



AN INTERVIEW WITH

Patrícia Gonçalves

by Lisa Santos*

Let us start with what was behind this interview, the millionaire starting grant you won from the European Research Council (ERC). Tell me a bit about the preparation of your application . . .

The application was a complex process and it was very difficult for me to finish it. During this time I went to India, where I spent two weeks. Before leaving, I went to the traveler's medical consultation in Portugal, I did the malaria prevention, but three days after arriving back to Portugal, I picked up a very high fever whose cause no one could explain, my face was full of blemishes. I remember finishing the application, on the last day, which coincided with my son's birthday, with a high fever.

I submitted the application on November 17. I knew that I was approved for the interview phase on Women's Day, March 8. The interview took place on June 1, I had plenty of time to prepare myself. It took me a lot of time to make the slides, I made millions of versions, I asked for the opinion of many colleagues who had already competed for ERC scholarships. Several of my co-authors have read the project. I knew that if they did not understand what I wrote, the panel would not understand either.

The application has two parts: the part B1, which describes a generalist mathematics, trying to catch the attention of the two or three referees who will read this part; the part B2 is a technical part that I know (now)

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that is sent to eight referees. In the end, I received all the reports. The referees assign a level to the candidate, a level to the project and a level to its suitability to the institution where the candidate is inserted. Even the time of dedication of the PI to the project is classified. In this ranking, I was told that I was in the first third of the candidates. But there have been cases of candidates who stayed in the second third and who, in the end, got the scholarship.

Is the requirement of the application, compared to an FCT project, much bigger?

Yes, it's really much bigger. The application is very demanding, and has many rules, from letter size, to file names, exact values of hiring amounts of team members, . . .

What about the rules for spending money, the process is less complicated than the Portuguese?

No, the difficulties are the same. I started to spend the money in early December but the problem is that we are in Portugal, subject to a general law that corsets us. For example, I cannot buy a computer. Although ERC financed the purchase, I have to make an exception request which is currently waiting for approval from the Ministry of Finance, because the money is considered public money. In the next semester I am going to spend three months in Paris and I'm having a hard time to pay for an apartment. Portuguese legislation only allows you to pay hotels and not apartments, . . . it is absurd, and much more expensive, to stay in a hotel for three months!

Let us talk now about what was the genesis of your application.

I knew very little about ERC grants. When I was finishing my PhD at IMPA, in Brazil, a colleague from my area visited IMPA and had just applied for a starting grant. While I was in Brazil, it made no sense to compete, but I wished to return to Portugal.

In the edition in which I applied there were more than eighty applications in Mathematics, from all over the world, and only ten were selected. These applications are very different from the applications for projects to which we are used to compete. It is necessary to present a fantastic idea supported by arguments that we are able to put this idea into practice.

Out of all the applications, a short list is chosen, with those who pass to the interview. Being part of this short list is already very good. For example, candidates in France who go through this phase and are not funded are called by the French Ministry of Science and Technology and receive funding, because the mere fact of being selected for the interview means that the project is excellent. In Portugal, I asked to the Office of Promotion of R&D Framework Program (<http://www.gppq.fct.pt/>) if there was something like this and the answer was no.

In Germany, France and England training is given to people who are applying for ERC grants. When I applied I had no help, except in the financial component of the project, where I received some support from the Project Support Office of the University of Minho.

In France, people who have won an ERC grant give training to anyone who wants to compete. There is a kind of open day where they tell their experience, which helps those who want to compete. If they asked me that, I would do it with pleasure. In Portugal, in the area of Mathematics, I was the 13th candidate to apply since the launch of the ERC grants contest but the first one to get it.

