Encyclopedia of Mathematics and Society

Ingrid Daubechies

Category: Mathematics Culture and Identity.

Fields of Study: Algebra; Number and Operations; Representations.

Summary: The first female president of the International Mathematical Union, Belgian Ingrid Daubechies revolutionized work on wavelets.

Ingrid Daubechies is a physicist and mathematician widely known for her work with time frequency analysis, including wavelets, and their applications in engineering, science, and art. Some people even refer to her as the "mother of wavelets." In 1994, Daubechies became the first tenured woman professor in the Mathematics Department of Princeton University, and in 2004 she was named the William R. Kenan, Jr. Professor of Mathematics at Princeton. Daubechies has achieved many honors internationally and was the first woman to receive a National Academy of Sciences Award in Mathematics. In 2010, she became the first woman president of the International Mathematical Union.

Daubechies was born in Houthalen, Belgium, in 1954. As a child she enjoyed sewing clothes for dolls, saying about her experiences, "It was fascinating to me that by putting together flat pieces of fabric one could make something that was not flat at all but followed curved surfaces." She also computed powers of two in her head before sleeping, a childhood activity that coincidentally her future husband also engaged in. She had the support of her parents, which she appreciated. Her father, a coal mine engineer, answered her mathematical questions, and she tried to do the same with her own children. She attended a single-sex school and was not exposed to the idea that there might be gender differences in mathematics, saying, "So it didn't occur to me. … Later on, I did meet people who felt or even articulated very clearly that women were less 'suited' for mathematics or science, but by then I was confident enough to take this as a sign of their narrow-mindedness rather than let it influence me." She earned her bachelor's degree in 1975 in physics, and her Ph.D. in physics in 1980 from the Free University (Vrije Universiteit) in Brussels, Belgium. She held a research position at the Free University until 1987, when she accepted a position as a member of the technical staff of the Mathematics Research Center at AT&T Bell Laboratories in the United States. She remained at the Bell Labs until 1994, although she took two leaves of absence for research: one for six months at the University of Michigan, and another for two years at Rutgers University

Wavelet Analysis

Daubechies is best known for her work in wavelet analysis, a cross-disciplinary field that allowed her to combine her interest in mathematics with her training in physics. She has stated that she now considers herself a mathematician rather than a physicist because her work in physics was always highly theoretical and mathematical, and because she is interested in applications outside physics, particularly in engineering. A wavelet is an oscillation that has an amplitude that moves from zero to some point and then decreases back to zero (similar to an

oscillation on a heart monitor). A wavelet transform is a mathematical function, similar to a Fourier transform, which allows data to be divided into frequency components and may be used to analyze signals that contain discontinuities and spikes. Jean Morlet and Alex Grossman developed the continuous wavelet function in the 1980s, and Daubechies, working with Yves Meyer and Alex Grossman, developed a discrete approach that allowed the reconstruction of wavelets from discrete values.

Applications of Wavelet Analysis

Wavelet analysis has many practical applications, particularly in creating and storing digital images. For instance, the U.S. Federal Bureau of Investigation (FBI) has used wavelet analysis since 1993 to encode digitized fingerprint records. This application is due in large part to the fact that a wavelet transform of an image reduces the amount of computer memory required to store it by as much as 93% compared to conventional image storage methods. Another application of wavelet analysis is in medical imaging systems, such as magnetic resonance imaging and computerized tomography. These technologies use scanners to collect digital information that is then assembled by a computer into a two- or three-dimensional picture of some internal aspect of the patient's body. Data processing methods involving wavelet transforms "clean up" and smooth digital information to yield a sharper image. Using wavelet transforms in medical scanning also reduces the time used to take the scan (thus reducing the patient's exposure to radiation) and makes the process of acquiring usable images faster and cheaper.

Further Reading

Case, Bettye Anne, and Anne Leggett. *Complexities: Women in Mathematics*. Princeton, NJ: Princeton University Press, 2005.

Haunsperger, Deanna, and Stephen Kennedy. "Coal Miner's Daughter." *Math Horizons* 7 (April 2000).

National Academy of Sciences. "InterViews: Ingrid Daubechies." http://www.nasonline.org/site/PageServer?pagename=INTERVIEWS_Ingrid_Daubechie.

Sarah Boslaugh

See Also

Animation and CGI; Digital Images; Digital Storage; Women.