

# Kiyosi Itô Receives Kyoto Prize

KIYOSI ITÔ is to receive the 1998 Kyoto Prize in the category of Basic Sciences. The prize, which carries a cash award of 50 million Japanese yen (approximately \$350,000), is presented by the Inamori Foundation and is Japan's highest private award for lifetime achievement.

## The Research of Kiyosi Itô

Kiyosi Itô has made great contributions to the advancement of mathematical sciences, physics, engineering, biology, and economics through his research in stochastic analysis. He is primarily known for his invention of stochastic differential equations, which enable us to describe random motions—similar to Brownian motion—and random phenomena in nature and society. Solving a stochastic differential equation leads to the construction of a probability measure in the path space.

The notion of Brownian particles, which grew out of observation of the motion of pollen grains in water, was first studied by physicists A. Einstein, J. Perrin, and others at the beginning of the twentieth century. In 1923 N. Wiener laid the mathematical foundation for stochastic analysis by constructing a probability measure on the path space which describes Brownian motion.

In the subsequent establishment and development of modern probability theory, the initiation of Itô's theory of stochastic differential equations in 1942 brought about drastic changes in stochastic analysis. He reconstructed stochastic analysis as analysis based on the notion of stochastic integrals. This theory continues to play a key role in the foundation of stochastic analysis. Coinci-

dentally, during that same year R. Feynman, the winner of the 1965 Nobel Prize in Physics, submitted his doctoral dissertation on physics based on path integrals.

Since the early 1950s the theory of stochastic differential equations has been gaining new perspectives through interactions with various branches of mathematics, including partial differential equations, potential theory, harmonic integrals, differential geometry, and harmonic analysis, as well as theoretical physics. Thanks to the efforts of P. Malliavin, S. Watanabe, and others, we now have a mathematically well-established calculus on path spaces. Attempts have been made to develop asymptotic analysis and differential geometry on path spaces as well.

Itô's initial motivation for developing stochastic differential equations was purely mathematical. However, this theory wound up reaching far beyond the confines of mathematics and has been playing a crucial role in various applications in physics, biology, economics, and engineering. Itô's theory of stochastic differential equations, now known as the "Itô calculus", is one of the indispensable tools in analyzing random phenomena. It may not be an exaggeration to say that the research on filtering



Photograph courtesy of Inamori Foundation.

Kiyosi Itô

done by R. Kalman, the 1985 Kyoto Prize laureate in Advanced Technology, could not have developed to its current stage without stochastic differential equations. In the mathematical finance research of F. Black and M. Scholes, who received the 1997 Nobel Prize in Economics, the Itô calculus played a role analogous to that played by ordinary calculus in classical mechanics. Stochastic differential equations and “Itô’s formula” for stochastic integrals are indispensable tools nowadays, even in the real world of finance. Virtually no textbook on mathematical finance fails to have a chapter on the Itô calculus. Itô has made significant contributions to many other topics as well, such as one-dimensional generalized diffusion processes and multiple Wiener expansions.

Itô’s work in stochastic analysis, along with the central role he has played in its subsequent development, typify the twentieth-century mathematical sciences—having mathematical depth and strong interaction with a wide range of areas.

### Biographical Sketch

Kiyosi Itô was born on September 7, 1915, in Hoku-sei-cho, Mie Prefecture, Japan. He graduated from the Imperial University of Tokyo in 1938. He served in the Statistics Bureau of the Cabinet Secretariat of Japan from 1939 until 1943, when he became an assistant professor in the Faculty of Science at Nagoya Imperial University. In 1945 he received his D.Sc. from the Imperial University of Tokyo. He became a professor at Kyoto University in 1952 and professor emeritus in 1979. He held concurrent positions at the Institute for Advanced Study (1954–75), Aarhus University (1966–69), Cornell University (1969–75), and Gakushuin University (1979–85). He served as director of the Research Institute for Mathematical Sciences at Kyoto University from 1976 to 1979.

Itô has received some of Japan’s highest honors, including the Asahi Prize (1978), the Imperial Prize and the Japan Academy Prize (1978), and the Fujiwara Prize (1987). He also received Israel’s Wolf Foundation Prize in 1987. He is an associate foreign member of the Académie des Sciences of France, a member of the Japan Academy, and a foreign member of the U.S. National Academy of Sciences. He has received honorary degrees from the Swiss Federal Institute of Technology in Zurich and the University of Warwick.

### About the Prize

The Kyoto Prizes are presented annually by the nonprofit Inamori Foundation to recognize individuals and groups worldwide who have made significant contributions to the betterment of humanity. The foundation was established in 1984 through a personal endowment of \$200 million from Kazuo Inamori, the founder and chairman emeritus of the Kyocera Corporation, the world’s

top producer of technical ceramics, and DDI Corporation, one of Japan’s leading telecommunications providers.

Two other Kyoto Prizes are to be presented this year: biologist Kurt Wüthrich is to receive the Advanced Technology prize and media artist Nam June Paik is to receive the prize for Creative Arts and Moral Sciences. Each laureate will receive a diploma, a Kyoto Prize medal of 20 karat gold, and a cash gift of 50 million yen. The prizes will be presented during awards ceremonies to be held November 9–12 in Kyoto.

Among previous recipients of the Kyoto Prize are several who have worked in the mathematical sciences: Rudolf E. Kalman (1985), Claude E. Shannon (1985), John McCarthy (1988), I. M. Gelfand (1989), André Weil (1994), and Donald E. Knuth (1996).

—*from Inamori Foundation news release*