and geometry and dynamics of contact transformations, and it exhibited surprising links with classical and quantum integrable systems.

In recent years (2013–2015), Eliashberg found a number of astonishing appearances of homotopy principles in symplectic and contact topology, leading him to a solution of a number of outstanding open problems and leading to a "mentality shift" in the field. Before these developments, the consensus among experts was that the symplectic world is governed by rigidity coming from Gromov's theory of pseudoholomorphic curves or, equivalently, by Morse theory on the loop spaces of symplectic manifolds. The current impression based on Eliashberg's discoveries is that rigidity is just a drop in the ocean of flexible phenomena.

Biographical Sketches

Sir Simon K. Donaldson was born in 1957 in Cambridge, United Kingdom. Through his passion for sailing as a young man, he became interested in the design of boats and, in turn, in mathematics. He received his BA degree in mathematics from Pembroke College, Cambridge University, in 1979 and his PhD from Oxford University in 1983 under Nigel Hitchin and Michael Atiyah. After receiving his degree, he was appointed a junior research fellow at All Souls College, Oxford. He spent the academic year 1983–1984 at the Institute for Advanced Study, then returned to Oxford as Wallis Professor of Mathematics in 1985. He spent a year as visiting professor at Stanford University and joined the faculty at Imperial College London in 1998. He joined the Simons Center in 2014. Donaldson was awarded the Fields Medal in 1986. His honors and awards also include the Junior Whitehead Prize of the London Mathematical Society (1985), the Crafoord Prize in Mathematics (1994), the Pólya Prize of the LMS (1999), the King Faisal International Prize (2006), the Nemmers Prize (2008), the Shaw Prize (with C. Taubes, 2009), the Breakthrough Prize in Mathematics (2014), and the Oswald Veblen Prize in Geometry (with X. Chen and S. Sun, 2019). He is a Fellow of the AMS and of the Royal Society and a foreign member of the US National Academy of Sciences and the Royal Swedish Academy of Sciences. He was knighted in 2012 for his service to mathematics.

Yakov Eliashberg was born in 1946 in Leningrad. He received his PhD from Leningrad University in 1972 under the direction of V. A. Rokhlin. He was a faculty member at Syktyvkar State University from 1972 to 1979. He worked in software engineering from 1980 to 1987. In 1988 he moved to the United States, where he joined the faculty at Stanford University in 1989. He was awarded a Guggenheim Fellowship in 1995. Other honors include the Oswald Veblen Prize in Geometry (with J. Cheeger and M. J. Hopkins, 2001), the Heinz Hopf Prize (with H. Hofer, 2013), and the Crafoord Prize (2016). He was elected to the US National Academy of Sciences in 2002. He is a Fellow of the AMS.

About the Prize

The Wolf Prize carries a cash award of US$100,000. The science prizes are given annually in the areas of agriculture, chemistry, mathematics, medicine, and physics. Laureates receive their awards from the President of the State of Israel in a special ceremony at the Knesset Building (Israel's Parliament) in Jerusalem. The list of previous recipients of the Wolf Prize in Mathematics is available on the website of the Wolf Foundation, `www.wolffund.org.il`.

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