

*At a Meeting of the Faculty of Arts and Sciences on November 12, 2002, the following Minute was placed upon the records.*

## **GARRETT BIRKHOFF**

Born: January 10, 1911  
Died: November 22, 1996

Garrett Birkhoff spent practically his entire scientific life at Harvard. He was born in Princeton on January 10, 1911. His family moved to Cambridge in 1912 when his father, George D. Birkhoff was appointed to the Harvard Faculty where he served as Professor of Mathematics until 1944. G.D. Birkhoff was a leading American mathematician, domineering and competitive. It is a testament to Garrett Birkhoff's strength of character that he entered a field dominated by his father and was able to have such a brilliant and varied career.

Garrett Birkhoff was educated at home until age eight, and then attended public elementary school for three years. Rather than entering high school at an exceptionally young age, he took a year off riding his bicycle, playing baseball and skating before entering Browne and Nichols for high school at age twelve. After high school he again spent a year at a boarding school at Lake Placid with an emphasis on skiing. When he joined his parents in Europe for the summer, his father gave him a calculus book in French to read, so that he would know calculus when he entered Harvard in the Fall. At Harvard, four of his instructors: Brinkman, Morse, Walsh, and Whitney were his father's Ph.D's, and Prof. Kellogg, of potential theory fame, was his next door neighbor. As Garrett put it, "my undergraduate mathematics education was almost an inside job."

As an undergraduate in the class of 1932, he prepared for a career in mathematical physics. In his senior year he took a course with Kemble on the then radically new theory of physics called quantum mechanics. This course consisted mainly of finding the mathematical solutions to Schödinger's equation in various settings. He was awarded a Henry fellowship which he used to study at Cambridge University after graduation, where he attended Dirac's lectures. Kemble's course at Harvard did not prepare him for Dirac. Only after hearing a lecture on the recently discovered positron did he realize that Dirac's lectures were aimed at describing particles which had not yet been observed!

At Cambridge his interest shifted to abstract algebra. In 1933 he visited Caratheodory who advised him to read van der Waerden's *Moderne Algebra* which was the first text to give a coherent presentation of the astounding achievements of the German algebraists headed by Emmy Noether. Around this time he became interested in "lattice theory," a subject of which he is one of the founding fathers and principle contributors.

As he said in an interview<sup>1</sup> "my ideas about lattice theory developed gradually. It was my father who, when he told Ore at Yale about what I was doing some time in 1933, found out from Ore that my lattices coincided with Dedekind's Dualgruppen...I was lucky to have gone beyond Dedekind

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<sup>1</sup> All direct quotes are taken from the interview by G.L. Alexanderson and Carroll White in *Mathematical People: Profiles and Interviews*. Albers and Alexanderson, eds., 1985. Cambridge, MA: Birkhäuser.

before I discovered his work. It would have been quite discouraging if I had discovered all my results anticipated by Dedekind.”

In 1933 Garrett returned to Harvard as a Junior Fellow.

In 1936 he published a seminal paper with John von Neumann entitled “The logic of quantum mechanics.” The thrust of this paper is that the truly revolutionary nature of quantum mechanics consists in the overthrow of Aristotelian logic: In classical logic, there is an axiom known as the distributive law: If A, B, and C are propositions, then the proposition “A and (B or C)” is the same as the proposition “(A and B) or (A and C)”. The startling result of the Birkhoff-von Neumann paper is that in “quantum logic” the distributive law does not hold.

Among many mathematicians and philosophers, this approach is taken as the foundation stone of quantum mechanics. Among physicists, the paper by Birkhoff and von Neumann has had a more mixed reception.

In 1936 he was appointed as instructor. Birkhoff said “Morse had told me that no one under thirty should write a book. So I thought it over and wrote two.” The first book was a monograph, *Lattice Theory*, published in 1940, which has been the standard in this subject to this very day.

The second book was *A Survey of Modern Algebra* (with Saunders Mac Lane), and first published in 1941. It is difficult to over-estimate the tremendous importance of this book. This book was clearly and enthusiastically written, covering a range of topics which had originated at the end of the nineteenth century but had only been brought to fruition in the 1920s. It could be read by a bright high-school student, but contained topics which were not yet part of the curriculum in most American universities.

During World War II Birkhoff was involved in the development of the proximity fuse. Earlier, anti-aircraft shells were set to explode by time of flight fuses (since direct hits were extremely unlikely). The proximity fuse was set off by determining the distance to a target by the time it took for a radar echo to return to the fuse. This proximity fuse can be regarded as the granddaddy of the “smart bombs” of today.

Later in life, when asked which, of his many contributions, was he most proud of, he responded “I am proud of having contributed to the defeat of Hitler through my work of shaped charges and to the understanding of technology through my work on scientific computing.”

Birkhoff served as assistant professor from 1938 to 1941, associate professor from 1941 to 1946, and full professor from 1946 to 1981. In 1969 Birkhoff was appointed George Putnam Professor of Pure and Applied Mathematics, a post he held until his retirement in 1981.

Garrett Birkhoff married Ruth Collins in 1938. They had three children and five grandchildren, one of whom is currently an undergraduate at Harvard. Ruth was an avid gardener and horticulturist, and Garrett contributed with meticulous weeding of the lawn. Garrett Birkhoff died on November 22, 1996.

Respectfully submitted,

Andrew Gleason

Benedict Gross

Barry Mazur

Wilfried Schmid

Shlomo Sternberg, Chair