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Artur Avila – Fields Medalist

Something interesting always goes on in math

Artur Avila, the first Fields Medalist from Latin America, represents a growing presence of southern hemisphere in mathematics. The 35-year-old Rio de Janeiro native will be the face of Brazil when his hometown hosts the International Congress of Mathematicians four years later.

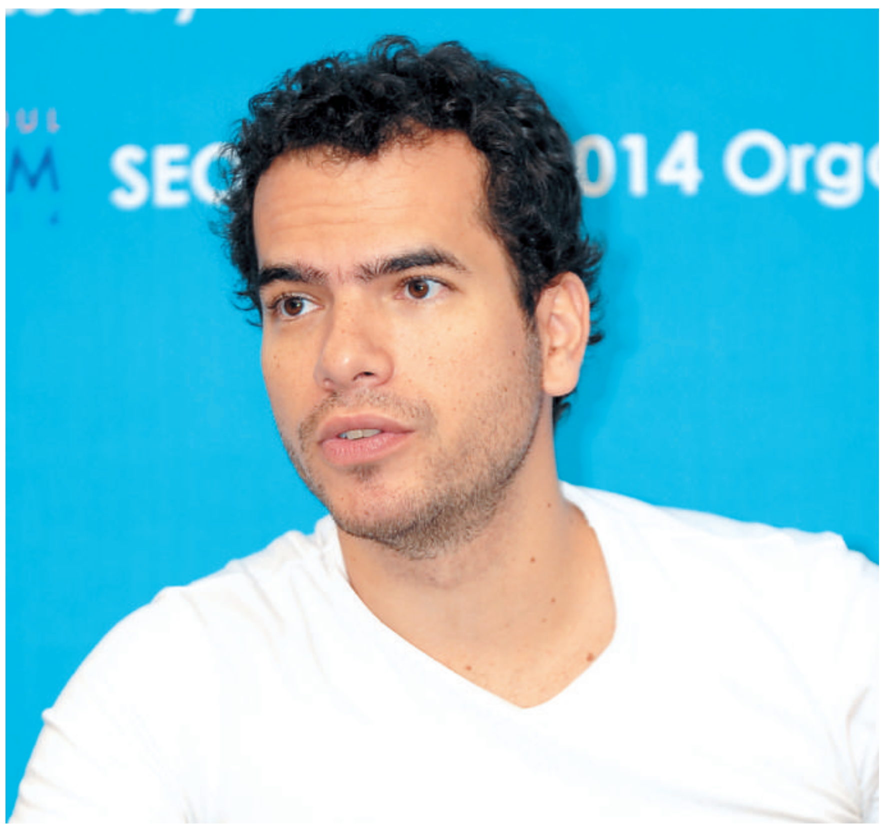
In a joint press interview Monday during the SEOUL ICM 2014, Avila attributed much of his success to the education he received in his two mother countries - Brazil and France. He earned Ph.D. at the age of 21 thanks to math prodigy program at IMPA in Brazil, and furthered his research at CNRS in France, where he was later naturalized.

Q: You received your Ph.D at 21. How were you able to do it at that age?

A. Thanks to no age restriction in course enrollments at IMPA, I was invited to study at IMPA at an early age. This early development for mathematical talent was encouraged at IMPA and my case is not unique. I can recall a fellow student, who at the tender age of 13 was enrolled in the linear algebra class for which I was a teaching assistant and subsequently received Ph.D at 19.

Why did you choose dynamical systems? What drew you to your research?

During the masters coursework at IMPA, I realized my mathematical strength was in analysis. At IMPA, there are many strong groups of people working in various aspects of dynamics, and I was naturally led to the field. I became happy because the field can be applied to whatever interesting things I like to do. I developed the work around quadratic unimodal maps at IMPA, and later I was exposed to other topics in dynamical systems in France.



Artur Avila, winner of a 2014 Fields Medal, speaks to reporters at the SEOUL ICM 2014 on Monday.

Could you explain the idea of renormalization, which was repeatedly emphasized in your lecture?

The word renormalization has different meanings in different parts of mathematics. It is a method to look at a certain kind of dynamical system which is a study of a long term behavior. When you restrict a system to a small part of the space we get a new system similar to the original. This can be repeated. Then you have the sequence of microscopic spaces that allows you to look at smaller and smaller scale. And what happens to the behavior at a smaller scale is that they resemble the same behavior at large scales. The renormalization process involve understanding the nonlinear dynamics in infinite dimension.

