

# Stephen Smale awarded Wolf Prize in mathematics

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Stephen Smale, a Fields Medalist and a major contributor to many fields of mathematics, has received the prestigious Wolf Foundation Prize in Mathematics. Smale proved, among other things, that a sphere can be turned inside out without breaking it, or even leaving a crease.

Stephen Smale, a professor emeritus of mathematics at the University of California, Berkeley, who has contributed to a broad range of mathematical fields, has been named a recipient of the 2007 Wolf Foundation Prize in Mathematics, one of an array of prestigious prizes awarded yearly by the Israeli foundation.

Smale, 76, who also holds a half-time appointment with the Toyota Technological Institute at the University of Chicago, will split the \$100,000 prize with co-winner Harry Furstenberg of Hebrew University of Jerusalem.

"It's very nice. I'm very, very happy to have it," Smale said.

Smale's work has been called "audacious" and has had a fundamental influence on numerous fields of mathematics, garnering him in 1966 the Fields Medal of the International Mathematical Union, often called the Nobel Prize of mathematics. The Wolf Prize honors Smale for "his groundbreaking contributions that have played a fundamental role in shaping differential topology, dynamical systems, mathematical economics and other subjects in mathematics."

Smale is a member of the National Academy of Sciences, a fellow of the American Academy of Arts and Sciences, a 1996 winner of the National Medal of Science, and the subject of a 2000 biography, "Stephen Smale: The Mathematician Who Broke the Dimension Barrier," by Steve Batterson.

Though retired from UC Berkeley since 1994, Smale continues to explore new fields, such as learning theory - the mathematical description of nerve connections in the brain that give rise to intelligence and learning; flocking, the tendency of group behavior to look coordinated, as with a flock of birds or a school of fish; and the mathematics of data mining.

He is scheduled to deliver two lectures next Monday, Jan. 22: one at the Mathematical Sciences Research Institute in Berkeley on the dynamics and emergence of flocking; and one at the campus's math department on the mathematics of vision.

Smale has arranged his research and teaching schedules at UC Berkeley and the University of Chicago to leave several months free each year for curating his large mineral collection, which is the subject of a 2006 coffee-table book, "The Smale Collection: Beauty in Natural Crystals," edited by Gloria Staebler and Günther Neumeier. The collection, which contains several thousand minerals and includes some 500 prized specimens, is the result of decades of collecting by Smale and his wife, Clara, in areas such as China and Pakistan. The book jacket blurb calls the 100 photos, 30 of them by Smale, "masterpieces from one of the world's finest private collections."

"I guess maybe I had something of a collector in me," Smale said of his long interest in minerals, especially gemstones. "Thirty-eight years ago, I found that I could get some of the very best minerals on our salary, I found them very beautiful, and I went very strong at it from the

beginning."

The public can take a look at 100 of his best minerals later this month at the big Tucson gem and mineral show, where he will be buying, selling, trading and exhibiting.

A native of Flint, Mich., Smale got off to a mediocre start as an undergraduate at the University of Michigan because of his leftist political activities, but, under threat of expulsion, he hunkered down and earned his Ph.D. from that institution in 1957. The following year, he made a splash in the infant field of differential topology with a proof that you could turn a sphere inside out without breaking it or creating a sharp crease, a trick called an eversion. Recent films show how this can be done. (Link: [realvideo.ncsa.uiuc.edu/ramfiles/optiverse.ram](http://realvideo.ncsa.uiuc.edu/ramfiles/optiverse.ram) -- RealPlayer)

In the early 1960s, Smale again startled the mathematical world with a proof of the famous Poincaré Conjecture, though only for dimensions greater than 4. The conjecture was originally formulated in three dimensions, stating that if any loop can be shrunk to a point, then the space is the equivalent of a sphere. Essentially, this means that we, living inside a three-dimensional world, can tell whether or not it's a sphere instead of, for example, a doughnut. The generalized Poincaré Conjecture extends this idea to other dimensions.

Smale's proof of the generalized conjecture opened up vast areas of research which were previously untouchable, and was largely responsible for Smale winning the Fields Medal, which is awarded every four years, traditionally to a mathematician under 40. In 2002 and 2003, Russian Grigori Perelman finally provided a solution for all dimensions, for which he received the Fields Medal last year.

"His (Smale's) proof of the Poincaré Conjecture for dimensions bigger

or equal to 5 is one of the great mathematical achievements of the 20th century," the Wolf Foundation jury wrote. An extension of this proof, his so-called h-cobordism theorem, "has become probably the most basic tool in differential geometry," the jury said.

The h-cobordism theorem showed why it is easier to prove some topological theorems in higher dimensions than in four or our own three dimensions.

Smale joined the UC Berkeley Department of Mathematics in 1960, left for three years to teach at Columbia University, then returned to UC Berkeley in 1964 as a full professor.

During the 1960s, according to the jury, Smale also reshaped the view of the world of dynamical systems, primarily systems of moving objects governed by non-linear laws that make calculation of their ultimate behavior difficult or impossible. In the 1970s, he began work on mathematical economics and non-linear models of economic behavior. Basing his analysis methods on differential topology, he recast the foundations of much of equilibrium theory.

This economic work led in the early 1980s to a consideration of the general problems of complex computations, such as those now relegated to computers. Among his contributions were calculations of how long it takes for several standard algorithms to converge to a solution of a problem. He also showed why the simplest and most widely used method to solve linear programming problems - the simplex algorithm - works in almost all cases. His results have been of immense importance because much of the world's computation on computers involves linear programming.

Smale's politics also dominated his life during these years. He joined the Communist Party while in college, helped organize anti-war

demonstrations on the UC Berkeley campus in the 1960s, including co-organizing with Jerry Rubin a 33-hour "Vietnam Day" teach-in in 1965, tried to stop troop trains passing through the city, and barely avoided a subpoena from the House Unamerican Activities Committee investigating Communists in this country.

Considering the conservative climate of the era, it's not surprising that when he joked that his best mathematics work was done "on the beaches of Rio" - where, in fact, he came up with the partial solution to the Poincaré Conjecture - the National Science Foundation tried to yank his travel funds and remove him as administrator of a large grant. The funding agency eventually backed down, and Smale is supported today by an NSF grant. Among his other hobbies is sailing his boat, Stardust.

After retiring from UC Berkeley in 1994, Smale served as a Distinguished Professor at the City University of Hong Kong from 1995 to 2001, then joined Toyota Tech to help build up its research and teaching, he said.

Smale's honors include the 1965 Veblen Prize for Geometry, awarded every five years by the American Mathematical Society; in 1988, the Chauvenet Prize by the Mathematical Association of America; and in 1989, the Von Neumann Award by the Society for Industrial and Applied Mathematics.

The Wolf Foundation award will be presented to the laureates by the president of the state of Israel in a special ceremony at the Chagall Hall of the Knesset building (Israel's parliament) in Jerusalem on Sunday, May 13.

Source: UC Berkeley

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