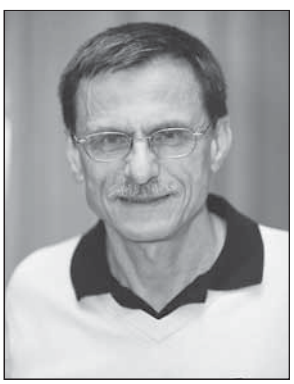
2010 E. H. Moore Prize

SORIN POPA received the 2010 E. H. Moore Research Article Prize at the 116th Annual Meeting of the AMS in San Francisco in January 2010.

Citation

The E. H. Moore Research Prize for 2010 is awarded to Professor Sorin Popa of UCLA for his article "On the superrigidity of malleable actions with spectral gap", *J. Amer. Math. Soc.* **21** (2008), no. 4, 981–1000. This article represents a major breakthrough in the author's remarkable program concerning von Neumann rigidity, orbit equivalence, and strong rigidity of ergodic measure preserving actions of countable groups. In the article, Popa uncovers a substitute for Kazhdan's property (T) hypothesis that appeared to be crucial in previous work on the subject by Connes, Popa, and others. The new condition, which involves spectral gaps, allows one to address a surprisingly general class of groups.



Sorin Popa

Popa's article also presents several applications of the new techniques to this large class of groups. For example, a superrigidity result in the case of Bernoulli actions shows that orbit equivalence implies conjugacy; this means that such groups are determined by the orbits of their Bernoulli actions. As a consequence, a large class of groups admit uncountably many nonorbit equivalent ergodic actions. The author proves a strong von Neumann rigidity theorem that shows that every isomorphism between the group measure space factors associated with free ergodic measure-preserving actions of such groups arises from a conjugacy of actions. This is in sharp contrast to the case of an amenable group, in which all ergodic measure-preserving actions are orbit equivalent and share the same group measure space factor.

Experts in the field remarked that before Popa's work, "such results were inconceivable in von Neumann algebras" and that "even recognizing some properties of the groups from the isomorphism of their group measure space algebras was notoriously hard". They further indicated that "a unique tensor product decomposition result in the setting of type II factor von Neumann algebras answers a thirty-five year old problem of Alain Connes" and said that Popa's work has "completely changed the landscape of operator algebras".

Biographical Sketch

Sorin Popa received his Ph.D. in 1983 from the University of Bucharest, Romania, with Dan Voiculescu as his adviser. From 1978 to 1987 he was a researcher in the mathematics department of INCREST in Bucharest. After spending a year as a visiting professor at UCLA, he assumed his present position of professor of mathematics in 1988. Popa also held a professorship at the University of Geneva from 1996 to 1998. He was a visiting professor at IHES (1991–1992), the Université de Paris 7 (1996), CNRS, and College de France (2004), and he was a frequent visitor at the University of Rome II and Odense University. Popa was an invited speaker at ICM 1990 in Kyoto and a plenary speaker at ICM 2006 in Madrid. He has received a number of awards, including a Guggenheim Fellowship (1995) and, most recently, the 2009 Ostrowski Prize. He is a coeditor of the *Pacific Journal of Mathematics* and serves on the editorial board of the *Journal of the AMS* and the *Journal of Operator Theory*. Popa's area of interest is functional analysis and operator algebras (von Neumann and C*-algebras) and the aspects of group theory and ergodic theory that pertain to operator algebras.

