



## Interview with Fernando Codá Marques



Photo courtesy of Fernando Codá Marques.

**Fernando Codá Marques** is Professor of Mathematics at Princeton University. He and André Neves proved the Willmore Conjecture in 2012. Check out the video of him presenting at MCA2013 at <https://www.youtube.com/watch?v=mYEauQnx6C0>.

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

**Codá Marques:** I always liked mathematics, but in school I did not know what it really meant to be a mathematician. I did not know it was an active field. I started reading a lot about physics, especially theoretical physics and astrophysics too. I entered the university as a student in civil engineering, but quickly and by myself I discovered many books on advanced mathematics in the university library. The beauty and rigor of the mathematics presented in those books made it clear to me that this was what I wanted to do. During those times I read a lot of algebra. Only later I realized that geometry and analysis were more suitable fields for me.

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

**Codá Marques:** When I started my studies at IMPA [Instituto Nacional de Matemática Pura e Aplicada in Rio de Janeiro, Brazil], I took two PhD courses with Professors Manfredo do Carmo (in geometry) and Elon Lages Lima (in

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topology). They also happen to be from my hometown, Maceio, in the northeast of Brazil, and that also helped on a personal level. Those courses were very inspiring and made a profound impression on me. The atmosphere was very stimulating.

Later these professors encouraged me to pursue my PhD studies in the United States, to learn geometric analysis. It was great advice. I went to Cornell University to study with José F. Escobar, a wonderful mathematician and human being, and a few years later I spent a year at Stanford University learning from Richard Schoen. From Rick I learned a sense of what is important in mathematics and refined my mathematical taste.

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

**Codá Marques:** I study geometric problems by means of analytic tools. These problems are often associated to nonlinear partial differential equations, and variational techniques play a very important role. Currently I am very interested in the Morse-theoretic properties of the space of minimal varieties inside some ambient space. This involves a lot of geometric measure theory. There was some foundational work by Almgren in the 1960s and by Pitts in the early 1980s, but many basic questions are still unanswered. I am trying to develop the theory further in my work with André Neves.

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

**Codá Marques:** I am most proud of my paper with André in which we prove the Willmore conjecture. This problem was proposed by T. J. Willmore in 1965 and concerned optimal shapes of toroidal surfaces in three-space. The problem has conformal symmetry, and this makes it more difficult because the group of symmetries is noncompact. It is one of those questions that end up stimulating a lot of mathematics.

At some point we realized that there was a connection with the min-max theory of minimal surfaces developed by Almgren and Pitts. We were very excited. We developed

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*I try to keep learning and thinking continually about mathematics.*

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# THE GRADUATE STUDENT SECTION

a strategy that was based on the study of the geometric properties of some new five-parameter families of surfaces we had defined. We had to overcome several difficulties, one by one, but the real breakthrough came when we discovered how the genus of the original surface would play a role. It was pure topology, and it was beautiful. Even though we needed months to write everything carefully and check all the details, it was instantly after this breakthrough that we realized we had found a proof of the Willmore conjecture.

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

**Codá Marques:** I think that being able to find your own questions, and good ones, is a fundamental skill in mathematics. It takes time to develop a sense of what the important or interesting questions are. Of course this is very subjective, but graduate school is a good time to start working on that.

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

**Codá Marques:** We cannot let ourselves feel discouraged. Most times we are stuck in mathematics, but this is normal. I love my job. I try to keep learning and thinking continually about mathematics. The environment at Princeton University is great for that.

**Diaz-Lopez:** *Louis Nirenberg recently won the Abel Prize. How has Nirenberg's work influenced your mathematics?*

**Codá Marques:** Professor Nirenberg is one of the greatest mathematicians of our time. As a geometric analyst, I have been profoundly influenced by his papers. I also remember an interview with him in the *Notices* [April, 2002] in which he comments on his love of inequalities. He says inequalities can be more interesting than identities, and I was affected by that. I do not know many things that are as beautiful and perfect as a sharp inequality.

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

**Codá Marques:** Most likely a theoretical physicist. I have great admiration for the profession and for the kind of intuition one needs to have. But I should say that I am platonist and believe that all, in the end, is mathematics.

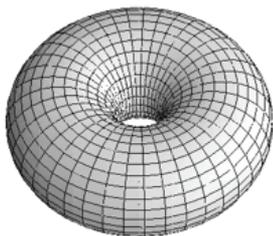
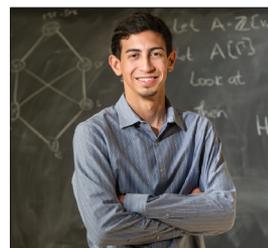


Image courtesy Tom Banchoff.

**The Willmore Conjecture concerned optimal shapes of toroidal surfaces in three-space.**



**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.

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