Title
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Journal
Notices of the American Mathematical Society, 45(June-July)

ISSN
1088-9477

Author
Hirsch, MW

Publication Date
1998

Peer reviewed

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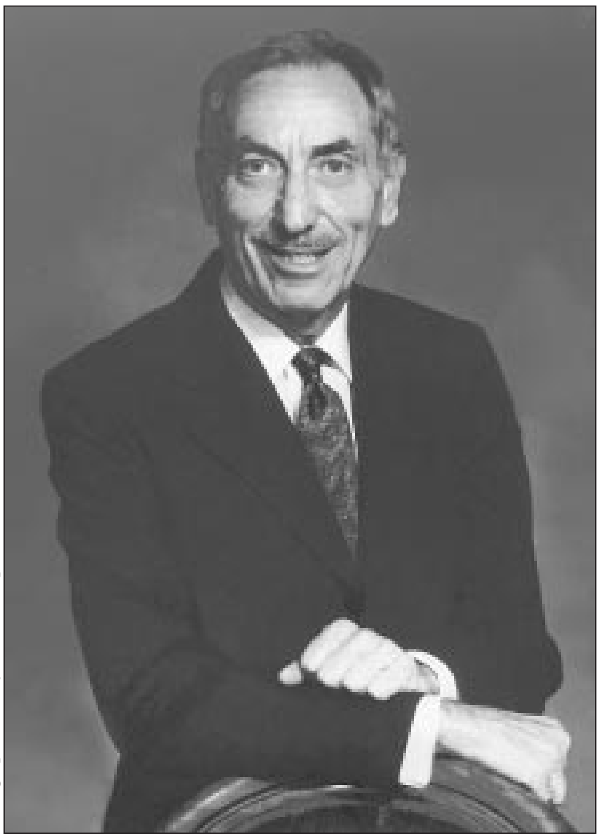
Morris W. Hirsch



Photograph courtesy of Jerome Spanier.

Edwin Spanier

Edwin Henry Spanier died of cancer in Scottsdale, Arizona, on October 11, 1996. Born in Washington, D.C., on August 8, 1921, he was graduated from the University of Minnesota in 1941 and then spent three years as a mathematician in the U. S. Army Signal Corps. He received his doctorate in mathematics in 1947 from the University of Michigan under the direction of Norman Steenrod. After a postdoctoral fellowship at the Institute for Advanced Study in Princeton, New Jersey, he joined the faculty at the University of Chicago in 1948. He was a Guggenheim Fellow in Paris in the academic year 1952–53, a member of the Institute for Advanced Study in 1958–59, and a Miller Research Fellow at Berkeley in 1961–62. His visiting appointments include positions in Argentina, Brazil, Canada, Chile, France, Germany, Italy, Spain, and Switzerland, and at UCSD and UCLA.

Morris W. Hirsch is professor of mathematics at the University of California at Berkeley. His e-mail address is `hirsch@math.berkeley.edu`. *He received his Ph.D. in 1958 under the supervision of Ed Spanier.*

Spanier was appointed professor of mathematics at Berkeley in 1959 at the beginning of a period of rapid expansion of the mathematics department. An internationally recognized authority in the swiftly developing field of topology, he attracted first-class mathematicians as visitors and new faculty members. He played a major role in organizing new programs in geometry and topology, subjects in which Berkeley soon achieved preeminence. He served several times as vice chair and acting chair of the department and directed fourteen doctoral dissertations at Berkeley in addition to three at Chicago. In 1991 he became professor emeritus.

From his doctoral dissertation through the mid-1960s, and again in the last fifteen years of his life, Spanier's research was concentrated in algebraic topology. This subject, founded a century ago by Henri Poincaré to aid in the qualitative analysis of differential equations, was little known to most mathematicians when Spanier started his career. His dissertation supervisor, Norman Steenrod, together with Samuel Eilenberg, had just set out simple and powerful axioms for the main tool, homology theory; this cleared up much of the confusion endemic in a subject that combines geometry, algebra, and analysis. Spanier was at the forefront of the explosive development of algebraic topology during the next decade. The importance of his work was quickly recognized; in

1950 he gave an Invited Address to the International Congress of Mathematicians at Harvard. Spanier's interest in topology continued throughout his career. Both his first paper in 1948 and one of his last, published in 1992, dealt with the Eilenberg-Steenrod axioms.