The year 2015 was the penultimate year in which I could run for a starting grant. In fact, I could not have competed for a starting grant at this point, if I had not children, because for each child the deadline extends for a year and a half. It turned out that 2015 was the perfect timing. I have a work with Milton on the KPZ equation (Kardar-Parisi-Zhang equation). There is a conjecture that says this equation is a universal law that describes certain patterns of growth in nature. The theme of the project is the universality of the physical systems and how to prove this universality starting from stochastic discrete systems. Milton and I submitted a result, which was considered very good, we were able to prove the existence of a weak solution of this equation, and the definition of weak solution in this context has been introduced by us. We have also proved that all particle systems satisfying certain conditions fall into that equation, but there was one small problem, we had not been able to prove the uniqueness of that solution. Martin Hairer proved the uniqueness in a more general context and for a different notion. A while later he won the Fields Medal! Up to now, none has been able to apply his notion to the particle systems setting. We could not verify that our particle systems satisfy the hypotheses that Martin Hairer poses. In September 2015, some colleagues also proved the uniqueness, but in the context that interested us, thus sustaining that our definition of solution was not a crazy thing. The conditions that sustained my application to an ERC grant were met. I could move on to the proof that more particle systems can fall into this equation.

The application is very ambitious, no doubt. Our main objective in the area of particle systems is to obtain the hydrodynamic limit, a partial differential equation (PDE) or a stochastic partial differential equation that describes how is the evolution, in space and time, of a quantity which the particle system conserves. We usually pick up a particle system, which is a sort of discretization of a PDE (the best way to discretize a PDE) and establish the link between the discrete problem and the continuous problem. I have at hand in this moment several problems that have nothing to do with probability, involving fractional laplacians, fractional derivatives, regularity of weak solutions of PDEs, . . . We have sometimes questions concerning the part of analysis, but the results that we find are in such a generalized setting that they are not useful to our concrete questions. In short, the project consists of



identifying the PDEs that are obtained in the hydrodynamic limit of certain particle systems, understanding if they are universal, in what sense, how will we get them from the particle systems and what peculiarities we have in a certain particle system that allow us to arrive at these equations. For example, changing locally the dynamics of a particle system, does this change the PDE we have reached?

My interview in Brussels should have started with a video, which I will describe shortly, but there was a problem. They tell us in the guidelines for not using videos or simulations but I used a pdf file that had the video and several simulations because I thought I would explain much better what I wanted to say. They make exceptions and I asked the secretary to test my file, which had a video, on her computer. We soon saw that it did not work but she let me use my laptop and called the technician.

The interview took place in a very small room with U-distribution. I already knew this because I was installed in a hotel just opposite to the place of the interview, and from the window of my room, I saw the interviews of the others. The interviews are scheduled, but we have to get there one hour in advance. I knew there was a person in my area in the competition, but when I got there I saw another person from my area, in the waiting room, whom I had no idea he was competing and I thought things were complicated (we ended up with the grant, the three of us!). But at that moment I became more relaxed. I thought, I'm here to show to these mathematicians, who are excellent

researchers, a very nice subject and I hope they enjoy it and feel the pleasure I have in doing Mathematics.

At that U-table were about sixteen persons and there were two screens, one where the time runs and other where our presentation is placed, ready to start. I had twelve minutes to make my point. The technician took my computer (and I could not have a quick last look of my slides) and told me that everything was working. When I got to the interview room, my computer was hibernated, I was not able to open it, I shut it down and opened it again and nothing happened, there was some problem of incompatibility of the projector with my Mac . . . and the whole panel was waiting for me! I had another presentation without the video—the plan B! I believe that the panel saw the video while the technician was doing the verifications. The video describes growth patterns. It starts with someone sitting inside a car that sees ice particles falling, which begin to gather in the windshield of the car, and do a very nice pattern. The geometry of ice particles is quite funny, they leave holes. And this pattern of growth is described by the KPZ equation. This pattern also exists in the growth of tumors, in the growth of bacteria, and if we burn a paper sheet, the way the fire moves has the same behavior. The objective of the project is to study to what extent this equation is universal. It is universal for certain types of physical systems, which we characterize as a certain class of universality (it is not unique, there are others). The questions are: how to model these systems



microscopically; how does the growth of the particles evolves over time; whether it is this equation or others which model this growth . . . and we also ask what kind of universality classes exist. In the interview they asked me several times if the topic was not too ambitious, if I thought I could do everything.

Talking to you, it is obvious you love what you do!