Response

I am deeply honored and elated to receive the E. H. Moore Research Article Prize. This honor adds to the extreme satisfaction I had when I actually obtained the results back in 2006. The article came after years of intense work and several previous papers in which I developed some new techniques for proving rigidity results in orbit equivalence relations and von Neumann algebras (II_1 factors) arising from measure-preserving actions of countable groups on probability spaces. The techniques required a deformability assumption on the algebras involved, such as *malleability*, a property that Bernoulli actions have. They also seemed to depend crucially on assuming some version of property (T), a fact that drastically limited the applications. The cited paper removed this latter assumption completely, merely using spectral gap rigidity, a property which is often automatically satisfied. This allowed many surprising applications, including a *cocycle superrigidity* result with arbitrary targets for Bernoulli actions of nonamenable product groups, and a result showing that any isomorphism of II_1 factors arising from such group actions comes from a conjugacy of the actions. Further striking applications of these ideas and techniques were obtained since then in my separate joint work with Narutaka Ozawa and Stefaan Vaes, respectively; and in subsequent work by Ionut Chifan, Cyril Houdayer, Adrian Ioana, and Jesse Peterson. I am grateful to them all for the fresh insight and creativity they brought to this direction of research.

About the Prize

The Moore Prize is awarded every three years for an outstanding research article that appeared in one of the primary AMS research journals: *Journal of the AMS, Proceedings of the AMS, Transactions of the AMS, AMS Memoirs, Mathematics of Computation, Electronic Journal of Conformal Geometry and Dynamics*, or *Electronic Journal of Representation Theory*. The article must have appeared during the six calendar years ending a full year before the meeting at which the prize is awarded. The prize carries a cash award of US$5,000.

The prize honors the extensive contributions of E. H. Moore (1862–1932) to the AMS. Moore founded the Chicago section of the AMS, served as the Society's sixth president (1901–1902), delivered the Colloquium Lectures in 1906, and founded and nurtured the *Transactions of the AMS*.

The Moore Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2010 prize, the members of the selection committee were: Carolyn S. Gordon (chair), Sergiu Klainerman, Kenneth A. Ribet, Richard M. Schoen, and Efim I. Zelmanov.

The previous recipients of the Moore Prize are Mark Haiman (2004) and Ivan Shestakov and Ualbai Umirbaev (2007).

About the Cover *(continued from page 516)*

continue on beyond its laminar separation point. From p. 146 of Shapiro's book: "The question is whether this assisting viscous force applied by the outside flow is sufficiently large to counterbalance opposing forces due to friction at the wall and to the increase of pressure from nose to tail."

This explanation does not lead to precise predictions. Applying the Navier-Stokes equations in turbulence is notoriously difficult because the range of relevant scales is so large. The problem of explicitly simulating what happens on a computer is daunting, and it is only recently that anyone has claimed seriously to be able to do it—take a look at the *New York Times* article `http://www.nytimes.com/2008/11/30/sports/golf/30score.html`. A fascinating video illustrating the simulation made by the team referred to there can be found at `http://ecommons.library.cornell.edu/handle/1813/11586`. Technical details are given in the paper "Numerical investigation of the flow over a golf ball in the subcritical and supercritical regimes" by Clinton Smith et al., to appear later this year in the *International Journal of Heat and Fluid Flow*. One motivation for practical computation is that the golf ball is a relatively simple example of a ubiquitous phenomenon. But it is also true that golf is an enormously popular game, and anything promising to improve one's game is eagerly investigated.

It would be nice to have a qualitative account somewhere in between Shapiro's explanation and the detailed computation.

On the cover of this issue, it is apparent that until recently the placing of dimples was relatively simple, usually around latitudes on the ball. (The old balls possessed a natural equator since they were constructed by joining two separate halves.) But modern golf balls, such as the Callaway at lower right, are more sophisticated, placing dimples (in the image, mostly hexagonal ones) in accord with icosahedral symmetry. You can perceive this by locating the small pentagons on this ball in a field of hexagons. The symmetry of these patterns is discussed by Ian Stewart in the 1997 *Scientific American* article referenced by Doug Arnold.

We wish to thank Michael Riste of the BC Golf Museum in Vancouver for allowing us to photograph the museum's collection of golf balls; Jane Hooper Perroud of the Calloway Golf Company for granting permission to display the Calloway ball; and Kyle Squires, one of Clinton Smith's collaborators, for responding to our queries.

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