

# Mathematics People

## Hirachi Receives Bergman Prize

KENGO HIRACHI of the University of Tokyo has been awarded the 2006 Stefan Bergman Prize. Established in 1988, the prize recognizes mathematical accomplishments in the areas of research in which Stefan Bergman worked. The prize consists of one year's income from the prize fund. Currently this income is about US\$25,000 per year.

The previous Bergman Prize winners are: David W. Catlin (1989), Steven R. Bell and Ewa Ligocka (1991), Charles Fefferman (1992), Yum Tong Siu (1993), John Erik Fornæss (1994), Harold P. Boas and Emil J. Straube (1995), David E. Barrett and Michael Christ (1997), John P. D'Angelo (1999), Masatake Kuranishi (2000), László Lempert and Sidney Webster (2001), M. Salah Baouendi and Linda Preiss Rothschild (2003), Joseph J. Kohn (2004), and Elias M. Stein (2005). On the selection committee for the 2005 prize were Michael Christ, John P. D'Angelo (chair), and Charles Fefferman.

### Citation

The Bergman prize for 2006 is awarded to Kengo Hirachi of the University of Tokyo for his deep work on the singularities of the Bergman and Szegő kernels and their relationship to CR geometry. Hirachi's work employs a wide range of tools in geometry and analysis, including several complex variables, the complex Monge-Ampère equation, microlocal analysis, parabolic invariant theory, explicit computations, and computer algebra packages.

In a paper in the *Annals of Mathematics* (2000) Hirachi constructed CR invariants of strongly pseudoconvex boundaries via a deep study of the logarithmic singularity of the Bergman kernel. He has proved various results linking the Bergman and Szegő kernels, and he has made significant progress to a program in which the Bergman kernel function plays a role analogous to the heat kernel of Riemannian geometry.

The Bergman kernel function of a bounded domain  $D$  in complex Euclidean space  $\mathbb{C}^n$  is the integral kernel for the orthogonal projection from  $L^2(D)$  to the closed subspace of holomorphic functions in  $L^2(D)$ . Let  $\bar{D}$  denote the closure of  $D$ , and let  $\Delta$  denote the boundary diagonal. When  $D$  is strongly pseudoconvex (more generally when the  $\bar{\partial}$ -Neumann problem is subelliptic) the Bergman

kernel function is smooth on  $\bar{D} \times \bar{D} - \Delta$ . In 1974 Fefferman established an asymptotic expansion for the Bergman kernel  $K$  on strongly pseudoconvex domains. Let  $r$  denote a smooth defining function for  $D$ . There are smooth functions  $\phi$  and  $\psi$  on  $\bar{D}$  such that  $K = \phi r^{-n-1} + \psi \log(r)$ .

In 1979 Fefferman described an analogy between CR geometry and Riemannian geometry in which the Bergman kernel is analogous to the heat kernel. Since then many authors have studied the relationship between the singularities of the Bergman kernel and CR geometry, relating the complex Monge-Ampère equation to the invariant theory developed by Chern-Moser-Tanaka, thereby developing the analogy. Bailey-Eastwood-Graham expressed the singularity of  $\phi r^{-n-1}$  in terms of CR invariants of the boundary of  $D$ , but the coefficient  $\psi$  of the logarithmic term has remained more mysterious.



Kengo Hirachi

One of Hirachi's striking contributions is an expression for the singularity of  $\psi \log(r)$  in terms of so-called Weyl functionals of weight  $k$ . For weight  $k$ , with  $k \leq n+2$ , he proved that all Weyl invariants of weight  $k$  are CR invariants and vice versa.

Hirachi has also done important work relating the Bergman and Szegő kernels.

The Szegő kernel is analogous to the Bergman kernel; its domain is square-integrable functions on the boundary with respect to some smooth surface measure  $dm$ , and it projects to boundary values of holomorphic functions. There is an asymptotic expansion for the Szegő kernel on strongly pseudoconvex domains as well, where the exponent  $-n-1$  above is replaced by  $-n$ .

Consider  $\int_{bD} \psi dm$ , where  $\psi$  is now the coefficient of the log term in the formula for the Szegő kernel. Hirachi proved that this integral is independent of the choice of smooth measure  $dm$ , and that it is invariant under smooth (strongly pseudoconvex) deformations of the domain  $D$ . Any smooth convex domain whose boundary has nowhere vanishing Gauss curvature can be deformed smoothly to a ball, whose Szegő kernel has no logarithmic terms. Hirachi's theorem therefore implies that  $\int_{bD} \psi dm = 0$ , and consequently  $\psi$  must vanish somewhere. Hirachi

proof-of-concept ice detection system for aircraft. She is an All-American cross-country skier and a rower on the U.S. junior national rowing team. She plans to do a doctorate in astrophysics at Oxford.

