Phillip Griffiths

Phillip Griffiths is a singular figure in mathematics. For more than 50 years, he has been a leader in research, making contributions at the highest level in several areas, most notably algebraic geometry and differential geometry. He has also been an outstanding teacher and mentor for young people entering mathematics. His exposition has garnered accolades, and his books have had a lasting influence. On top of these contributions to the field of mathematics, Griffiths has had a substantial impact on the entire scientific enterprise the world over, through his extensive work on science policy, through his leadership of the Institute for Advanced Study for more than a decade, and through his work on behalf of science in the developing world. To have contributed at such a high level to so many different aspects of mathematical and scientific life is truly extraordinary.

Right after he received his PhD from Princeton University in 1962, under the direction of Donald Spencer, Griffiths went to the University of California, Berkeley, where he was a Miller Fellow. There, he came into contact with Shiing-Shen Chern (1911-2004), after whom the Chern Medal is named. One of the towering figures of 20th century mathematics, Chern was a geometer of wide interests and deep insights. He also had a profound sense of responsibility for developing the culture and community of mathematics. He made a lasting impression on the young Griffiths. The two became collaborators and lifelong friends.

In his mathematics research, Griffiths is known not so much for having proved big theorems or for things named after him—though he certainly has both. Rather, he is known more for pioneering new approaches or strategies that have proven very fruitful, for developing connections between areas that had previously seemed unrelated, and for opening new lines of research that he and others then pursued. He also has the ability, despite the formidable technical machinery used in his work, to hold fast to the intuitive heart of the problem at hand, noted Robert Bryant of Duke University, who served as chair of the 2014 Chern Medal selection committee. "Even when mathematicians discuss very abstract geometric concepts, they often speak as though there are tangible objects being represented and attach an almost physical sense to them," said Bryant. "Exactly how this sort of metaphorical sense contributes to our understanding of the concepts is mysterious, but it is frequently the hallmark of great insight. Griffiths has an amazingly strong ability to invoke those kinds of intuitions and to communicate them to others."

One of Griffiths' great contributions has been to perceive this intuition in the work of past mathematical masters and reinterpret it in modern terms. For example, mathematicians looked askance at the work of the Italian school of algebraic geometry of the late 19th and early 20th century because the work did not conform to new standards of rigor that arose afterward. The Italian algebraic geometers nevertheless had a genius for geometric intuition. Griffiths imbibed this intuition and made it precise, using modern techniques. He also absorbed and revived interest in the work of Élie Cartan (1869-1951) on exterior differential systems. While it was full of tremendous insights, Cartan's work had been neglected because was difficult to read and had not been put into a systematic framework. After Griffiths and his collaborators developed and expanded on ideas from Cartan's work, exterior differential systems went on to have a significant impact on the theory of partial differential equations. "There was a kernel of beautiful geometric ideas that ran through these classic works and—once you got through the old-fashioned language and notations—an extraordinary relevance to modern problems," said Mark Green of the University of California at Los Angeles, who will be presenting the laudatio for Griffiths. "Griffiths was a great believer in the power of deep geometric ideas, and he encouraged his students to engage with these classic books and papers."

Four volumes of the selected works of Griffiths have appeared: Analytic geometry, algebraic geometry, variations of Hodge structures, and differential systems. There is also ample material for a fifth volume, which is under consideration. This staggering output ranges over an enormous variety of topics. Nevertheless, one can still perceive some unifying and powerful geometric ideas that run through his work. An example can serve to illustrate the nature of these ideas. A fundamental distinction in mathematics is between algebraic functions, such as the square root of x, and transcendental functions, such as sine and cosine, which cannot be expressed algebraically. An important insight that emerged in algebraic geometry over the course of the 19th century is that objects described in terms of algebraic equations can be productively studied using transcendental functions; this gives rise to the subject known as transcendental algebraic geometry. For algebraic curves in the plane, one aspect of these transcendental methods was embodied in a construction known as the period map. However, when one goes beyond curves to higher dimensions, genuinely new phenomena occur that no one had anticipated until the work of Griffiths. He found an innovative way to bring together modern methods, such as deformation theory and Hodge theory, with the classic framework.

