An Interview with Marcelo Viana

First, we congratulate you for being awarded, recently, the first ever Ramanujan Prize, which "distinguishes young mathematicians for conducting outstanding research in developing countries". What does this prize mean to you ?

It was a great pleasure and honor to be awarded the first Ramanujan Prize, of course. The prize is a great recognition of the quality of what I, and people close to me, have been doing. I do perceive it as a distinction granted to the individual, but I am aware that it also pays tribute to the Mathematics that is being done in Brazil and, more broadly, in Latin America.

Marcelo Viana after receiving the Ramanujan Prize for 2005 (ICTP, Trieste, Italy, December 15, 2005).
Photo: ICTP Photo Archives, Massimo Silvano.

How is it to pursue a top mathematics career in a developing country ?

It is really very exciting. Economical, social, and educational conditions are much less favorable than in developed countries. That is frustrating sometimes, but it also means that our work must have a broader scope than in other parts of the world. It is not only about proving theorems and teaching graduate courses, we must be involved in improving education at all levels, spreading good mathematical activity across the country, helping bring mathematical "literacy" to everyone. That is what it makes it so exciting: there are many things to be done, many opportunities to make a real impact.

Your main workplace has been the IMPA in Rio de Janeiro. You are now its Deputy Director. Can you describe what makes this institute a very special place ?

IMPA is a small institute, with a very well defined mission, which is to create mathematics, to train high level researchers, and to disseminate mathematical knowledge at all levels. Since it was founded, in 1952, IMPA has developed a tradition of scientific excellency that, I believe, is now part of its essence. Being small means there is a very personal contact between faculty students and staff, which adds to the great scientific ambiance, as do the many visitors coming around the year. And, being located in one of the nicest places I have ever seen, between the Botanical Garden and what is said to be the largest urban forest in the world, can only help, right ?

What has been the impact of the activities of IMPA for Mathematics in Brazil and, more generally, in Latin America ?

For one thing, IMPA is the main graduate school in Mathematics in Latin America. It has granted more than 250 doctoral degrees and nearly 500 master degrees so far. Most of these students came from Latin American countries, including all the regions of Brazil, and what they have been doing for the development of Mathematics in the continent can not be overestimated. Most university departments in Brazil include former students from IMPA, as do many institutions in Argentina, Chile, Colombia, Cuba, Ecuador, Mexico, Peru, Uruguay, Venezuela. More recently, we have been attracting students from Bolivia and Paraguay as well.

Incidentally, Portugal is among the countries with the largest number of researchers with a doctoral degree from IMPA: I remember 10, at least.

Another important aspect are our collaboration agreements with several universities in Brazil. Through these agreements, IMPA and its faculty support the graduate teaching, help organize meetings and Summer Schools, and interact scientifically with researchers in those institutions. In the Latin American scenario we have strong

ties with the most important centers, both directly and through UMALCA, the Latin American Mathematical Union. Researchers from IMPA have been very active in organizing Schools, as a means to attract the best students of the region to a career in Mathematics, and other scientific events in various countries in the region. For instance, I have just come back from Santiago de Chile, where I helped organize the first International Congress on the Applications of Mathematics, held jointly by UMALCA, the European Mathematical Society - EMS, and the Society for Industrial and Applied Mathematics - SIAM.

Do institutes like IMPA influence the way mathematicians do research?

To some extent, yes. To begin with, we keep a vigorous visiting program. Around the year and, specially, during our Summer Program in January-February, we host a large number of researchers, both from Brazil and from abroad. This gives them a chance to get away from their daily obligations and benefit from the working conditions at IMPA, which are great.

There is also a certain style of doing Mathematics. A Dutch colleague once told me that interacting with colleagues from IMPA he discovered that "research is fun!". I have heard similar comments from other colleagues, and this is something I try to convey to my own students. Successfully, I have reasons to believe.

There is yet another point. Recently, a famous American mathematician wrote that a place like IMPA is "a beacon to the mathematics community" in the developing world. I do believe that letting our talented youth know that personal and professional realization is possible in our countries through Mathematics may be one of the most beneficial influences.

Let us now talk a little about you. When did you first become interested in Mathematics? What was it about Mathematics that attracted you?

It happened gradually in school. We moved quite a lot when I was a kid, because my mother was a teacher and she was appointed in various places by the government. Eventually we settled down in Póvoa de Varzim, which is where I went to high school, in the *Liceu Eça de Queirós*. I was quite successful in most topics, but I had a clear preference for exact sciences. Among them, Mathematics was the "neatest", the most "proper". So I was more and more inclined to it and when the time came to make a definite decision, that was easy.