How is your research being applicable?

Doing research, for some mysterious reason, often turns out to have an application. It is not something you can predict as you do it. You can see how important it is to research mathematics in general just by looking at historical records. I have a lot of respect for applied mathematicians. I find that it's also good that people are concerned with mathematics only because they are attracted to the problems of purest kind. And there are also people who interact with both groups, and they make the transition happen. In my case, I don't get motivated by the possibility of having an application, and I do not have an answer to the question. I am attracted by the beauty of mathematics and by the richness of its theories. Something interesting always goes on in mathematics.

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Achievements

Avila leads and shapes the field of dynamical systems. With his collaborators, he has made essential progress in many areas, including real and complex one-dimensional dynamics, spectral theory of the one-frequency Schrödinger operator, flat billiards and partially hyperbolic dynamics.

With his tremendous analytical power, Avila made outstanding contributions to dynamical systems. One of his early significant results closes a chapter on a long story that started in the 1970s, accompanied by a complete renormalization theory At that time, physicists, most notably Mitchell Feigenbaum, began trying to understand how chaos can arise out of very simple systems. The dichotomy of regular vs. stochastic was proved in many special cases, and the hope was that eventually a more-complete understanding would emerge. This hope was realized in a 2003 paper by Avila, Welington de Melo, and Mikhail Lyubich, which brought to a close this long line of research. Avila and his co-authors considered a wide class of dynamical systems-namely,those arising from maps with a parabolic shape, known as unimodal maps and proved that, if one chooses such a map at random, the map will be either regular or stochastic. Their work provides a unified, comprehensive picture of the behavior of these systems.

He has also sometimes done the reverse, applying dynamical systems approaches to questions in analysis. Avila establishes that, unlike the special case of the almost Mathieu operator, general Schrödinger operators do not exhibit critical behavior in the transition between different potential regimes. In the spectral theory of one-frequency difference Schrödinger operators, Avila came up with a global description of the phase transitions between discrete and absolutely continuous spectra, establishing surprising stratified analyticity of the Lyapunov exponent.

His work in complex dynamics led to a thorough understanding of the fractal geometry of Feigenbaum Julia sets.

Avila and Forni proved long-standing conjectures that almost every interval exchange transformation is weakly mixing. This work is connected with the weak mixing property of regular polygonal billiards which was done together with Vincent Delecroix. He made deep advances in our understanding of the stable ergodicity of typical partially hyperbolic systems.

Compiled by
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Invited ICM Panel 3 – 'Mathematics is everywhere'

Popularizing math: mathematicians' central role

A panel discussion on the topic 'Mathematics is everywhere' will be held by an invited International Congress of Mathematicians Panel, Panel 3. The discussion will take place from 4:30 to 6 p.m. today in Session Room 402. The panelists are Eduardo Colli, Universidade de São Paulo, Brazil; Fidel Nemenzo, University of the Philippines; and Konrad Polthier, Freie Universität, Berlin, Germany. Christiane Rousseau, Université de Montréal, Canada will moderate the session.

The following is an overview of the panelists' thoughts on the subject that they provided earlier by email.

Q. What is your approach to this discussion?

A. The four of us have a passion for communicating mathematics. We were delighted to be given the title "Mathematics is everywhere" because it is one of the important messages that we always wish to convey when we speak to the public. We have many examples and will present several to illustrate our messages. One of us will take you on a guided tour of Seoul as seen through mathematical eyes; the others will show how mathematics provides models for nature.

We will also stress the key ideas that power technological applications are seen in everyday life.

While to many mathematicians it seems obvious that mathematics is everywhere, that it is a living discipline within science and technology, most people are unaware of this and ignore completely the role of mathematics in scientific ventures. The message must be conveyed more effectively to the broadest audience possible. In our panel, we also want to discuss how we can help build a powerful message. An ICM is a great time for such a discussion because we have here some of the best ambassadors of many countries. Can we join forces for greater impact?

