George David Birkhoff

George David Birkhoff	
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Born	March 21, 1884 Overisel, Michigan
Died	November 12, 1944 (aged 60) Cambridge, Massachusetts
Nationality	American
Fields	Mathematics
Institutions	Harvard University Yale University Princeton University Radcliffe College
Alma mater	University of Chicago
Doctoral advisor	E. H. Moore
Doctoral students	Clarence Adams David Bourgin Raymond Brink Robert D. Carmichael Hyman Ettlinger Bernard Koopman Rudolph Langer Charles Morrey Marston Morse G. Baley Price I. M. Sheffer Marshall H. Stone Joseph L. Walsh Hassler Whitney David Widder Kenneth Williams
Known for	Ergodic theorem

George David Birkhoff (March 21, 1884 – November 12, 1944) was an American mathematician, best known for what is now called the ergodic theorem. Birkhoff was one of the most important leaders in American mathematics in his generation, and during his prime he was considered by many to be the preeminent American mathematician.[1]

His parents were David Birkhoff and Jane Gertrude Droppers.[2] The mathematician Garrett Birkhoff (1911–1996) was his son.

Career

Birkhoff obtained his A.B. and A.M. from Harvard. He completed his Ph.D. in 1907, on differential equations, at the University of Chicago. While E. H. Moore was his supervisor, he was most influenced by the writings of Henri Poincaré. After teaching at the University of Wisconsin and Princeton University, he taught at Harvard University from 1912 until his death.

Awards and honors

In 1923, he was awarded the inaugural Bôcher Memorial Prize by the American Mathematical Society for his paper Birkhoff (1917) containing, among other things, what is now called the Birkhoff curve shortening process.

He was elected to the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, the Académie des Sciences in Paris, the Pontifical Academy of Sciences,[3] and the London and Edinburgh Mathematical Societies.

Service

- Vice-president of the American Mathematical Society, 1919.
- President of the American Mathematical Society, 1925–1926.
- Editor of Transactions of the American Mathematical Society, 1920–1924.

Work

In 1912, attempting to solve the four color problem, Birkhoff introduced the chromatic polynomial. Even though this line of attack did not prove fruitful, the polynomial itself became an important object of study in algebraic graph theory.

In 1913, he proved Poincaré's "Last Geometric Theorem," a special case of the three-body problem, a result that made him world famous. In 1927, he published his *Dynamical Systems* [4]. He wrote on the foundations of relativity and quantum mechanics, publishing (with R E Langer) the monograph *Relativity and Modern Physics* in 1923. In 1923, Birkhoff also proved that the Schwarzschild geometry is the unique spherically symmetric solution of the Einstein field equations. A consequence is that black holes are not merely a mathematical curiosity, but could result from any spherical star having sufficient mass.

Birkhoff's most durable result has been his 1931 discovery of what is now called the ergodic theorem. Combining insights from physics on the ergodic hypothesis with measure theory, this theorem solved, at least in principle, a fundamental problem of statistical mechanics. The ergodic theorem has also had repercussions for dynamics, probability theory, group theory, and functional analysis. He also worked on number theory, the Riemann–Hilbert problem, and the four colour problem. He proposed an axiomatization of Euclidean geometry different from Hilbert's (see Birkhoff's axioms); this work culminated in his text *Basic Geometry* (1941).

In his later years, Birkhoff published two curious works. His 1933 *Aesthetic Measure* proposed a mathematical theory of aesthetics. While writing this book, he spent a year studying the art, music and poetry of various cultures around the world. His 1938 *Electricity as a Fluid* combined his ideas on philosophy and science. His 1943 theory of gravitation is also puzzling, since Birkhoff knew (but didn't seem to mind) that his theory allows as sources only matter which is a perfect fluid in which the speed of sound must equal the speed of light .

Influence on hiring practices

Albert Einstein and Norbert Wiener, among others, accused Birkhoff of advocating anti-Semitic hiring practices. During the 1930s, when many Jewish mathematicians fled Europe and tried to obtain jobs in the USA, Birkhoff is alleged to have influenced the hiring process at American institutions to exclude Jews. While Birkhoff may have held anti-Semitic views, it was also the case that he had always been outspoken in his promotion of American mathematics and mathematicians. It has been argued that Birkhoff's actions were in good part motivated by a desire to assure jobs for home-grown American mathematicians.[*citation needed*] Saunders Mac Lane (1994), a close friend and collaborator of Birkhoff's son, argued that any anti-Semitic tendencies Birkhoff may have had were not unusual for his time.

However, Birkhoff took a particular liking to certain Jewish mathematicians, including Stanislaw Ulam. Gian-Carlo Rota writes: "Like other persons rumored to be anti-Semitic, he would occasionally feel the urge to shower his protective instincts on some good-looking young Jew. Ulam's sparkling manners were diametrically opposite to Birkoff's hard-working, aggressive, touchy personality. Birkoff tried to keep Ulam at Harvard, but his colleagues balked at the idea."[5]

Selected publications

- Birkhoff, George David. 1913. "Proof of Poincaré's geometric theorem" *Trans. Amer. Math. Soc. 14*: 14–22.
- Birkhoff, George David. 1917. "Dynamical Systems with Two Degrees of Freedom" *Trans. Amer. Math. Soc. 18*: 199–300.
- Birkhoff, George David and Ralph Beatley. 1959. *Basic Geometry* 3rd ed. Chelsea Publishing Co. [Reprint: American Mathematical Society, 2000. ISBN 978-0-8218-2101-5]

Notes

[4] http://www.ams.org/online_bks/coll9/

[5] *From cardinals to chaos: reflections on the life and legacy of Stanislaw Ulam*, Necia Grant Cooper, Roger Eckhardt, Nancy Shera, CUP Archive, 1989, Chapter: *The Lost Cafe* by Gian-Carlo Rota, page 26

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- Aubin, David, 2005, "Dynamical systems" in Grattan-Guinness, I., ed., *Landmark Writings in Western Mathematics*. Elsevier: 871–81.
- Saunders Mac Lane, 1994, "Jobs in the 1930s and the views of George D. Birkhoff," *Math. Intelligencer 16*: 9–10.
- Kip Thorne, 19nn. *Black Holes and Time Warps*. W. W. Norton. ISBN 0-393-31276-3.
- Vandiver, H. S., 1963, "Some of my recollections of George David Birkhoff," *J. Math. Anal. Appl. 7*: 271–83.
- Norbert Wiener, 1956. *I am a Mathematician*. MIT Press. Especially pp. 27–28.
- George D. Birkhoff,Proc Natl Acad Sci U S A. 1943 August; 29(8): 231–239, "Matter, Electricity and Gravitation in Flat Space-Time".

Further reading

- Morse, Marston (1970–80). "Birkhoff, George David". *Dictionary of Scientific Biography* **2**. New York: Charles Scribner's Sons. pp. 143–146. ISBN 0684101149.

External links

- O'Connor, John J.; Robertson, Edmund F., "George David Birkhoff" (http://www-history.mcs.st-andrews.ac.uk/Biographies/Birkhoff.html), *MacTutor History of Mathematics archive*, University of St Andrews.
- George David Birkhoff (http://genealogy.math.ndsu.nodak.edu/id.php?id=5879) at the Mathematics Genealogy Project
- Birkhoff's biography (http://darwin.nap.edu/books/0309082811/html/45.html) – from National Academies Press, by Oswald Veblen.
- National Academy of Sciences Biographical Memoir (http://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/birkhoff-george-d.pdf)

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