2008 Cole Prize in Number Theory

The 2008 Frank Nelson Cole Prize in Number Theory was awarded at the 114th Annual Meeting of the AMS in San Diego in January 2008.

The Cole Prize in Number Theory is awarded every three years for a notable research memoir in number theory that has appeared during the previous five years. The awarding of this prize alternates with the awarding of the Cole Prize in Algebra, also given every three years. These prizes were established in 1928 to honor Frank Nelson Cole (1861–1926) on the occasion of his retirement as secretary of the AMS after twenty-five years of service. He also served as editor-in-chief of the *Bulletin* for twenty-one years. The endowment was made by Cole, contributions from Society members, and his son, Charles A. Cole. The Cole Prize carries a cash award of US$5,000.

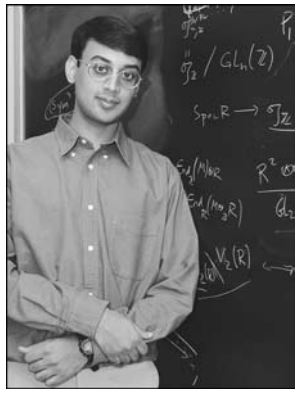
The Cole Prize in Number Theory is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2008 prize the members of the selection committee were: Nicholas M. Katz, Kenneth A. Ribet (chair), and Alice Silverberg.

Previous recipients of the Cole Prize in Number Theory are: H. S. Vandiver (1931), Claude Chevalley (1941), H. B. Mann (1946), Paul Erdős (1951), John T. Tate (1956), Kenkichi Iwasawa (1962), Bernard M. Dwork (1962), James B. Ax and Simon B. Kochen (1967), Wolfgang M. Schmidt (1972), Goro Shimura (1977), Robert P. Langlands (1982), Barry Mazur (1982), Dorian M. Goldfeld (1987), Benedict H. Gross and Don B. Zagier (1987), Karl Rubin (1992), Paul Vojta (1992), Andrew J. Wiles (1997), Henryk Iwaniec (2002), Richard Taylor (2002), and Peter Sarnak (2005).

The 2008 Cole Prize in Number Theory was awarded to MANJUL BHARGAVA. The text that follows presents the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

Professor Manjul Bhargava of Princeton University is cited for his revolutionary work on higher composition laws. His series of articles on this subject introduced completely new and unexpected ideas into a subject that began with work of Carl Friedrich Gauss in 1801.



Manjul Bhargava

At that time, Gauss anticipated the modern theory of abelian groups by constructing a law of composition on the set of equivalence classes of binary quadratic forms of given discriminant. By the end of the nineteenth century, the fundamental concept of an abstract group allowed one to view the system of equivalence classes of binary quadratic forms of given discriminant as the "ideal class group" of a quadratic field. Once this recasting of Gauss's work became established, Gauss's "law of composition" became something of a curiosity—evidence of how a brilliant mathematician can uncover a fundamental phenomenon even without the right tools to think about it.

Bhargava's original and surprising contribution is the discovery of laws of composition on forms of higher degree. His techniques and insights into this question are dazzling; even in the case considered by Gauss, they lead to a new and clearer presentation of that theory. If Bhargava had stopped with this discovery, his work would already be quite remarkable. But Bhargava has gone on to use his composition laws to solve a new case of one of the fundamental questions of number theory, that of asymptotic enumeration of number fields of given degree as the discriminant grows. The question is trivial for degree 1, and the quadratic case was solved by Gauss's work. Davenport and Heilbronn

treated the cubic case in 1971. Bhargava used his new composition laws to solve the degree 4 case, brilliantly overcoming very serious analytic problems that had completely blocked all previous work on the problem.

Biographical Sketch

Manjul Bhargava was born in Hamilton, Ontario, Canada, but spent most of his early years in Long Island, New York. He received his A.B. in mathematics summa cum laude from Harvard University in 1996 and his Ph.D. from Princeton University in 2001. After holding visiting positions at the Mathematical Sciences Research Institute in Berkeley, the Institute for Advanced Study in Princeton, and Harvard University, he joined the faculty at Princeton University as professor of mathematics in 2003. He was also named the Clay Mathematics Institute's first Five-Year Long-Term Prize Fellow in 2001. An accomplished tabla player whose research interests span number theory, combinatorics, and representation theory, Bhargava has received numerous awards and honors, including the Hoopes Prize for Excellence in Scholarly Work and Research from Harvard University (1996), the AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Undergraduate Research in Mathematics (1997), the MAA Merten M. Hasse Prize for Exposition (2003), the Packard Foundation Fellowship in Science and Engineering (2004), the Clay Research Award (2005), the SASTRA Ramanujan Prize (2005), and the Blumenthal Award for the Advancement of Research in Pure Mathematics (2005). He has been a three-time recipient of the Derek Bok Award for Excellence in Teaching and was named one of *Popular Science* magazine's "Brilliant 10" in 2002. Bhargava was an invited speaker at the International Congress of Mathematicians in Madrid in 2006 and has given numerous other invited addresses, colloquia, seminars, and public lectures at colleges and universities across North America and Europe.

Response

I am very grateful and honored to be the recipient of the 2008 Cole Prize. During the past few years I have had the good fortune of interacting with many wonderful mathematicians (both faculty and students) whose friendship and wisdom have been a constant source of inspiration for me. I would like to thank them all. In particular, I wish to express my deep gratitude to my graduate school teachers, Andrew Wiles, Peter Sarnak, and John Conway; and my undergraduate teachers and mentors, Dick Gross, Barry Mazur, Persi Diaconis, Joe Gallian, and Dave Cargo, from whom I have learned (and continue to learn!) so much and by whom I have been constantly inspired. I am also extremely grateful to Hendrik Lenstra and Don Zagier for their kindness and generosity and for always being available to discuss interesting mathematics!

I thank the Department of Mathematics at Princeton University for providing me with a wonderful work environment and the Clay Mathematics Institute and the Packard Foundation for funding my work.

The papers cited above build on ideas that go way back, starting with the mathematical works of Brahmagupta, Gauss, Dirichlet, Eisenstein, and Dedekind and leading up to the works of modern mathematicians such as Delone-Faddeev, Davenport-Heilbronn, Sato-Kimura, Wright-Yukie, and Gan-Gross-Savin. I gratefully acknowledge my indebtedness to all these mathematicians!

Perhaps I should also take this opportunity to thank here Erno Rubik for making his cube!

Finally, I thank my family for all their love and support.