

# 2003 Morgan Prize



**Melanie Wood**

The 2003 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student was awarded at the Joint Mathematics Meetings in Phoenix in January 2004.

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. Es-

tablished in 1995, the prize was endowed by Mrs. Frank Morgan 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 \$1,000.

Recipients of the Morgan Prize are chosen by a joint AMS-MAA-SIAM selection committee. For the 2003 prize the members of the selection committee were: Kelly J. Black, Fan Chung Graham, Thomas C. Hales (chair), Svetlana R. Katok, Kris Stewart, and Philippe M. Tondeur.

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), and Joshua Greene (2002).

The 2003 Morgan Prize was awarded to MELANIE WOOD. Receiving an honorable mention was KAREN YEATS. The text that follows presents the selection committee's citation, a brief biographical sketch,

and the awardee's response upon receiving the prize. The same information is provided for the honorable mention.

## **Melanie Wood**

### **Citation**

The winner of the 2003 Morgan Prize for Outstanding Research by an Undergraduate is Melanie Wood. The award is based on research on two different topics: Belyi-extending maps and  $P$ -orderings.

The first topic is concerned with finite coverings of the projective line that are ramified only at three points of the projective line. The absolute Galois group of the field of rational numbers acts on these coverings and on diagrams (that Grothendieck named *dessins d'enfants*) associated with the coverings. Melanie Wood's research gives a way to generate genuinely new Galois invariants of *dessins* from old ones. Her work yields important insights into the actions of the Galois group on fundamental groups. This research has attracted the attention and admiration of the specialists working in this field. The paper has been submitted for publication.

In a separate project, Melanie Wood studies  $P$ -orderings in Dedekind rings. These  $P$ -orderings were introduced by Bhargava in 1995 to generalize the usual factorial function. It is well known that a polynomial with rational coefficients takes integer values at the integers if and only if it is an integer linear combination of binomial coefficient polynomials  $\binom{x}{k}$ . One of her results in this area implies that, in imaginary quadratic fields, the integer-valued polynomials cannot possess a basis of this same general form. Melanie began this work during the 2000 Duluth Summer Research Program (directed by Joseph Gallian), and her paper on  $P$ -orderings has recently appeared in the *Journal of Number Theory*.

Richard Hain (with help from Makoto Matsumoto) mentored her work at Duke.

Melanie Wood's research has been described in glowing terms by her mentors and by other experts in her field. The work is deep and original. The committee commends her for the mature mathematical perspective in her writings. The AMS, the MAA, and SIAM are pleased to award the 2003 Frank and Brennie Morgan Prize to Melanie Wood.

#### **Biographical Sketch**

Melanie Wood graduated from Duke University in May 2003 with highest distinction in mathematics. Her math competition honors include top place finishes in the USA Mathematical Olympiad and the Asian Pacific Mathematical Olympiad, and the designation of Putnam Fellow. She won both a Gates Cambridge Scholarship and a Fulbright to study at the University of Cambridge, where she is currently doing a one-year math program. This fall she will enter the math Ph.D. program at Princeton on a National Science Foundation Graduate Fellowship. Her current research interests are in algebraic number theory and arithmetic algebraic geometry. Melanie also enjoys acting, especially classical acting and voice work; directing; dancing; and philosophy.

#### **Response**

I am extremely honored to be awarded this prize. My experiences doing math research have been tremendously rewarding and the critical factor in my decision to continue on to graduate work in mathematics. That I had these experiences at all is due to two institutions that enable and encourage undergraduate math research: Duke University and the REU [Research Experiences for Undergraduates] at the University of Minnesota, Duluth. At Duke, I wish to thank Richard Hain, who supervised my research on the absolute Galois group, and Robert Bryant, who was available for many helpful conversations. I wish to thank Makoto Matsumoto for quick and helpful responses to technical questions. I also wish to thank Joe Gallian, director of the Duluth REU, for his support of my research, and all those affiliated with the Duluth REU who gave me feedback on my  $P$ -orderings paper.

#### **Honorable Mention: Karen Yeats**

##### **Citation**

The Morgan Prize Committee is pleased to award honorable mention for the 2003 Morgan Prize for Undergraduate Research to Karen Yeats for a series of outstanding contributions on topics ranging from asymptotics and number theory to mathematical logic. A few examples indicate the broad versatility of her research.

One of Karen Yeats's research projects is motivated by a precise analogy between results in additive number theory and results in multiplicative number theory. Based on this analogy, Karen Yeats

has proved a multiplicative version for Dirichlet series of a classical estimate of Schur on the size of the coefficients of a product of two power series.

In her second paper Yeats determines bounds on the size of values of a character, expressed as a function of the degree of the character, for exceptional compact Lie groups. This research completes the work of other researchers, who had previously obtained results for classical compact Lie groups.

In a third paper she makes a model-theoretic investigation of exotic identities of the positive integers. An exotic identity is one involving addition, multiplication, and exponentiation that is not a consequence of eleven basic arithmetic identities, articulated by Dedekind in 1888.

The committee was impressed by the quality of the papers, the enthusiastic letters from her mentors, and the speed and independence of her research. The committee is proud to honor Karen Yeats with this award.

#### **Biographical Sketch**

Karen Yeats is a native of Halifax, NS, Canada. She began enjoying mathematics through regional, national (Canadian), and foreign contests. She entered the University of Waterloo in September 1998 and graduated with an honors BMath in Pure Math and a Governor General's Silver Medal in 2003. During that time she had the opportunity to spend three summers as an NSERC (Natural Sciences and Engineering Research Council of Canada) undergraduate research assistant and benefited greatly from the strong faculty and program in pure mathematics at Waterloo. She is now pursuing a Ph.D. in mathematics at Boston University. Karen is an accomplished recorder player and also enjoys playing clarinet and singing in choirs, as well as the occasional foray into making teddy animals and working on free software.

#### **Response**

I am truly honored to have been named honorable mention for this year's Morgan Prize. Great thanks to the creators and organizers to whom the prize owes its existence. I also owe great thanks to NSERC, Kathryn Hare, Frank Zorzitto, and especially Stan Burris for my summer research terms, which have made all this possible. At the University of Waterloo I also want to thank everyone in Math and Pure Math for making it clear to me that I was in the right place from the very beginning, and in Halifax to everyone who encouraged me on the contests.