The second half of the session will be an open discussion with the people in the room. It is very important for us that this panel be a two-way discussion. In particular, we hope to hear creative suggestions from our fellow ICM participants on how to convey the message and maximize the impact of popularization activities.

What are your concrete ideas about the potential mathematics popularization?

There is a great need for many more popularization activities but there are many obstacles for increasing the number of outreach activities. First, some special skills are required to communicate with the public, and not all mathematicians are interested.

Next, it takes time to prepare good material. But the situation is changing; it is now considered a plus for a professional mathematician to participate in outreach activities. Also, we are convinced that one way to improve the present situation is to invite mathematicians to popularization activities; they will learn how to communicate with the public and that stimulates their creativity to find their own themes or ways of explaining things.

Sharing resources is also essential; it minimizes the time required to prepare material and it enlarges the spectrum of topics that can be presented to a local community.

What do you think are the most important parts of mathematics popularization?

The main purpose of popularization is to dispel fears of and misconceptions about mathematics and present a positive image of our discipline. There are many different ways to reach this goal.

First of all, it is good to bring the public into contact with mathematicians because that puts a human face on a discipline that too often is considered as cold, dry, and lifeless. If you like the person carrying the message and you realize that the message is fun or interesting, then you may change your opinion of mathematics.

The messages could be very diverse, from mathematical games to mathematical contributions to the arts, to showing the beauty of mathematical reasoning, and to pointing out the numerous applications of mathematics in science and technology.

What impact do you hope to see on the general public with the popularization of mathematics?

As the language of science, mathematics is an essential tool for economic development and for addressing the challenges that our planet will be facing in the next decades. Changing the image of mathematics among the public, among children in school and among decision makers is likely to help mathematics play a greater role for the benefit of all.

Can we have a few words from each of you individually?

Eduardo Colli: I believe that things are moving ahead more consistently than ever before. This year, in September, there will be in Dresden the first MATRIX (Mathematics Awareness, Training, Resource, & Information Exchange) conference. This shows that math popularization is beginning to be not only a hobby of enthusiastic mathematicians but in fact an academic activity in its own right.

Fidel Nemenzo: A growing number of mathematicians is taking part in popularization activities – writing popular mathematics books, columns and blogs. This is a good thing. We need to be able to communicate our passions beyond the borders of our specializations and our discipline. Mathematicians themselves need to join others in the forefront of raising public awareness of mathematics.

Konrad Polthier: Mathematics is an integral part of our society and a key driving force of science and technology. Raising public awareness of this central role of mathematics and its benefits for everyday life is a central aspect of our popularization activities.

Christiane Rousseau: The international year "Mathematics of Planet Earth 2013" was a great success. It had no budget of its own, but its structure, with partners contributing their own resources to the initiative, is a model of how cooperation can increase the impact significantly.

Moderator
Christiane Rousseau
Université de Montréal

At a Japanese reception, socializing and honoring one of their own

Mathematicians participating in the Seoul International Congress of Mathematicians 2014 at a reception at the conference site yesterday. The social occasion, organized by the Mathematical Society of Japan, was especially festive because Shigefumi Mori, a professor of Kyoto University, had just been elected as the next president of the IMU. Mori, who received the Fields Medal in 1990, is the first mathematician based in Asia to be elected as IMU president.

AVILA, from Page 1

You have many collaborators. What are the benefits?

Collaboration plays several different roles in doing a research. For one of them, I like talking to people rather then reading papers to understand what's going on. That's how I've got into several new fields. When I start working on a new field, I usually start collaborating on a project, and this gives me the opportunity to learn about it. I then ask what we should work on, and someone might know a little bit of what to work on, we start talking and he tries to show something that can help. Another positive aspect of collaboration is that when you are developing your ideas, discussing and explaining them make you understand it better. Trying to be comprehensive helps you figure out the relationship between different objects in a clear way. It's very helpful for me.

Can you say a few words about Jean Bourgain's work (a Belgian mathematician and a 1994 Fields Medalist)?

His work is very inspiring. Definitely, I was attracted to this particular field by studying his papers. It showed a kind of a map that I had not seen before. I was attracted by his style of mathematics. At the same time, it was very risky to be working on the same field as Jean Bourgain, but somehow I managed to find my place.

Answer to Aug. 19 Daily Math Puzzle $992 \times 9 = 93 \times 96$