ADAM D. CHANDLER of Burlington, North Carolina, is a senior at Duke University majoring in mathematics. He has conducted numerous research projects in applied computational mathematics, including work on computational quantum chemistry, molecular evolution, and traffic modeling. As a research intern at the National Security Agency, he focused on problems in cryptography. He is a Goldwater and Byrd scholar and managing editor of the *Journal of Young Investigators*. He is a cellist and president of the Duke Symphony Orchestra, and he has volunteered at an orphanage in Tanzania. He plans to study for an M.Sc. in applied and computational mathematics at Oxford.

RAHUL SATIJA of Potomac, Maryland, is a senior at Duke University who majors in biology and music and minors in mathematics. He has conducted research in bioinformatics and has won a Faculty Scholar Award from Duke University and a Meritorious Solution Award at the International Mathematical Contest in Modeling. He is the recipient of a Goldwater Scholarship and of Duke's only music performance scholarship. He is concertmaster for the Duke Symphony Orchestra and first violinist of a student string quartet; he also teaches violin to inner-city youths and plays recreational tennis. He plans to work for a D.Phil. in bioinformatics at Oxford.

ELIANA HECHTER of Phoenix, Arizona, is an eighteen-year-old senior mathematics major at the University of Washington. She has done research on the neurobiological basis of behavior in marine fauna and has been supported through a Vertical Integration of Research and Education (VIGRE) grant in mathematical sciences from the National Science Foundation. She works as a research assistant at the Center for Cell Dynamics and as a teaching assistant for advanced calculus. She is a Goldwater Scholar, a creative writer, and a long-distance runner. She plans to study for a D.Phil. in mathematics at Oxford.

Rhodes Scholarships provide two or three years of study at the University of Oxford in England. The value of the Rhodes Scholarship varies depending on the academic field, the degree (B.A., master's, doctoral), and the Oxford college chosen. The Rhodes Trust pays all college and university fees and provides a stipend to cover students' necessary expenses while they are in residence in Oxford, as well as during vacations, and transportation to and from England. The total value averages approximately US\$40,000 per year.

—From a Rhodes Scholarship Trust announcement

## Professor of the Year Awards Announced

M. VALI SIADAT of Richard J. Daley College in Chicago, Illinois, and JIM COYKENDALL of North Dakota State University have been chosen to receive State Professor of the Year

awards by the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education (CASE), which cosponsor the awards. The Professor of the Year Awards are intended to reward outstanding professors for their dedication to teaching, their commitment to students, and their innovative instructional methods.

The State Professors of the Year Award Program selects outstanding educators in all fifty states, the District of Columbia, Guam, Puerto Rico, and the U.S. Virgin Islands. Winners receive personalized award certificates as well as national and local media recognition. State and national winners are chosen on the basis of their dedication to undergraduate teaching, determined by excellence in the following four areas: impact on and involvement with undergraduate students; scholarly approach to teaching and learning; contributions to undergraduate education in the institution, community, and profession; and support from colleagues and current and former undergraduate students.

—From a Carnegie Foundation announcement

## Szpiro a Finalist for Descartes Prize

GEORGE SZPIRO, a reporter and columnist for the Swiss newspaper *Neue Zürcher Zeitung*, was named a finalist for the Descartes Prize for Science Communication, given by the European Union. Being named a finalist carries a cash prize of 5,000 € (about US\$6,000). Szpiro was cited for his series of stories "Maths for Sunday Morning—50 Stories on Mathematics and Science". He writes a monthly mathematics column that appears on Sundays in the *Neue Zürcher Zeitung*. Szpiro is also the author of the book *Kepler's Conjecture: How Some of the Greatest Minds in History Helped Solve One of the Oldest Math Problems in the World* (John Wiley and Sons, January 2003), which was reviewed in the January 2005 issue of the *Notices*. His latest book, *The Secret Lives of Numbers: 50 Easy Pieces on How Mathematicians Work and Think*, will appear in spring 2006.

—Allyn Jackson

## Authors Receive Chauvenet Prize for Notices Article

GÜNTER ZIEGLER and FLORIAN PFENDER have been honored with the 2006 Chauvenet Prize of the Mathematical Association of America (MAA) for an article that appeared in the *Notices*. Their article, "Kissing numbers, sphere packings, and some unexpected proofs", appeared in the September 2004 issue. The *Notices* editors extend their congratulations to the authors. Additional details about the prize will appear in the May 2006 *Notices*.

—Allyn Jackson