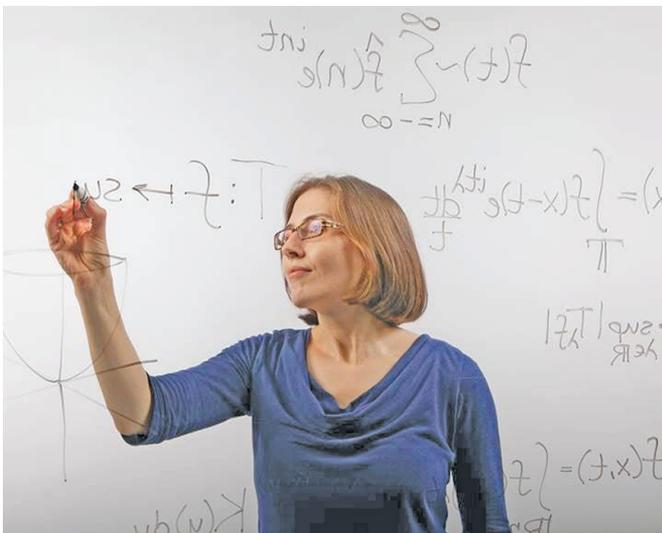




Lillian Pierce Interview

Conducted by Laure Flapan

Communicated by Alexander Diaz-Lopez



Lillian Pierce is assistant professor of mathematics at Duke University. Her areas of research are analytic number theory and harmonic analysis. She received a CAREER Award from the National Science Foundation in 2017 and a 2017–2018 von Neumann Fellowship from the Institute for Advanced Study in Princeton.

Flapan: *When did you know you wanted to be a mathematician?*

Pierce: First I had to learn that mathematicians still existed. I was really little when I fell in love with numbers: the way they looked, the way they talked to each other—which is how I perceived arithmetic. I remember a visceral delight in filling out math workbooks in kindergarten. But I don't think I explicitly realized that doing mathematics research was a career until partway through college. I started out as a math major at Princeton because I had "always liked math," but my goal was to head for MD/PhD programs, and I completed all the pre-med requirements. Meanwhile, I became absolutely captivated by the feeling of doing mathematics, and this coincided with a stellar sequence of courses at Princeton (which became the series *Princeton Lectures in Analysis* by Stein and Shakarchi). By the last year of college, my goals became centered on mathematics.

Flapan: *Who encouraged or inspired you?*

Pierce: I have been encouraged and inspired by dozens of mathematicians, and also more broadly, scientists. I feel extremely lucky in this way. Just now, I started to write down names but the list is so long that it looked like bragging. Many, many people have been generous with their interest in me, generous with suggesting problems or questions to me, generous with checking in on me as I reached a transition point in my education or career, generous with writing me letters of reference or nominations, or inviting me to visit, or to speak at a conference. Of course, even in such a list, my graduate and postdoc mentors stand out: Roger Heath-Brown, Peter Sarnak, Eli Stein. They have each been absolutely foundational in guiding my research interests.

Flapan: *How would you describe your research to a graduate student?*

Pierce: My work lies in the union of analytic number theory and harmonic analysis. In number theory, I'm interested in counting integral points on varieties via the circle method and sieve methods, and in studying properties of class numbers of number fields. In analysis, I'm interested in bounding oscillatory integral operators,

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DOI: <http://dx.doi.org/10.1090/noti1586>

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Radon transforms, and Carleson operators, and their discrete analogues. In either setting, the methods often hinge upon finding a good bound for an oscillatory integral or an exponential or character sum—this is because many of the methods I use are based on Fourier analysis. I'd say that typically the arguments I like are sequences of simple ideas using recognizable objects. In culinary terms, I'd be more in the philosophy of farm-to-table than molecular gastronomy.

