

# Interview with Research Fellow

## Maryam Mirzakhani



**Maryam Mirzakhani**, a native of Iran, is currently a professor of mathematics at Stanford. She completed her Ph.D. at Harvard in 2004 under the direction of Curtis T. McMullen. In her thesis she showed how to compute the Weil-Petersson volume of the moduli space of bordered Riemann surfaces. Her research interests include Teichmüller theory, hyperbolic geometry, ergodic theory, and symplectic geometry.

*What first drew you to mathematics? What are some of your earliest memories of mathematics?*

As a kid, I dreamt of becoming a writer. My most exciting pastime was reading novels; in fact, I would read anything I could find. I never thought I would pursue mathematics before my last year in high school. I grew up in a family with three siblings. My parents were always very supportive and encouraging. It was important for them that we have meaningful and satisfying professions, but they didn't care as much about success and achievement. In many ways, it was a great environment for me, though these were hard times during the Iran-Iraq war. My older brother was the person who got me interested in science in general. He used to tell me what he learned in school. My first memory of mathematics is probably the time that he told me about the problem of adding numbers from 1 to 100. I think he had read in a popular science journal how Gauss solved this problem. The solution was quite fascinating for me. That was the first time I enjoyed a beautiful solution, though I couldn't find it myself.

*Could you talk about your mathematical education? What experiences and people were especially influential?*

I was very lucky in many ways. The war ended when I finished elementary school; I couldn't have had the great opportunities that I had if I had been born ten years earlier. I went to a great high school in Tehran, Farzanegan, and had very good teachers. I met my friend Roya Beheshti the first week after entering middle school. It is invaluable to have a friend who shares your interests, and helps you stay motivated. Our school was close to a street full of bookstores in Tehran. I remember how walking along this crowded street, and going to the bookstores, was so exciting for us. We couldn't skim through the books like people usually do here in a bookstore, so we would end up buying a lot of random books.

Also, our school principal was a strong-willed woman who was willing to go a long way to provide us with the same opportunities as the boys' school. Later, I got involved in Math Olympiads that made me think about harder problems. As a teenager, I enjoyed the challenge. But most importantly, I met many inspiring mathematicians and friends at Sharif University. The more I spent time on mathematics, the more excited I became.

At Sharif University, we had problem-solving sessions and informal reading groups with my classmates. The friendship and support of all the people I met there and later at Harvard helped me a lot in many different ways. I am grateful to all of them.

*Did you have a mentor? Who helped you develop your interest in mathematics, and how?*

Many people have had a great influence on my math education, from my family and teachers in high school to professors at Sharif University, and later at Harvard.

*You were educated in Iran. Could you comment on the differences between mathematical education there and in the US?*

It is hard for me to comment on this question since my experience here in the U.S. is limited to a few universities, and I know very little about the high school education here.

However, I should say that the education system in Iran is not the way people might imagine here. As a graduate student at Harvard, I had to explain quite a few times that I was allowed to attend a university as a woman in Iran. While it is true that boys and girls go to separate schools up to high school, this does not prevent them from participating say in the Olympiads or the summer camps.

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But there are many differences: in Iran you choose your major before going to college, and there is a national entrance exam for universities. Also, at least in my class in college, we were more focused on problem solving rather than taking advanced courses.

*What attracted you to the particular problems you have studied?*

When I entered Harvard, my background was mostly combinatorics and algebra. I had always enjoyed complex analysis, but I didn't know much about it. In retrospect, I see that I was completely clueless. I needed to learn many subjects which most undergraduate students from good universities here know. I started attending the informal seminar organized by Curt McMullen. Well, most of the time I couldn't understand a word of what the speaker was saying. But I could appreciate some of the comments by Curt. I was fascinated by how he could make things simple, and elegant. So I started asking him questions regularly, and thinking about problems that came out of these illuminating discussions. His encouragement was invaluable. Working with Curt had a great influence on me, though now I wish I had learned more from him! By the time I graduated I had a long list of raw ideas that I wanted to explore.

*Can you describe your research in accessible terms? Does it have applications to other areas?*

Most problems I work on are related to geometric structures on surfaces and their deformations.

In particular, I am interested in understanding hyperbolic surfaces. Sometimes properties of a fixed hyperbolic surface can be better understood by studying the moduli space that parametrizes all hyperbolic structures on a given topological surface.

These moduli spaces have rich geometries themselves, and arise in natural and important ways in differential, hyperbolic, and algebraic geometry. There are also connections with theoretical physics, topology, and combinatorics. I find it fascinating that you can look at the same problem from different perspectives, and approach it using different methods.

*What research problems and areas are you likely to explore in the future?*

It's hard to predict. But I would prefer to follow the problems I start with wherever they lead me.

