Melanie Wood Interview

Photo by Joe Rabinoff.

Melanie Wood *is assistant professor at the University of Wisconsin-Madison and an American Institute of Mathematics Five-Year Fellow.*

Diaz-Lopez: *When did you know you wanted to be a mathematician?*

Wood: My mathematics research experiences as an undergraduate at the REU [Research Experiences for Undergraduates] at the University of Minnesota-Duluth and through the PRUV [Program for Research for Undergraduates] program at Duke University, where I was an undergraduate, were really the tipping point for me in deciding I wanted to be a mathematician. I had always liked math, but until these experiences I didn't really have any sense of what math as a career would be like. I had so much fun working on my own research problems that I knew it was something I would want to do as a job.

Diaz-Lopez: *Who encouraged or inspired you?*

Wood: I have been extraordinarily lucky to have so many wonderful teachers and mentors that have encouraged me and inspired me along my path to becoming a mathematician. Some who particularly stand out from my youth: Bob Fischer, who was the Indiana MATHCOUNTS® coach when I was in 7th and 8th grade and the first person I can remember giving me math problems I didn't know how to solve; Joanne Black, a teacher at my high school who was incredibly supportive of my mathematical development; Zvezdelina Stankova, who particularly inspired me as a teacher at the Math Olympiad Summer Program. Then throughout college and graduate school the mathematicians who have encouraged and inspired me are too numerous to mention all of them. I had a lot of wonderful math professors as an undergraduate at Duke. My PhD advisor, Manjul Bhargava, was incredibly supportive, not to mention inspiring, through the somewhat rocky path of graduate school. When I was a postdoc, Ravi Vakil was an important mentor and inspiration.

Diaz-Lopez: *How would you describe your research to a graduate student?*

Wood: I work on a lot of different questions, mostly focused in number theory but also in algebraic geometry, algebraic topology, and probability. I am interested in the most basic objects in number theory, number fields, which are finite extensions of the rational numbers. I want to understand how many number fields there are and how often they have various properties. As basic as it is, this sort of question can be incredibly difficult and require ideas from a broad spectrum of mathematics. I also am interested in questions about the number of solutions of polynomial equations, both solutions that are rational numbers and solutions that lie in a finite field. These questions are deeply connected to the geometry of the space of solutions of the equations.

Diaz-Lopez: *What theorem are you most proud of, and what was the most important idea that led to this breakthrough?*

Wood: I am most proud of my results proving the distribution of sandpile groups of random graphs or, relatedly, cokernels of symmetric random matrices. First, let's talk about the cokernel of a matrix. Take a free abelian group on n generators, and then pick n relations (sums of those n generators). If

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you put the n^2 coefficients of the relations in a matrix, the abelian group you get by taking generators mod relations is the cokernel of the matrix. It is just a natural way to build a random abelian group. Many different properties of random matrices have been well studied, and in general they are much easier to understand when the entries of the matrices are all independent. My work had to tackle two kinds of dependency in the matrices and still understand their random behavior. I got interested in thinking about random abelian groups this way because class groups of number fields, which measure the failure of unique factorization in those number fields, occur naturally this way via matrices whose entries are dependent in deep and mysterious ways. I wouldn't say that there was a single most important idea that led to the breakthrough. The work took a long time, with many different breakthroughs (and some antibreakthroughs!) along the way, and required developing several kinds of new methods.

Diaz-Lopez: *What advice do you have for graduate students?*

Wood: Figure out what you want to get out of graduate school and what it takes to get that. Tell your advisor what you want and ask his or her advice for what it will take to get it, and ask other faculty for advice as well. The figuring-out part might be a significant project for some people, and you should undertake it as real work. Talk to finishing students about what kinds of jobs they got and what it took to get them—what kinds of skills they had to develop, what kind of experience they needed, what kinds of theorems they proved, what kinds of teaching evaluations or feedback. Talk to mathematicians in a range of different jobs about what their jobs are like and what it takes to get them. Go to conferences and talk to a wide range of people there. These are some of the questions you can ask them.

Practice talking about your work to a wide range of mathematicians, and figure out what it takes to communicate what you do and why it is interesting to them. Ask your advisor for advice about this, and pay attention in seminar talks to how people motivate their work. Learn how to put your work in context at many different levels. What are the overarching goals of your field and how does your work fit into that? You can ask a similar question about your subfield or more specialized area. Remember that what you say about your work should depend on your audience. Graduate students generally tend to assume other people know way more about the topic they are studying for their thesis than anyone actually does. Talk to other graduate students and tell them to stop you if you say something they don't know.

Diaz-Lopez: *All mathematicians feel discouraged occasionally. How do you deal with discouragement?*

Wood: I keep a list of positive experiences—when I proved a result, had a great mathematical conversation, got inspired by a talk—and go to it when I feel discouraged. I also have mathematical colleagues who are good friends whose advice and support help keep me afloat.

Diaz-Lopez: *You have won several honors and awards. Which one has been the most meaningful and why?*

Wood: The American Institute of Mathematics (AIM) Five-Year Fellowship has meant the most to me. As I was finishing graduate school, I wasn't even sure if becoming a professional mathematician was the right career for me. I found graduate school lonely and discouraging in parts. The AIM Five-Year Fellowship was greatly needed positive feedback about my work and allowed me to start a postdoc in ideal conditions. My experience as a postdoc was exciting and encouraging, as I started new collaborations and took my research in new directions.

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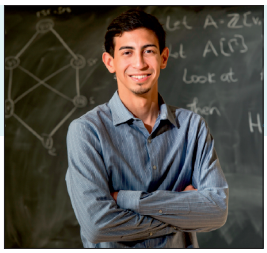
Diaz-Lopez: *If you were not a mathematician, what would you be?*

Wood: It is hard to say because I have always had a lot of interests. I started college thinking I would go into cognitive science. Lately, I've gotten interested in supreme court jurisprudence, and so I could imagine really enjoying going to law school.



Alexander Diaz-Lopez is a PhD student at the University of Notre Dame. Diaz-Lopez is the first graduate student member of the *Notices* Editorial Board.