Were any people or events particularly influential in your choice of Mathematics as a career? Were there teachers who made a particular difference?

I always had very good Mathematics teachers, who added to the general feeling that everything about the subject was quality stuff. In that sense they all were influential in my picking Mathematics as my first choice when I applied for college.

At later stages, Prof. Arala Chaves, from the University of Porto, and Prof. Jacob Palis, from IMPA, played key parts.

You were born in Brazil but moved with your parents to Portugal almost immediately after. Can you tell us something about your youth in Portugal? How were you as a student?

We moved around the North of Portugal for a while, then we settled down in Póvoa de Varzim, which is where my parents are from. As I said, I was generally quite successful at school. This is not always a good thing, because somehow it puts you a little bit apart from the others. At those ages, school is the foremost ground for social interaction and I was eager to establish friendships.

Did you find that your undergraduate education in Portugal prepared you well academically?

Yes, definitely. The education I got was quite solid and I did not experience any particular difficulties when I moved to graduate school. I believe it would have been the same if I had joined any other graduate school, in any part of the world. But I did find out later that part of my education was somehow out of touch with "reality". Many advanced topics I was taught were not as central as they had been, and could have been replaced. Also, I came to miss a more "experimental" approach to mathematical knowledge. These things have improved substantially over the last two decades, because there is nowadays much more research activity in Portugal. But I still notice in some of my Portuguese students a tendency to view mathematical issues as finished objects, a difficulty at realizing that (re)formulating questions is an important part of the game.

After graduating from the University of Porto, you got your PhD under Jacob Palis at IMPA, with a thesis entitled "Strange attractors in higher dimensions". How did you first become interested in Dynamical Systems? What fascinates you in the area?

That I chose Dynamical Systems as my research topic was primarily due to Prof. Manuel Arala Chaves, from the University of Porto. He introduced me and my colleagues to the subject in the last year of the Licenciatura, at the *Faculdade de Ciências do Porto*. He directed me to visit the *École Normale Supérieure* in Paris, in 1984, and it was also at his advice that I attended a scientific meeting at the University of Coimbra in 1985, that was a crucial event in my career.

At that meeting in Coimbra I met Prof. Jacob Palis, who would become my doctoral advisor. He convinced me to come to IMPA, and is largely responsible for my remaining here after two decades (rather than the two or three years I hoped to get away with, when I came).

After your PhD you decided to leave definitely Portugal. Why ? Did you notice big differences when you arrived at IMPA ?

I did come back to Portugal for a while, but somehow I did not feel happy. A good part of it was due to personal reasons, to some important changes that were taking place in my personal life. Somehow, it was difficult to separate things. It is true that I already felt very well at IMPA, professionally. But, all in all, personal issues ended up being crucial.

Mathematical research in Portugal is mostly based at the universities. Do you have any suggestions to improve the working environment at universities ?

Science is done by individuals or groups of individuals, and even more so in the case of Mathematics. Institutions are often more of a nuisance, if I may say so. In the last couple of decades, Portugal has moved a good deal in the direction of acknowledging the role of individuals and groups, for instance in the way funding is being distributed, and I have no doubt that was fundamental for the excellent evolution experienced in this period. I believe there is still room to proceed in this direction. A fine scientific ambiance is often the work of one or more people with strong leadership. As many other institutions with a past and tradition, the Portuguese universities give limited room for the action of such leaders.

I also gather from conversations that the teaching and administrative load has been rising, at least in some institutions. Such duties are certainly part of a scientist's job description, as are other academic activities beyond the teaching plus writing papers binomial. However, creative thinking does demand a lot of time and tranquility. A few years ago, during a meeting held in Lisbon by the Minister for Science and Technology, I suggested the creation of a mechanism for "teaching buy-outs" aimed, specially, at the most talented young researchers.

A common trace of your work has been the search for very general theorems and global theories suitable for the majority of dynamical systems. Is this the kind of approach to mathematics that attracts you (generalization instead of specialization ...) ?