Yes, I never say, “I’m going to work”, I say “I am going to have fun!”

I feel it too. I often say: happy is the one who is paid to do what he loves! Did you trust the success of your application?

I always had some hope of success, otherwise I would not even try to compete, because it’s a lot of work. I had faith that if someone read the project carefully and if I tried to convince that panel, I had a chance. I look back and despite the mishap of the video, I left the interview very satisfied, I thought it went very well. The interview was on June 1, in Portugal it was almost summer, in Brussels it was raining and it was cold. I remember thinking about how lucky we are with our weather . . .

How did it feel when you learned you had won?

I went on vacations on the 28th or 29th of July, I was on the beach and I thought I had to see the mail (the internet on my cell phone was very recent) and I saw that I had a

mail saying “Project has been retained for funding”. If I had not read all those blogs of other colleagues, I would not know that this was the magic phrase. They did not say amounts and asked not to advertise the prize at the institution because I would receive a formal letter with the amounts and all the details. The formal letter was only received on August 22, and the disclosure only occurred on September 8.

At a meeting of the Pedagogical Council of the University of Minho, a colleague from the Department of Chemistry congratulated the Department of Mathematics and Applications and I did not even understand why! Only later I did realize that the newspapers announced your scholarship indicating the University of Minho as the host institution.

Yes, the host institution was the University of Minho. In the meantime, I won a contest for Associate Professor at IST and my host institution has changed.

You said, somewhere, that you would like to create a school in Portugal. Do you want to detail a little more?

They asked me in the interview why I was asking for five masters students. I explained that in Portugal there are no people working in my area and that it is possible for a master’s student to start being introduced to these subjects slowly. My idea was to start forming a team in my research area. They asked me what kind of thesis I could give to a master’s student. I replied that I already



had a student who did a master's thesis with me in this area, and that this is possible if the student has a good background in Probability. This student is now doing his PhD with me and with Cédric Bernardin, based at the University of Nice. In fact, they only gave me two one-year scholarships for master's students.

I'm sure I could attract some established researcher from PDEs or from Physics. The interaction of people from different areas is very good and very important. I could get people who already have a solid career . . . but it would be harder to make them leave their research to get into a new thing, it would be simpler to grab younger students and train them at first. They also gave me two PhD fellowships, each lasting four years and three postdoc fellowships, each lasting two years. My main concern is: how will I find MSc students who want to make a career in this field? The path I need, in stochastic processes, is not very developed in Portugal. The Probability part that is given is, in large part, more towards Statistics. I really want to create a group that bridges the gap between Probability and PDEs.

My collaborators who work on this topic are all on the project, but as external collaborators. The team is me and the MSc, PhD and postdocs students that I will hire.

MSc scholarships are things that do not exist at the moment, in Portugal, which makes them appealing.

Yes. And they are of the same level as those of PhD. They are 980 euros per month.

I had prepared a question to ask you: "Is there any challenging result that you have not yet been able to prove?" But you have already told me that you and Milton could not prove the uniqueness of the KPZ equation and that the appearance of this proof was the touchstone to submit the application to the ERC grant.

Yes. From the results published so far, the one I'm most proud of (it was published in ARMA) was the existence of solution of the KPZ equation and it was relevant in my decision to move forward for this application. There is another article I like very much, but this one is the result that has the most impact. When I finished the exams and qualifying exam at IMPA, Milton finished his PhD, also at IMPA, having stayed there for one or two years as a postdoc and that's when we began to interact. Since 2008 I've been telling Milton, "we have to do this" but we knew it was too hard and it was going to take time. The other article I like a lot was published in CPAM, it is a work easier to understand, which was done while I was at the Courant Institute.

How did you go to the Courant?

