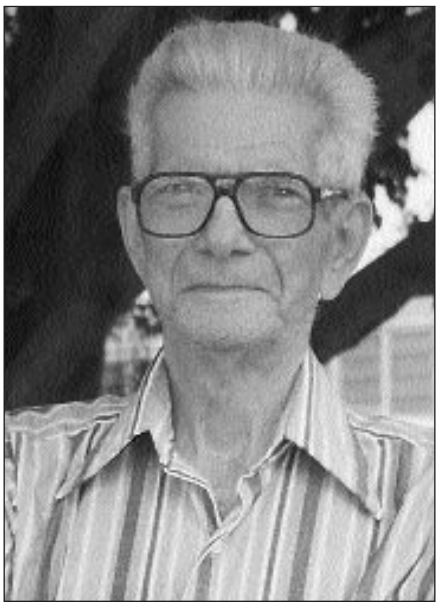
Nathan Fine 1916–1994

George E. Andrews



Nathan (Nat) Fine, a member of the American Mathematical Society for 53 years and of the Mathematical Association of America for 52 years, died on November 18, 1994, in Deerfield Beach, Florida, at the age of 78. Fine was born on October 22, 1916, in Philadelphia. He obtained a B.S. from Temple University in 1936, an A.M. from the University of Pennsylvania in 1939, and a Ph.D. there in 1946. In 1947, he was appointed assistant professor of mathematics at Penn. Before that he had held a variety of mathematical jobs: junior high teacher, 1941–1942; instructor at Cornell, 1942; and Purdue 1942–1945; as well as research mathematician for the Naval Ordnance Plant (Indianapolis), 1944–1945, and for the Operations Evaluations Group (Washington, D.C.), 1946–1947.

He rose to full professor at Penn in 1956. In 1963, he moved to Penn State University, where he remained until his retirement as Emeritus Professor in 1978. In 1953–1954 he was an NSF Postdoctoral Fellow, and in 1958–1959 he held a Guggenheim Foundation Fellowship; in 1966 he was the M.A.A.'s Hedrick Memorial Lecturer, where he presented an introduction to the material in his subsequent book on basic hypergeometric functions. He also served on a number of national committees on mathematics and mathematics education. Fine had three Ph.D. students: Justin Price (Purdue), Anthony Hager (Wesleyan), and William Webb (Washington State).

In addition to mathematics, he enjoyed a variety of games, including Go, chess, bridge, billiards, and backgammon. He was a life master at bridge and played duplicate bridge until two days before he died.

While the above provides a quick outline of Fine's life and achievements, it tells nothing of his essential qualities as a mathematician. His contributions are sufficiently broad that a short article by only one of his many friends and students will convey a somewhat distorted view. Having said that, I would like to offer the following account of how Nathan Fine profoundly affected my life.

I first met Nat in 1961 when I began graduate school at the University of Pennsylvania. In 1962 I took his course "Basic Hypergometric Functions" under the mistaken assumption that "basic" meant "elementary". This was perhaps the most fortunate mistake I ever made. Twenty-six years later, I wrote the foreword to his book *Basic Hypergeometric Series and Applications*. The following is an abridged version of what I said:

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"In 1948, Nathan Fine published a note in the *Proceedings of the National Academy of Sciences* announcing several elegant and intriguing partition theorems. These results were marked both by their simplicity of statement and by the depth of their proof. Fine was at that time engaged in his own special development of q-hypergeometric series, and as the years passed he kept adding to his results and polishing his presentation. Several times, both at Penn and Penn State, he presented courses on this material. I took the course twice, first in 1962–1963 at Penn and then in 1968–1969 at Penn State. As a graduate student at Penn, I wrote my thesis on mock theta functions under Rademacher's direction. The material that Fine was lecturing about fit in perfectly with my thesis work and introduced me to many aspects of this extensive subject. The course was truly inspiring. As I look back at it, it is hard for me to decide whether the course material or Fine's exquisite presentation of it impressed me most.

"Research on q-hypergeometric series is significantly more active now than when Fine began his researches. There are now major interactions with Lie algebras, combinatorics, special functions, and number theory."

Much more could be added about Fine's "exquisite presentation". My fellow students and I viewed him as a mathematical juggernaut. He spoke deliberately and somewhat slowly (thank goodness). He smoked unfiltered Camel cigarettes which he Persian-inhaled throughout each lecture. I look back fondly on Nat, his beautiful mathematics, and his ever-present cigarettes. In each lecture, he was clearly having a whale of a good time, and so were we.

It is almost impossible to describe the impression I had of his intellect. I think I can come closest by relating a story about the first class I took from him, a first-year graduate course in algebra in 1962. Fine often assigned homework from the text and one day inadvertently included one of those extra challenging problems designed to humble even the most arrogant graduate student. Whenever you do this, it is, of course, wise to make sure you know how to do the problem before you get to class. Nat had failed to notice the jawbreaker in this otherwise innocuous mixture of soft candies. When he asked at our next meeting, "Are there any questions," a number of hands went up. "What about problem X?" Nat asked if anyone had done the problem. A number thought they had. Two things emerged as the hour progressed: (1) This problem was a killer. (2) Each of my fellow students who thought he had solved the problem hadn't.

Fine put on a display like I had never seen previously; it was clear from what he said that he had not looked at the problem before. In his slow and deliberate manner he dismantled each of the incorrect solutions clearly pointing out each error. All the while one could sense that he was just buying time and devoting only a small fraction of his attention to these incorrect answers. With ten minutes left, you could sense his relief as he had clearly solved the problem, and his last ten minutes were devoted to his correct solution of it. I subsequently thought of him as a mathematical Sherman Tank, not terribly speedy but absolutely inexorable as he rolled over mathematical challenges. This image, while partially correct, fails to convey the elegance and charm of Fine's discoveries. He was a grand mathematician, and we who knew him mourn his passing.

This is probably not the place to provide a detailed analysis of Fine's mathematical work. However it is perhaps appropriate to mention that in the introduction to his book on basic hypergeometric series, he singled out

$$\prod_{n\geqq 1}\frac{(1-q^{2n})(1-q^{3n})(1-q^{8n})(1-q^{12n})}{(1-q^{n})(1-q^{24n})}=$$

$$1+\sum_{N\geqq 1}E_{1,5,7,11}(N;24)q^{N}$$

as a result that especially pleased him (where $E_{1,5,7,11}(N;24)$ is the sum of the divisors of N congruent to 1,5,7 and 11 mod 24 minus the sum of those $\equiv$ to -1,-5,-7 and -11). One sees here the sort of mathematical taste that typified Ramanujan.

Fine published nearly forty papers on a variety of topics including number theory, logic, combinatorics, group theory, linear algebra, partitions and functional and classical analysis. Perhaps the most enduring of his papers is his Ph.D. dissertation on Walsh functions written under the direction of A. Zygmund and inspired by earlier work of his friend, H. Radamacher. This paper, together with his further work on Walsh functions, eventually led to his invitation to prepare his article on Walsh functions for the *Encyclopedic Dictionary of Physics*. His work on rings of quotients of continuous functions with Len Gillman, as well as the book with Gillman and Lambek, has been of continuing interest in functional analysis.

Finally it should be noted that Nat was a devoted problem solver. In addition to contributing problems and their solutions to numerous journals, he was also one of the active faculty participants in the legendary Pro-Seminar at the University of Pennsylvania. When he moved to Penn State, he instituted a problems course there, and in his retirement in Florida he taught such a course at Broward Community College as in-service training for mathematics faculty.