In my experience, Mathematics is done from examples. I really do not understand those areas (and there are a few honorable ones!) where experts are not able to indicate simple interesting examples to motivate their statements. One of my favorite advices to the students is "do not try to solve the whole thesis problem at the same time: look for an interesting particular case, and focus on it for a while." My own work has been much driven by examples, the Hénon map, the Lorenz attractor, DA diffeomorphisms, and so on. But I also believe the ultimate goal is to reach statements with the "right" level of generality. For instance, the Role Theorem was first discovered for polynomials; the statement we now find in Calculus books is better, not because it is more general, but because the result has nothing to do with the algebraic structure, it is really only about differentiability.

Marcelo Viana delivering his lecture "Lorenz strange attractors" at the Math Colloquium of the University of Coimbra.
(February 14, 2006)

In an article in the book "Mathematics Unlimited — 2001 and Beyond" (MU2001) you give an overview of the challenges that Dynamical Systems face in this century. What are some of the most significant unsolved problems in the area ?

In the 1960's people believed that it would be possible to give a global description of how "most" dynamical systems behave. Steven Smale, made a concrete proposal, inspired by his previous work in Morse theory: he believed that globally most dynamical systems look very much like gradient flows. It was rapidly clear that this was not really so: Smale himself gave the first counter-example! I think the most exciting questions are: Can such a global picture be obtained, and how ? In the mid 1990's, Palis proposed a new program to this effect, and there has been a lot of progress. In that article, I mentioned some important specific challenges in this direction.

One intriguing issue, which has been blocking progress for quite some time, is the so-called closing lemma. In

some cases, one can prove that if a dynamical system has a trajectory that is almost closed then, by modifying the system a little, one can cause the orbit to actually close. There has been a great deal of effort to try to extend the validity of this statement, which would have tremendous implications. However, after four decades, the results are really meager. At this point, I think we should change the strategy, and move on developing the field *without* the closing lemma. There has been some progress along these lines, specially in low dimensions.

In MU2001 you say that even Hilbert, in his 1900 famous speech, could not foresee the birth and extraordinary development of Dynamical Systems (in spite of two of his problems — 16th and 21st — being related to it). Do you have any explanation for this ?

Hilbert's list is mostly about specific mathematical problems. One exception is the sixth problem, where he asks for the axiomatization of Physics, and we have to acknowledge that was premature, at the very best. Hilbert had a remarkable insight and, together with Poincaré, he may have been the last "universal" mathematician. But the kind of forces that led to the development of Dynamical Systems, very often arising from the experimental sciences, were not particularly close to his heart (they were much closer to Poincaré's).

How would you describe Dynamical Systems to a layman ?

I usually describe it as the mathematical discipline that studies systems that evolve in time, in order to understand and predict this evolution. This definition is a bit "imperialistic", in the sense that it includes almost anything, but a few examples help make it more clear: the motion of planets, the evolution of ecological environments, the spreading of epidemics, fluids in motion. In all these, and many other systems, one would like to understand how and why they evolve, and how external factors may affect that evolution. Dynamical Systems provides the conceptual tools to model and predict their behavior.

You are in Coimbra to participate at the Annual Scientific Council meeting of CIM. What do you think about CIM and its role in the Portuguese mathematical community ? and about Portuguese mathematics in general ?

I think it is very important for the country to have an institution such as CIM. Limited as its budget is, the Centro has been having a very positive effect at large, that goes much beyond the concrete activities it supports. CIM also serves as a forum and meeting ground at the national level, which I find very important as the Portuguese mathematical community has grown bigger and more sophisticated. I believe its influence and importance will steadily grow in the future.

You are also going to present a talk in Coimbra for the students of the Delfos programme. What advice do you give to young students who are coming to like mathematics and to show real talent ?

Just do it. I often try to convey to young people the pleasures of personal and professional realization one can attain through Mathematics, or Science in general, and how so very few professional activities can boast the same.

Marcelo Viana delivering his Delfos Lecture at the University of Coimbra (February 12, 2006).

How can we encourage young people to take up mathematics, especially in the schools ?

This is something we are very concerned in Brazil as well. There are many mechanisms for attracting young talents to Mathematics. But they all involve having researchers and educators exposing students to Mathematics in a way that displays its beauty and, at the same time, gives the students the chance to exhibit their own capacity to face challenges. We all know this is often not the way Mathematics is presented in the lecture room, unfortunately.

You are a superb lecturer and seem to enjoy very much explaining ideas to others which suggest that you like teaching. What makes teaching fun for you ? What is your way of teaching ?

Teaching is a great way to interact with people. I enjoy conducting the audience to the understanding of the subject, withholding information till the right moment, disclosing the secrets when time is ripe. We mathematicians are trained to be rigorous, to do our best not to

say anything that is wrong. In my opinion, that is a mistake. Mathematical knowledge is ultimately stored in an orderly, rigorous fashion. But that is not the way it is discovered and so it is not the way it ought to be taught.