I really wanted to have a contact with Varadhan because he is fantastic. Almost every particle systems problem has a little bit of him. He developed several methods, extended the techniques to various contexts . . . I told my PhD advisor at IMPA that I would enjoy spending three months



in the Courant, I had money from the Gulbenkian's prize *Estímulo à investigação* that I won. I wrote to Varadhan and I asked Claudio to write him, telling him who I was, and he agreed to invite me. It was spectacular, I was very well received, I shared an office with Martin Hairer, it was very cute. At that time, I was pregnant, from home to the Courant there were about four blocks, but there were pizzas to sell on the street and I would come to the Institute very sick . . . and I used to say, "I hate New York, a person is sick all day!" I presented at the Courant a seminar on the work that I later submitted with Milton at CPAM.

Publish in the CPAM helps the prestige of the authors.

Yes, it is true. But the publication of this article took more than a year. This article and the one I mentioned above are my two most beautiful works. I also have one with Cédric Bernardin, Mariele Simon and Milton Jara, which I like very much, which is in the context of other classes of universality.

The KPZ equation is a universal law, but it is not the only one, there are many others. The question that the project also addresses is the following: we define any dynamics of a particle system, which has a probabilistic

law. For systems that conserve an amount that has some physical interest, this system is related to a stochastic PDE. But for systems that hold two, or three, or four, there are more equations. So these equations are part of different classes of universality. And the question is, what laws do we have to arrive at those kind of equations?

Imagine the following example, we have particles that move on coupled oscillators. We may think that we have an Hamiltonian dynamics given by a certain potential, and the particles begin to move and their dynamics conserve several quantities as, for example, the energy and volume of the particles. Each conserved quantity "lives in its world", the energy is described by a certain stochastic PDE and the volume by one other. And the question is, depending on the type of dynamics we choose, what kind of PDE do we get? And how are these equations related, are they coupled or not? And by slightly changing the parameters of a model, with a conserved quantity, as in the case of the KPZ equation, how to go from a certain equation to other equations? They are connected, in fact. I usually draw a picture with clouds, to represent this. One cloud is one class, another cloud is another class, and there is a line connecting them. And in the middle of this line, there is something that can be considered as a fixed point of a more general application. We are making

changes in the microscopic system and getting a link from one class of equations to another. The KPZ equation is a bit out of date, because with my work with Milton the subject is now quite well understood. What is now in fashion is the study of other universality classes, for systems with more than one conservation law, which lead us to coupled equations, fractional Laplacian equations, which are very trendy. It appears fractional Laplacians in which the exponents are given by the sequence of Fibonacci! Moving below, in the microscopic scenario, in the dynamics between particles, how do I go up to the macroscopic scenario, for example, to arrive at a fractional heat equation with an exponent that is related to the sequence of Fibonacci?

Tell me a little about your academic path: University of Porto, IMPA (versus a permanent place).

I first made the fourth year of the educational branch of Mathematics at the Faculty of Sciences of the University of Porto.

But why, were you looking for a safe job?

No, I would have been the only student in Pure Mathematics that year, and I did not want to be alone on the course, I thought it was awful to have teachers teaching just for me, but I quickly came to the conclusion that I did not want the teaching path. The following year, I did the fourth year of Pure Mathematics, we were four students. And at the time of first semester exams, I decided to go to IMPA, to take a summer course, to try to understand if I adapted. That was when I met Claudio Landim, my future advisor. I attended a course, taught by him, of Measure and Integration, which did not exist in my time in Porto.

The Licenciatura in Porto, in my time, was fantastic. When I arrived at IMPA, to do my PhD, I did Functional Analysis without any difficulty, I found it easy.

How did you end up in particle systems?

My teachers of the 4th year told us that IMPA was spectacular, specially in the area of Dynamical Systems. I had no idea IMPA had someone working on particle systems. The subjects that gave me pleasure to study were ODEs and Probability. My visit to IMPA at the end of 1st semester of the 4th year of Pure Mathematics was disastrous. When I arrived from IMPA, the 2nd semester classes had already begun and I had to do the 1st semester exams. It was very hard! But I came back with the idea that I needed to return to IMPA. I was hesitating between Analysis and Probability. I never thought of Dynamic Systems. I loved the disciplines of Functional Analysis, Spectral Theory and Stochastic Processes. I spoke with Claudio and he accepted me as his student. I really liked Claudio, his group, the exceptional environment of IMPA. It was a shot in the dark that went very well. The qualifying

exams are very hard, I did one in Probability and one in Analysis (my secondary area), but my doctorate went very well, IMPA has this ability to motivate the students. The trick is to do our work with passion. I really love what I do!