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

Pierce: I think it's a bit early to say I'm proud of any one particular theorem. What I am glad of is that I've been able to shift my focus repeatedly in order to work on problems that I find really appealing, even if they aren't obviously related. I get asked "Are you an analyst?" "Are you a number theorist?" I don't really want to make that division, for myself. Nevertheless, sometimes I watch someone give a talk and feel a bit envious that the territory they have chosen to work in consistently for a number of years is so well-defined: Problem A and variations. That person knows everything about the history of Problem A, all the current gossip about Problem A, and can be forgiven for ignoring things on the arXiv that aren't in the neighborhood of Problem A. I on the other hand feel like I've started over building expertise from scratch a number of times. It certainly isn't efficient. But some problems just feel like the right ones.

Flapan: *You received your PhD only eight years ago, but you have given over 100 talks. What is your favorite part about giving talks?*

Pierce: I learn a lot from giving talks. First, I think afresh while preparing a talk: Why would other people care about the problem? What are the historical origins? What are the connections to other areas? What are the truly key ideas in the proof? How can I strip them of technicalities so that people can remember them intuitively? Second, I learn from people's reactions to the talk. Sometimes I pick up historical facts I didn't know. Sometimes I learn how I could frame the result so that people in another field might find it more familiar. Sometimes I am prompted to strengthen the result or extend the method or start a new project. Third, I really like getting to meet in person the mathematicians I see represented on paper.

Flapan: *What are the biggest challenges young mathematicians today face?*

Pierce: I wonder about the speed of research now. I haven't experienced other eras, but nowadays it could feel like you are in a crowded international race twenty-four hours a day. When I was deciding on a career, one of the big attractions I felt to math was the contemplative nature of the work. I want to continue to choose to be a contemplative thinker, to write papers with great attention to exposition, to not feel rushed. I have learned a lot about patience from seeing my father, a woodworker, make

furniture. Once, he wanted to achieve a certain color for an oak bed, which historically would have been achieved with ammonia fuming. Instead, he devised a non-toxic water-based dyeing strategy, but while this attained the right color, it would have raised the grain and made the wood feel rough. To pre-empt this, he soaked every piece of the bed in water, which raised the grain, and then sanded it down by hand. He did this seven times, at which point the grain was recessed. Then he applied the water-based dyeing strategy, which now raised the grain just flush with the wood, leaving each surface of the bed satin smooth. Every piece he makes is gorgeous, strong, and clever—and comes with a lot of sanding.

Flapan: *All mathematicians feel discouraged occasionally. How do you deal with discouragement?*

Pierce: Discouragement was a bigger factor in grad school when I had just a couple distinct goals. Now I typically have more projects going, and usually one of them is looking somewhat tractable. Working with collaborators is really helpful—if they are a good mathematical and personal fit, they can really keep your spirits up. In general, I think a time of discouragement can be a time to rephrase what we do as "learning" rather than "proving." After all, proving a new theorem is just learning something no one has learned before. And we probably can each climb back to enjoying math if we temporarily set our sights on just learning something.

Flapan: *In a previous life, you were a professional violinist. What role does music play in your life today?*

Pierce: Like many people, I listen to music to give me energy as I work, particularly when writing. The Prokofiev piano concerti have been some of my best work music, for years. In another vein, for me, learning to play a piece of music is like building a detailed mental landscape, and that can be very much like assembling the pieces of a long-term math project. There's another thing too—after you have performed a concerto with an orchestra in a large concert hall, giving a math talk seems relatively low pressure. You're allowed to pause and think, for one thing!

Flapan: *What advice do you have for current graduate students in math?*

Pierce: If I were talking to me as a student, I'd say: "Pick a book and sit down every day and spend one hour working your way through it in detail." In grad school, it can feel like any time not spent banging your head directly on your thesis problem is wasted. But in reality, if you consistently take one hour a day away from that struggle and work through books, you'll gradually gain technical skills that will come in handy one day.

Flapan: *If you could recommend one book to graduate students, what would it be?*

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Pierce: Find a book in your field that is considered to be especially beautifully written. For me, say, Stein's *Harmonic Analysis*. Then figure out why it is so good. Math will be more fun for everyone, especially young people, if we all learn to write clearly and generously.

Flapan: Any final comments or advice?

Pierce: Here's a standard set by Anthony Trollope that I one day hope to achieve: "A small daily task if it really be daily, will beat the labors of a spasmodic Hercules."

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Laure Flapan

ABOUT THE INTERVIEWER

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