Spanier's first major contribution in topology was the theory of cohomotopy groups, which gave an algebraic classification of maps of polyhedra into spheres [4]. Together with S. S. Chern he pioneered the analysis of the homology groups of fibre spaces [1]. In a series of papers with the English topologist J. H. C. Whitehead, Spanier developed the new algebraic tool of duality in homotopy theory [5]. In 1966 his long-awaited book *Algebraic Topology* [3] was published. The first comprehensive modern treatment of the subject, it is still a fundamental source.

Ph.D. Students of Edwin Spanier

Clair Miller (1951)
Morris W. Hirsch (1958)
Elon Lima (1958)
Alphonse Thomas Vasquez (1962)
Robert Emmett Williamson Jr. (1963)
Samuel Feder (1964)
John Ucci (1964)
Benson Brown (1965)
Jose Alves (1965)
David Kraines (1965)
Denis Sjerve (1967)
Jon Goldstine (1970)
John Paul Alexander (1971)
Mark Luker (1975)
Kenneth Klingenstein (1975)
Gerald Eisman (1977)
Richard B. Hull (1980)

In all, Spanier published more than forty papers in algebraic topology, contributing to most of the major research areas in the field, including cohomology operations, obstruction theory, homotopy theory, imbeddability of polyhedra in Euclidean spaces, and topology of function spaces. Many of his results are now standard tools in all fields that utilize global geometrical reasoning. These include not only various subjects in pure mathematics, but also diverse areas in applied mathematics, including computer science, mathematical physics, economic models, and game theory. Interestingly, one of Spanier's theories, now called Alexander-Spanier homology, is currently being applied to analyze differential equations—a return to Poincaré's original use of algebraic topology.

In 1961 Spanier began a fruitful collaboration with Seymour Ginsburg of the University of Southern California, resulting in more than a score of papers on the structure of formal languages. This subject is of importance in several mathematical disciplines, including theoretical computer science and foundations of mathematics. Recently it has been applied in dynamical systems theory. Their work was driven by an operational perspective on formal languages: What formal operations on these objects are reasonable, and what are their effects? This view led them to abstract and study families of languages closed under specific operations. They also investigated abstract families of languages from this viewpoint and obtained a number of impressive results. In another approach, they investigated families of languages generated from a single grammar, machine, or structure using simple substitution operations.

The importance of their work can be seen from the review[1] of a 1983 article [2] by Spanier, S. Ginsburg, and J. Goldstine, "On the equality of grammatical families". The review states: "This paper presents a major and difficult decidability result in grammar form theory. It is proved that, given two arbitrary context-free grammar forms, it is decidable whether or not the family of one is contained in the other. This leads immediately to the decidability of the equality of two context-free grammar forms." This result is based on an earlier paper, "A prime decomposition theorem for grammatical families", in which the same authors obtained a prime decomposition for formal language families, closely analogous in form to the decomposition of whole numbers into prime factors.

Spanier's publications, as were his lectures, are characterized by unusual lucidity and precision and an even rarer quality of naturalness and simplicity. No matter how complex the subject, at the end the reader feels the theorems are the right ones, the hypotheses natural, and the methods as simple as possible.

Ed Spanier will be remembered as a gifted researcher, an inspiring teacher, an able administrator, and as a modest, friendly, wise, and helpful colleague.

References

[1] S. S. Chern and E. Spanier, *The homology structure of sphere bundles*, Proc. Nat. Acad. Sci. U.S.A. **36** (1950), 248–255.

[2] S. Ginsburg, J. Goldstine, and E. Spanier, *On the equality of grammatical families*, J. Comput. System Sci. **26** (1983), 171–196.

[3] E. Spanier, *Algebraic topology*, McGraw-Hill, New York, 1966.

[4] E. Spanier, *Borsuk's cohomotopy groups*, Ann. Math. **50** (1949), 203–245.

[5] E. Spanier and J. H. C. Whitehead, *Duality in homotopy theory*, Mathematika **2** (1955), 56–80.

[1]*Mathematical Reviews 85g:68037.*