Not far off from these developments lies one of the major challenges in mathematics, the Hodge Conjecture, which has been designated as one of the million-dollar Millennium Prize Problems of the Clay Mathematics Institute. W.D.V. Hodge (1903-1975) noted that to certain objects in algebraic geometry—namely, algebraic cycles—one can associate a particular type of object in topology, a "Hodge class". The Hodge Conjecture asks whether one can reverse this association: Can one take a Hodge class and find an algebraic cycle with rational coefficients to which it is associated? While no one has yet proved the Hodge Conjecture, Griffiths' work has been a potent force in shedding light on the contours of that problem and shaping much of the research that has been done on it.

Often mathematicians are categorized as "problem solvers" or "theory builders"; Griffiths does not quite fit into either group. "He's an 'understander'," said Bryant. "He wants to understand where an idea can go, its connections to other ideas, and how it might illuminate a problem he's considering." This drive to understand has made Griffiths an excellent communicator, not only among fellow researchers but for students as well. He has had 29 PhD students, many of whom have gone on to outstanding careers themselves; altogether, he has about 460 doctoral "descendents". Griffiths' mathematical writing is known for its clarity and polish as well as for the way it opens new directions for research. A prominent example is his paper "Periods of integrals on algebraic manifolds", which appeared in the *Bulletin of the American Mathematical Society* in 1970 and received the AMS Steele Prize the following year. His books have also had a wide influence, particularly *Principles of Algebraic Geometry*, written with his former PhD student Joseph Harris. Universally known by the shorthand "Griffiths and Harris", this textbook has become a standard reference for generations of students.

After his Miller Fellowship at UC Berkeley, Griffiths became a faculty member there. In 1967, he moved to Princeton University and in 1972 to Harvard. His appointment in 1983 as provost of Duke University began his work in administration, which, surprisingly, did not slow down at all his research output. In 1991, he became director of the Institute for Advanced Study (IAS) in Princeton, one of the world's foremost research centers, particularly in the areas of mathematics and theoretical physics. Under his 12-year directorship, the IAS launched several new initiatives, including programs in theoretical computer science and theoretical biology. Also during this time, three new buildings were completed, among them Simonyi Hall, which now houses the IAS School of Mathematics.

Griffiths has been much sought after for his wise council in matters of science and educational policy. As Green put it, "He is a person everyone trusts to be fair and judicious." Among the most prominent roles Griffiths played was as chair of COSEPUP, the Committee on Science, Engineering, and Public Policy of the National Academies, from 1992 until 1999. In that time, COSEPUP issued two especially influential reports, one on reshaping graduate education in science and engineering, and the other on the various facets of being an effective mentor in these areas. Griffiths also served on the National Science Board, the policymaking body of the National Science Foundation (1991-1996) and as secretary of the International Mathematical Union (1999-2006).

While director of the IAS, Griffiths got to know James Wolfensohn, president of the World Bank, who at the time served as an IAS trustee. Inspired by this contact, Griffiths launched the Science Initiative Group (SIG), an international team of leading scientists that aims to help developing countries build scientific capacity. Rather than imposing goals and frameworks from outside, SIG helps native-born scientists to identify critical national needs and to build the educational and research infrastructure required to address them. SIG's first effort was the Millennium Science Initiative, a research and education program that was funded mainly by the World Bank and that reached developing countries in Africa, Asia, and Latin America. Building on this experience, SIG launched RISE (Regional Initiative in Science and Education), which is funded by the Carnegie Corporation of New York and managed jointly by SIG and the African Academy of Sciences. RISE supports university-based research and training networks in sub-Saharan Africa, with the goal of preparing PhD-level scientists and engineers. RISE has put special emphasis on participation by African women, who have long been underrepresented in the sciences.

At 76 years of age, Griffiths shows little sign of slowing down. Now a professor emeritus at the IAS, he remains deeply involved with SIG. Over the past year he has teamed with other U.S. leaders in mathematics and science on a program that aims to effect constructive change in post-secondary mathematics education. And he is still doing research: His most recent paper, written with Mark Green, was posted on the arXiv preprint server in May 2014. With his distinguished legacy in mathematics research, his profound impact on young people in the field, and his contributions to supporting research and education around the globe, Griffiths is an inspiration to many—but not one who is easily emulated, Green noted. To take on as many projects as Griffiths has, "the rest of us would need extra hours in the day."