

# Judith Sally

(March 23, 1937–January 28, 2024)

Judith Sally (née Donovan) was born in New York on March 23, 1937. After attending high school at the Convent of the Sacred Heart in New York, she attended Barnard (BA 1958), and then began her graduate studies in mathematics at Brandeis (MA 1960).

While at Brandeis, Judith met Paul Sally, then in the Brandeis doctoral program in mathematics; they were married in November 1959. Judith postponed her career while they had three sons (David, Stephen, and Paul III). In 1965, Paul completed his dissertation at Brandeis and joined the Department of Mathematics at the University of Chicago. Judith entered Chicago's doctoral program in mathematics in 1968, and was awarded her PhD in 1971, working under Irving Kaplansky, her thesis on a topic in commutative algebra (published in the *Transactions of the AMS* in 1972). Judith then spent the year 1971–1972 as a postdoc at Rutgers University (while Paul was at the nearby Institute for Advanced Study).

Judith joined the Department of Mathematics at Northwestern University in 1972, where she remained until her retirement in 2002. Initially hired by Northwestern as a Visiting Assistant Professor (1972–1974), she was appointed Assistant Professor in 1974, and then promoted to Associate Professor in 1977 and Professor in 1982. Judith was the second woman to be appointed a Professor in mathematics at Northwestern. (Alexandra Bellow had been the first, in 1968. Earlier, Lois Wilfred Griffiths had been promoted to Associate Professor in mathematics in 1938, and Helen M. Clark had been promoted from Lecturer to Assistant Professor in mathematics in 1959.)

Judith was a highly active researcher during her thirty years at Northwestern. Her curriculum vitae for 1999 lists 37 papers, including ones in the *Proceedings* and *Bulletin* of the AMS, *Mathematische Annalen*, *Journal of the London Mathematical Society*, *Proceedings of the Cambridge Philosophical Society*, *American Journal of Mathematics*, *Journal of Algebra*, and *Journal of Pure and Applied Algebra*. She also wrote one book (*Numbers of Generators of Ideals in Local Rings*, 1978) and translated Dieudonné's *History of Algebraic Geometry* (1985) into English. In recognition of her research accomplishments, Judith was invited in 1995 to give the Association for Women in Mathematics Noether Lecture, an honor “for fundamental and sustained contributions to the mathematical science”. The AWM summarized her research thus:

Sally's research is in Commutative Algebra, one of the fields in which Emmy Noether's work had such impact. Her main interests lie in

the study of Noetherian local rings and graded rings with emphasis on Hilbert functions and birational extensions. These concepts play an important role in ascertaining the nature of singularities in applications in algebraic geometry. The Hilbert function of a local ring at a point on a variety is a very good measure of how bad the singularity is at the point. One of the themes in Sally's research is the interaction between the local ring and its associated graded ring. This interaction plays a critical role in understanding and computing the Hilbert function. She has also worked on birational blowing up of ideals, the extension of valuations and other concepts in the algebra involved in the resolution of singularities.

Judith's main research centered upon the passage of properties between a Noetherian local ring  $R$  with maximal ideal  $\mathfrak{m}$ , and its tangent cone, the ring  $G = R/\mathfrak{m} \oplus \mathfrak{m}/\mathfrak{m}^2 \oplus \mathfrak{m}^2/\mathfrak{m}^3 + \dots$ . General deformation arguments can be used to show that good properties of  $G$  force the same properties for  $R$ ; Sally's results and conjectures concerned the other direction. She famously proved that if  $R$  is either Cohen-Macaulay with minimal multiplicity or Gorenstein with almost minimal multiplicity, then the Hilbert series and Poincaré series are completely determined; she passes to  $G$  and its study to prove these results. She made striking conjectures extending her work, including the *Sally conjecture* (posed in 1983, but only proved thirteen years later, independently by Rossi and Valla in 1996 and Wang in 1997). The Italian group studying her questions used her techniques so much that they dubbed her methods the "Sally machine". The relationship between the tangent cone and the Rees algebra led her to concentrate on birational maps from  $R$  to various affine blowups, through study of the Rees algebra and *Sally modules*, named in her honor. Her introduction of the *core* of an ideal with David Rees led to an explosion of work on this topic.

During her time at Northwestern, Judith was awarded the National Science Foundation Visiting Professorship for women during the 1988–1989 academic year, during which she traveled to Purdue University in West Lafayette, Indiana. She also won the College of Arts and Sciences Teaching Award, a Bunting Fellowship at the Mary Ingraham Institute at Radcliffe College and the Alfred P. Sloan Foundation Fellowship, which recognizes academics successful performance and potential to contribute substantially to their fields.

Judith directed the dissertations of four students at Northwestern (Young Hyun Hong, 1981, John Gately, 1995, Petra Constapel, 1995, and Kewen Yao, 1997), as well as being the Director of Undergraduate Studies (although this had a different title back then) in 1982–1984 and 1990–1991. In later years Judith and her husband Paul developed an interest in mathematical pedagogy and outreach. This included teaching mathematics courses for four summers at the University of Chicago for historically underrepresented groups preparing to take the MCAT, and teaching geometry courses and seminars for four years for elementary school teachers. They wrote four books together: *TriMathlon: A Workout Beyond the School Curriculum*, Peters, 2003, *Roots to Research*, AMS, 2007, *Geometry: A Guide for Teachers*, AMS, 2011, and *Integers, Fractions and*

*Arithmetic: A Guide for Teachers*, AMS, 2012.

Judith's service at the national, university, and departmental levels was exemplary: she was the Editor of the *Transactions* of the AMS for three years (1990–1994), and her 1999 CV shows her serving on four AMS committees and panels; fifteen university committees, boards, and panels (including the 1996 Search Committee for the WCAS Dean); and eleven different department committees, including chairing the Undergraduate and Personnel committees twice each.

Judith died on January 28, 2024 in Chicago, at the age of 86. She leaves three children, eight grandchildren, and two siblings; her husband Paul had died ten years earlier. Judith will be remembered as a remarkable mathematician, and a wonderful friend and colleague.