SHIGEFUMI MORI

Algebraic geometry occupies a central place in pure mathematics, with connections to number theory, theoretical physics and differential geometry. Recent advances in the field have led to the discovery of an ongoing series of connections between algebraic geometry and computer algebra with applications in coding theory, cryptography and financial mathematics. In the 1970s **Shigefumi Mori** (February 23, 1951 -) and others initiated a new and powerful technique used in the classification problems of algebraic varieties of dimension three. Historically, classifying algebraic varieties has been a fundamental problem of algebraic geometry.

As background, originally algebraic geometry referred to the study of geometries that arose from algebra. In classical algebraic geometry, the geometry is the set of zeros of real-valued polynomials. In the latter part of the 19th century it was specified to be the study of algebraic invariants and birational transformations (so called because they are expressed algebraically as rational functions, and the inverse functions are also rational functions). Almost from the beginning of the study of algebraic geometry of curves, investigations were made in the theory of surfaces. Far less has been accomplished in the theory of surfaces than for curves. The subject of algebraic geometry now embraces the study of higher-dimensional figures defined by one or more algebraic equations.

An algebraic variety is a generalization to *n* dimensions of algebraic curves, which are represented by polynomials in two variables with coefficients in a field. There are systems of algebraic equations that can be solved and others where this is not possible. Today the study of the variety, that is, the set of solutions defined by the system, is the principal objective. The aim is a “classification” of abstract algebraic varieties. For dimension one, this is the classical approach, while the problem for dimensional two is almost complete. The problem in dimension three is still being investigated. Thus an algebraic variety is the set of points in *n*-dimensional real space (or *n*-dimensional complex space) satisfying a system of polynomial equations. In everyday usage, dimension refers to measurements of the size and shape of an object, but in algebraic geometry it refers to the number of degrees of freedom of movement in a space. In physics and chemistry, each way a particle of system may be moved is a degree of freedom.

Mori was born in Nagoya, Japan and received his B.A., M.A. and Ph. D. from Kyoto University, where he remained as an assistant until 1980. He then was appointed a lecturer in mathematics at the University of Nagoya, with a promotion to full professor in 1988. In 1990 Mori joined the faculty of the Research Institute for Mathematical Sciences at Kyoto. During the years 1977 to 1988 he spent much time in the United States as a visiting professor. He found a constructive way of factoring a general birational transformation of threefolds into elementary transformations.

In his article “On the Work of Shigefumi Mori,” which appeared in the *Proceedings of the International Congress of Mathematicians*, *Kyoto 1990*, a Fields Medal winner for his work on algebraic varieties, Heisuke Hironaka of Harvard University commented:

> “The most profound and exciting development in algebraic geometry during the last decade or so was the *Minimal Model Program* or *Mori Program* in connection with the classification problems of algebraic varieties of dimension three. Shigefumi Mori

initiated the program with a decisively new and powerful technique, guided the general research direction with some good collaborators along the way, and finally finished up the program by himself overcoming the last difficulty….Mori's theories on algebraic threefolds were stunning and beautiful by the totally new feat…Three in dimension was in fact a quantum jump from two in algebraic geometry."

For his achievements Mori was awarded a Fields Medal at the 1990 International Congress, which was held in Kyoto. That same year he was awarded the Cole Prize in Algebra by the American Mathematical Society. The will of John Charles Fields established the Fields Medal to make up for the lack of a Nobel Prize in Mathematics. In 1924, Fields was President of the International Mathematical Congress (now known as the International Congress of Mathematicians) when he first suggested that medals be awarded to mathematicians under the age of 40 as encouragement for further achievements. The awards were established in 1932. Besides Mori, the list of other recipients includes R. Thom, J.W. Milnor, M.F. Atiyah, P.J. Cohen, A. Grothendieck, S. Smale, E. Bombieri, and J. Bourgain.

The Frank Nelson Cole Prize in Algebra is named for Professor F.N. Cole of Columbia University, who for twenty-five years served as secretary of the American Mathematical Society and for twenty-one years editor of the *Bulletin of the American Mathematical Society*. Cole began the fund with money presented to him on his retirement. It was augmented by contributions from members of the Society, and was later doubled by his son, Charles A. Cole. The prizes are awarded at two different five-year intervals for contributions to algebra and the theory of numbers. Besides Mori, winners include Leonard E. Dickson, Claude Chevalley, Paul Erdős, Harish-Chandra, and Andrew Wiles.

Quotation of the Day: “Modern algebraic geometry has deservedly been considered for a long time to be an exceedingly complex part of mathematics, drawing practically on every other part to build up its concepts and methods and increasingly becoming an indispensable tool in many seemingly remote theories. It shares with number theory the distinction of having one of the longest and most intricate histories among all branches of science, of having attracted the efforts of the best mathematicians in each generation, and of still being one of the most active areas of research.” – Jean Dieudonné