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Benoit Mandelbrot to receive prestigious Japan Prize

Inventor of Fractal Geometry profoundly affected the sciences and the arts

IBM Fellow Emeritus Benoit Mandelbrot of the T.J. Watson Research Center, the inventor of fractal geometry, has been awarded the prestigious 2003 Japan Prize for outstanding achievements in the science and technology of complexity.

The announcement was made in Tokyo by the National Science and Technology Foundation of Japan, which has awarded Japan Prizes since 1985 “to scientists whose achievements contribute to the progress of science and technology and the promotion of peace and prosperity for humankind.” The prize will be awarded at the National Theatre in Tokyo in April of 2003 in the presence of the Emperor of Japan.

Few scientists' work has had such a revolutionary effect on the world of science and society. With a naturalist's broad view of science, Mandelbrot has ignored prevailing boundaries and methods in pursuit of his vision. In the process, he has become one of the most versatile mathematicians in history. More importantly, he has created a new geometry of nature centered in statistical physics and was cited by the Wolf Prize for Physics as having “changed our view of nature.”

“Father of fractals”

The paradigm of fractal geometry is rooted in the fact that fractals are complex geometric shapes having identical structure at all scales. Mandelbrot's multi-disciplinary explorations began fifty years ago, when his doctoral thesis in 1952 combined linguistics (the frequency distribution of words) with the tools of statistical thermodynamics. Thermodynamics interpreted in a very broad way has continued to link all his investigations together.

Fractal dimension in nature as measure of roughness

In recent years, Mandelbrot organized his many investigations into a broadly based beginning of a mathematical theory of roughness. The concept of roughness is natural and obvious but before fractals, its “intensity” could not be measured.

Mandelbrot's work came to fruition in his 1967 seminal paper in Science Magazine, titled "How long is the coast of Britain? Statistical self-similarity and fractional dimensionally?'' pointed out that the concept of length was meaningless when trying to describe something as seemingly concrete as a natural coastline; that length is dependent on one's choice of measuring stick.

To characterize this self-similar and yet infinitely complex effect, Mandelbrot introduced into science the concept of fractal dimension; if a smooth curve had a dimension of one, and a smooth surface a fractal dimension of two, a coastline, for instance, could be said to have a fractal

A fundamental discovery: simple rules can generate infinitely complex structures and behaviors

This is perfectly illustrated by a set he discovered in 1980. The Mandelbrot set, which is obtained by simple rules iterated over and over again, has been described as the “most complex object in mathematics.” It has now been studied in great depth, leading to profound mathematical insights. But it has also set generation of mathematicians, computer scientists, hackers, and even artists to generating and studying the beautiful images that resulted.

Computer-generated imagery of that set and of fractal landscapes “allowed him to identify substantial bridges over the chasms that now separate mathematics, science and technology from one another and from the interests of the common man and the child…” and made him “one of that small number of scientists whose ideas not only have a major impact upon science but also on the popular domain.”

dimension somewhere in between one and two, and its value is a measure of roughness, for coastlines and also far more generally.

Pioneer of the mathematical study of finance

In the early 1960s, and again in recent years, Mandelbrot has been a pioneer in the study of financial prices. He demonstrated that price fluctuations are not smooth, as economists thought or assumed for the sake of simplicity, but are often choppy and discontinuous, and the most important ones are concentrated in time so that wealth acquired on the stock market is typically acquired on a very small number of favorable periods. Mandelbrot's notions of fractal and multifractal forms of economic concentration are attracting great attention.

Mathematics of the Nile

At IBM Research, where he joined in 1958, Mandelbrot showed that errors propagating on telephone lines used to transmit computer information were not classically random and self-similar over any chosen period. Not only would there always be periods of error-free transmission and of error-plagued transmission, but it was impossible to find a fine-enough time scale in which that would not be the case.

Mandelbrot has also found self-similarity to hold true in the field of water resources, and his study of floods and droughts in the Nile River Basin revealed and modeled the persistence of weather and the tendency of droughts or floods to come in clusters.

From mathematical pathology to an essential feature of nature

Mandelbrot re-introduced the eye to the study of mathematics where his contributions have been twofold. He proposed several totally unexpected conjectures that turned out to be extraordinarily difficult to prove or even remain open. Moreover, according to New Scientist, " his massive...achievement has been to convert [an] abstract formalism into a flourishing branch of applied mathematics.'' Or in the words of the Mathematical Gazette, "Euclid is replaced as hero by a celestial committee....whose ideas have condensed into fractals under Mandelbrot's supervision.'' Fractals are proving extraordinarily useful in teaching mathematics in combination with physics and some aspects of art.

Mandelbrot's books

His books provided an extraordinary account of how ubiquitous fractality is in nature and communicate his ideas through computer-generated imagery. They mostly deal with physics, but also with the veins and arteries of anatomy, the hierarchical clustering of galaxies – and music and painting. His 1977 book was listed by American Scientist as one of ten greatest books in the hard sciences in the twentieth century.