Tell us about this mysterious link "Bola da Vez" on your website ?

The expression can not really be translated and I am not even sure how much sense it makes in Portugal. But, this being Brazil, you may guess it has to do with football. It all started with an exchange of teasing remarks between two of my students. As a result, there is now an actual football that is passed along from one student to another. Whenever a student finishes, (s)he signs and dates one of the hexagons, and gives the ball to the colleague who's expected to finish next. This "honor" tends to be more appreciated when the thesis defense is already in sight, of course. At some point I thought it would be good to have a replica of that ball on my website, with the students photos.

What are your mathematical plans for the near future, what areas and problems have your attention at the moment ?

I have several unfinished projects, about equilibrium states, partially hyperbolic systems, linear cocycles, dynamics of flows. My various coauthors kindly, and regularly, remind me how upset they are we are taking so long... So, the first priority will be to finish these projects. Then I would like to go deeper into the study of Teichmüller flows, on which I have been working over the last couple of years. I would like to really get into conservative Dynamical Systems, where one studies systems that preserve a volume form. And I keep going back to problems that I was unable to solve the first time.

What things interest you other than Mathematics ?

My family, of course. Including my five delicious nephews and nieces. I also like reading and listening to music. I tend to be conservative, and listen to the things I already know and like, but I have been making some discoveries, specially about ancient and medieval music. I really like History. Not so much recent History, but I have read about almost anything prior to the XXth century. Oh yes! I try to do some physical exercise, but my heart is not really into it.

Interview conducted by Maria Manuel Clementino and Jorge Picado (University of Coimbra)

Marcelo Viana is a Professor of Mathematics and Deputy Director of the Institute of Pure and Applied Mathematics (IMPA), Rio de Janeiro, Brazil.

Born in Rio de Janeiro on March 4, 1962, of Portuguese parents, he was educated in Portugal, for where he came at only the age of three months. He received his B.S. from the University of Porto in 1984, where he held a position, and got his Ph.D. from the IMPA in 1990, with a thesis entitled "Strange attractors in higher dimensions", written under the direction of Jacob Palis. He was awarded a Guggenheim fellowship to work at UCLA and Princeton in 1993, and since then he has been a visitor to main centers around the world. Marcelo Viana is a well-known mathematician worldwide in the fields of dynamical systems where he has made important contributions. His research focuses on dynamical systems, ergodic theory, and bifurcation theory. He has published more than 50 research articles in international journals (including *Acta Mathematica*, *Annals of Mathematics*, *Inventiones Mathematicae* and *Publications Mathématiques de l'IHES*) and has already supervised seventeen Ph.D. thesis.

Marcelo Viana has both Portuguese and Brazilian nationalities. Although he works in Brazil, he keeps strong links with mathematics in Portugal, by participating in research evaluation panels, conferences and seminars, and by supervising several Portuguese Ph.D. students. He is also a member of the Scientific Council of CIM.

Invited to give talks at two consecutive International Congresses of Mathematicians, Zurich-94 and Berlin-98 (the former as Section Speaker and the latter as Plenary Lecturer) he is considered a superb lecturer. Besides, he was also invited to give a Plenary Lecture at the International Congress on Mathematical Physics, (Paris, 1994). He is on the editorial board of seven mathematical journals: *Ergodic Theory & Dynamical Systems, Dynamical Systems: An International Journal, Portugaliae Mathematica, Discrete and Continuous Dynamical Systems, Journal of Stochastics and Dynamics, Nonlinear Differential Equations and Applications, Dynamics of Partial Differential Equations.*

Among his several prizes and distinctions are The Mathematical Union for Latin America and the Caribbean Award in Mathematics, 2000, the Great Cross of Scientific Merit, granted by the President of Brazil in 2000, Member of the Third World Academy of Sciences (elected in 2000), Third World Academy of Sciences Award in Mathematics, 1998, Member of the Brazilian Academy of Sciences (elected in 1997).

Last December Marcelo Viana was the first recipient of the Ramanujan Prize, which honors a researcher, younger than 45 years old, who has conducted outstanding research in a developing country. The prize is funded by the Niels Henrik Abel Memorial Fund and it is awarded by the Abdus Salam International Centre for Theoretical Physics in conjunction with the International Mathematical Union.