2012 Morgan Prize

JOHN PARDON received the 2012 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student at the Joint Mathematics Meetings in Boston in January 2012. Receiving honorable mentions were HANNAH ALPERT and ELINA ROBEVA.

Citation

John Pardon has been named the recipient of the 2012 Morgan Prize for Outstanding Research by an Undergraduate Student for solving a problem on distortion of knots posed in 1983 by Mikhail Gromov. Demonstrating brilliant geometric understanding, John solved the problem by exhibiting a sequence of torus knots with distortions going to infinity. More precisely, given a smooth (or rectifiable) embedding of a knot K into 3-space, consider the ratios of the intrinsic and extrinsic distances between pairs of distinct points on the knot. The supremum of this ratio over all pairs is the distortion of the embedding. The distortion of a knot K is the infimum of the distortions of all rectifiable curves in the isotopy class of K. John's elegant proof was a beautiful mix of geometry and topology combined with some analytic arguments. John learned about this problem on his own (and in high school). According to his letters of recommendation, with this problem, no one had any idea how to get started; the key insight that cracked this problem is due to John. This paper appeared in the July issue (volume 174, number 1) of the *Annals of Mathematics.*

John has had five papers published, with another two submitted, one of which (with János Kollár) resulted from a conversation at a Phi Beta Kappa dinner at which Kollár asked John about a topology problem he had been posing to various topologists for about a year, without success. A week later, John sent Kollár an email with a solution to the problem, and they began working together, leading to the paper submitted in April. John's letters of recommendation describe him as very knowledgeable and insightful. John has given talks on his work at the Southeast Geometry Conference at the University of South Carolina, at geometry and topology seminars at City University of New York, Georgia Tech, University of Georgia, as well as at Princeton seminars and conferences.

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Biographical Sketch

John Pardon was raised in Chapel Hill, North Carolina, and began taking mathematics classes at Duke University while he was still in high school at Durham Academy. He was the valedictorian of Princeton's 2011 graduating class, majoring in mathematics. John was also a member of Princeton's winning team in an international Chinese-language debate, having taken Chinese throughout all four years at Princeton. A Phi Beta Kappa, he is also an accomplished cellist, twice winning the Princeton Sinfonia's annual concerto competition; he was a four-year member of the Sinfonia.

John Pardon

John's first paper in mathematics, "On the unfolding of simple closed curves", was submitted to the *Transactions of the American Mathematical Society* in January of his senior year in high school. It was also in high school that one of his favorite pastimes (reading mathematics papers online) introduced him to the problem on distortion of knots posed [by] Gromov, the solution of which brings to him the Morgan Prize. John has received numerous recognitions for his academic achievements; some of these are the Goldwater scholarship, two-time winner of Princeton's Shapiro Prize for academic excellence, and an NSF Graduate Research Scholarship to support his graduate studies at Stanford University, where he is currently.

Response from John Pardon

I am very honored to receive the 2012 Morgan Prize. I would like to thank the AMS, MAA, and SIAM for sponsoring the award, and Mrs. Frank Morgan for endowing it.

I am grateful to everyone who has taught me mathematics, especially my dad, for sharing their expertise and enthusiasm.

Thanks are due to David Gabai for helpful discussions about my work on knot distortion and to János Kollár for sharing and discussing topology problems with me.

Citation for Honorable Mention: Hannah Alpert

Hannah Alpert is recognized with an Honorable Mention for the 2012 Morgan Prize for Outstanding Research by an Undergraduate Student for a body of work consisting of six papers, five of which were published and one submitted prior to her graduation from the University of Chicago in June 2011. The first of these, in terms of her timeline of work, is a joint paper on topological graph theory on which she worked while in high school. Her coauthors on this paper point out that they sent this high school student the remaining cases in the proof that all six-colorable triangulations of the torus satisfy Grünbaum's conjecture, cases on which they were stuck. Hannah finished them off quickly, and this paper appeared in the *Journal of Graph Theory* early in 2010. An anonymous referee's comment on Hannah's paper "Rank numbers of grid graphs" (*Discrete Mathematics*, 2010) says, "The compilation of results forms arguably the best paper on the topic in the last decade." This is one of three professional-level papers she wrote in her 2009 REU at University of Minnesota Duluth.

Rather than exploit her novel approach to ranking numbers (her first paper of the summer of 2009) to obtain more results, Hannah asked for a different topic and successfully extended previous results on phase transitions in countable Abelian groups. She also provided the first results on phase transitions for uncountable Abelian groups and infinite nonabelian groups. She spoke on this work at the Combinatorial and Additive Number Theory conference, which is sponsored by the New York Number Theory Seminar. Hannah had two papers related to tournaments following the Lafayette College REU and a joint paper in *Discrete and Computational Geometry* as a result of the Willamette Valley REU the summer after her first year at the University of Chicago.

Biographical Sketch

Hannah Alpert grew up in Boulder, Colorado, attending Fairview High School. It was in high school that she began her mathematical research that led to a joint paper published in the *Journal of Graph Theory*. Hannah participated in the Hampshire College Summer Studies in Mathematics for three summers and was a MathPath camp counselor the summer before she entered the University of Chicago, from which she graduated in June 2011.