*Could you comment on collaboration versus solo work as a research style? Are certain kinds of problems better suited to collaboration?*

I find collaboration quite exciting. I am grateful to my collaborators for all I have learned from them. But in some ways I would prefer to do both; I usually have some problems to think about on my own.

*What do you find most rewarding or productive?*

Of course, the most rewarding part is the "Aha" moment, the excitement of discovery and enjoyment of understanding something new, the feeling of being on top of a hill, and having a clear view. But most of the time, doing mathematics for me is like being on a long hike with no trail and no end in sight!

I find discussing mathematics with colleagues of different backgrounds one of the most productive ways of making progress.

*How has the Clay Fellowship made a difference for you?*

It was a great opportunity for me; I spent most of my time at Princeton which was a great experience. The Clay Fellowship gave me the freedom to think about harder problems, travel freely, and talk to other mathematicians. I am a slow thinker, and have to spend a lot of time before I can clean up my ideas and make progress. So I really appreciate that I didn't have to write up my work in a rush.

*What advice would you give to young people starting out in math (i.e., high school students and young researchers)?*

I am really not in a position to give advice; I usually use the career advice on Terry Tao's web page for myself! Also, everyone has a different style, and something that works for one person might not be so great for others.

*What advice would you give lay persons who would like to know more about mathematics—what it is, what its role in our society has been and so on? What should they read? How should they proceed?*

This is a difficult question. I don't think that everyone should become a mathematician, but I do believe that many students don't give mathematics a real chance. I did poorly in math for a couple of years in middle school; I was just not interested in thinking about it. I can see that without being excited mathematics can look pointless and cold. The beauty of mathematics only shows itself to more patient followers.

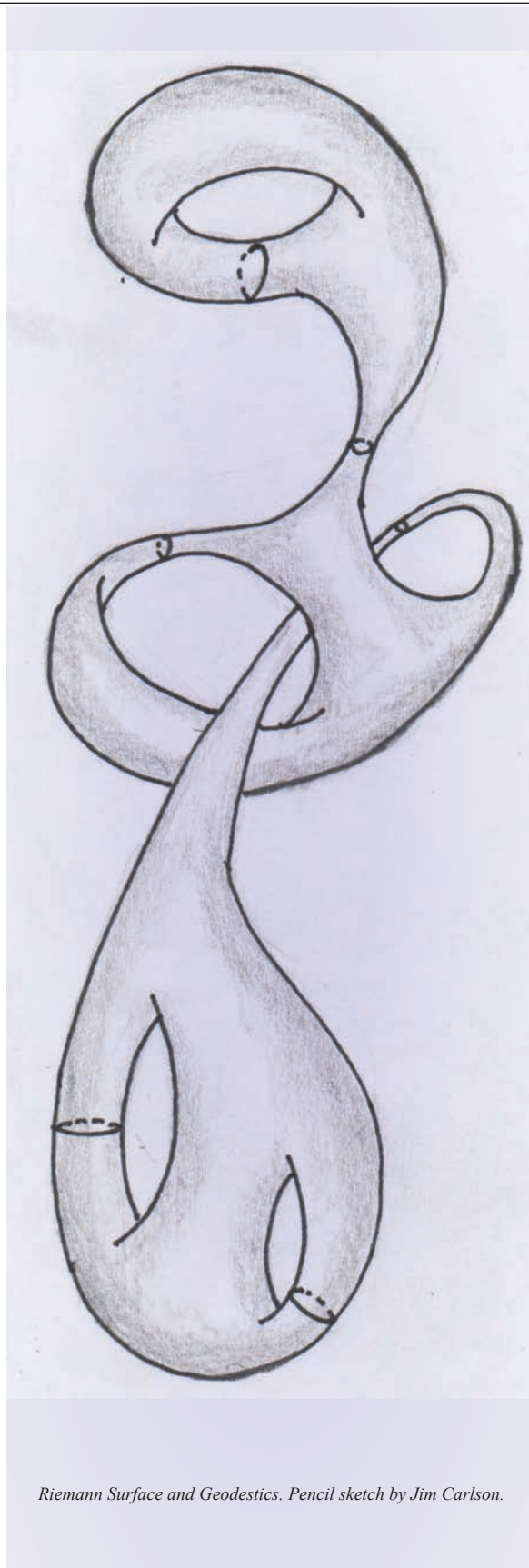
*Please tell us about things you enjoy when not doing mathematics.*

Mostly, I spend time with my family and husband. But for myself, I prefer solo activities; I enjoy reading and exercising in my free time.

## Recent Research Articles

"Ergodic Theory of the Earthquake Flow." *Int Math Res Notices* (2008) Vol. 2008.

"Ergodic Theory of the Space of Measured Laminations," with Elon Lindenstrauss. *Int Math Res Notices* (2008) Vol. 2008.



*Riemann Surface and Geodesics. Pencil sketch by Jim Carlson.*