While an undergraduate at Chicago, Hannah participated in three REUs (Willamette Valley, University of Minnesota Duluth, and Lafayette College) and in each of these successfully solved posed problems, resulting in publications in *Discrete and Computational Geometry, Discrete Mathematics, Integers,* and *Archiv der Mathematik*. She also participated in the Budapest Semesters in Mathematics. Hannah was recognized at JMM 2009 with an MAA Undergraduate Poster Session Prize. She was awarded the Barry M. Goldwater Scholarship in 2009 and was a winner of the 2010 Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman. Hannah is in her first year of graduate work at MIT, where she is supported with an NSF Graduate Fellowship.

Response from Hannah Alpert

I am grateful to have been selected for Honorable Mention for the 2012 Morgan Prize. I would like to thank Sarah-Marie Belcastro, Josh Laison, Joe Gallian, Mel Nathanson, and Garth Isaak for the work they have done to facilitate my research.

Citation for Honorable Mention: Elina Robeva

Elina Robeva is recognized with an Honorable Mention for the 2012 Morgan Prize for Outstanding Research by an Undergraduate Student for her work with Sam Payne of Yale University on a new proof of the Brill-Noether theorem using tropical geometry. Elina began work on the deep and difficult mathematics of Brill-Noether theory during her sophomore year at Stanford; the coauthored paper "A tropical proof of the Brill-Noether theorem" has been recommended for publication in *Advances in Mathematics.* Elina's letters of recommendation say that without her persistence, independence, and insight this project would have ended far short of the ultimate goal of a new proof of the Brill-Noether theorem. It is noted that the Brill-Noether theorem is a remarkable result that has spawned an entire subfield of algebraic geometry and that the paper of which Elina is a coauthor may reasonably be the most important paper of the year in tropical geometry. Multiple definitive breakthroughs along the way to the new proof were due solely to Elina.

Prior to the Brill-Noether work, Elina proved an elegant formula for the optimal strategy in Bidding Hex (where players bid for the right to move, rather than taking turns). Her formula is beyond the computing capacities of contemporary machines; however, Elina developed and implemented a Monte Carlo approximation to this optimal strategy that is available online and is undefeated against human opponents. This work led to a joint paper, "Artificial intelligence for Bidding Hex", which appeared in the volume *Games of No Chance* in December 2008. Elina is referred to by her references as a mature and powerful research mathematician who is known for her attitude of seeking out challenges and working both hard and wisely. "The essential quality in a mathematician, the willingness to dive into a research problem and not be fearful, is something that Elina has developed at a young age."

Biographical Sketch

Elina Robeva was born in and grew up in Sofia, Bulgaria. Her interest in mathematics developed in middle school through competitions. By the time she graduated from high school, she had won two silver medals in the International Mathematical Olympiad, a gold medal in the Balkan Mathematical Olympiad, and various other awards from national and international competitions. Then she enrolled at Stanford, where she concentrated on theoretical mathematics and research. She graduated in June 2011 and was recognized with a Deans' Award for Academic Accomplishment and a Sterling Award for Scholastic Achievement. The article announcing these awards says that she "devoured the most challenging undergraduate and graduate mathematics courses at Stanford." She also achieved an honorable mention on the 2010 William Lowell Putnam examination and spent a summer at Facebook as a software engineer. Elina is now in her first year of the mathematics Ph.D. program at Harvard.

Response from Elina Robeva

I am very honored to have received this recognition, and I thank the AMS, MAA, and SIAM for selecting me for this award.

I would like to express my gratitude to the people who have had the most impact on my mathematical education thus far. I thank Ravi Vakil for the great support and advice and for all the times when he encouraged me to pursue various challenging mathematical tasks. I thank Sam Payne for being a wonderful research advisor and providing me with really interesting and engaging research problems. I also express my gratitude to Persi Diaconis for his great advice during my time at Stanford. I thank my high school teacher, Svetla Angelova, and the Bulgarian Academy of Sciences for the great preparation and opportunities to take part in mathematical competitions. Finally, I thank my mother, Rumyana Ivanova, for her unbounded love, support, and patience, which have continuously guided me during my education.

About the Prize

The Morgan Prize is awarded annually for outstanding research in mathematics by an undergraduate student (or students having submitted joint work). Students in Canada, Mexico, or the United States or its possessions are eligible for consideration for the prize. Established in 1995, the prize was endowed by Mrs. Frank (Brennie) Morgan of Allentown, Pennsylvania, and carries the name of her late husband. The prize is given jointly by the AMS, the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM) and carries a cash award of US$1,200.

Recipients of the Morgan Prize are chosen by a joint AMS-MAA-SIAM selection committee. For the 2012 prize, the members of the selection committee were Colin C. Adams, Jill Dietz, Kathleen R. Fowler, Anna L. Mazzucato, Kannan Soundararajan, and Sergei Tabachnikov.

Previous recipients of the Morgan Prize are Kannan Soundararajan (1995), Manjul Bhargava (1996), Jade Vinson (1997), Daniel Biss (1998), Sean McLaughlin (1999), Jacob Lurie (2000), Ciprian Manolescu (2001), Joshua Greene (2002), Melanie Wood (2003), Reid Barton (2005), Jacob Fox (2006), Daniel Kane (2007), Nathan Kaplan (2008), Aaron Pixton (2009), Scott Duke Kominers (2010), and Maria Monks (2011).

— Elaine Kehoe