Your first prize was the *estímulo à investigação*, from the Gulbenkian Foundation. Tell me how it happened.

I saw the announcement near the Assis' office and I thought, "Why not?" Of course it was great, it gave me money to do a lot of things, like going three months to the Courant, for example. Of course the money makes this possible, contacts and funding are fundamental.

Finishing your doctorate, you returned to Portugal, you had a posdoc grant with Alberto Pinto, a scholarship from *Programa Ciência*, and then a development grant of *Programa Jovens Investigadores*. Am I right?

No. Before returning to Portugal I still did a six-month postdoc in São Paulo, with Pablo Ferrari and that was also a shot in the dark. I did not like São Paulo as much as Rio, but I loved working with him. In six months we made an article. At that time I had a four-year postdoc fellowship in Brazil, but I decided to come back to Portugal for personal reasons. I was welcomed by Cecília Azevedo, who had money from a project with Salvatore, which allowed me to stay at the University of Minho for three months. This was followed by a postdoc with Alberto Pinto, also in Minho, for a year and a half. I was a visiting assistant professor during a semester at the Universidade Nova de Lisboa, maintaining the postdoc in Minho, which gave me a small salary supplement. At the end of the semester, I returned to Minho, where I was advised by Luis Pinto, who was then the Director of the Centro de Matemática, to apply for a scholarship from FCT *Programa Ciência*, with the University of Minho as host institution, and my application was successful. At that time I was a little tired of making successive applications. I later canceled this scholarship and went to teach at PUC in Rio de Janeiro, but meanwhile I applied for another postdoc fellowship from the FCT, the *Programa Jovens Investigadores*.

The relevant question, when describing your academic path, is to make visible the hard life of a young researcher in Portugal, even in the case of one as successful as yours.

Yes, it is true, our life is really hard! My path had several other applications in the middle (involving many hours of work), some to positions in Portuguese universities and it did not end yet. In the meantime, I ran for a place at the Getúlio Vargas Foundation, and got a contract, with a salary of associate professor, fantastic. This foundation is a kind of IMPA, very well known in the area of Economics and has a Department of Mathematics that is growing. I was considering dropping the *Jovem Investigador* scholarship and returning to Brazil for this Foundation, but in the meantime, I gained the position of Associate Professor at IST.



Yes, it is easy to understand, by your description, that the pursuit of stability in Portugal for a doctorate is a very painful thing.

Yes, we apply and wait for the results, and sometimes we see aberrant things . . . , that deceive us. When I applied for the ERC scholarship, my contract was as a *Jovem Investigadora* at the University of Minho. I had tried, several times and without success, to obtain a place of teaching in a Portuguese university.

Tell me a little of your daily life as a mother. You travel a lot, right? How do you manage your life with two small children?

I travel, in fact, a lot, I make many trips a year. My oldest son is five, when I am out, he does not talk to me on skype, he says “you’re not here”. It is the power he thinks he has over me . . .

But when you take long term visits, you take them with you?

Yes of course! In the 2nd semester of this year I will go three months to Paris and they also go. More than fifteen days without them and I fell a tightening heart, more

than a week already cost me . . . When my son enters the school, I do not know how to solve these situations, maybe I can get a school that accepts him for a few months.

Yes, the life of a woman researcher (still) is not equivalent to that of a man. Even admitting that there is total equality in the tasks with the children and at home, the truth is that when the children are small, they need much more of the mother than of the father. Later that changes.

When my son was little, he hated my computer. The computer was his enemy, who stole my presence from him. I recognize that these five years of my son were very complicated. With my daughter I am already more relaxed, I already have a stable job. When I heard about my job at IST, I was at a dinner party with friends, I looked at my cell phone, I saw that I had won the contest, and tears were streaming down my face. My friends were worried and I told them I had good news. It was hard, my life. I have, at the moment, 38 years old and there was a lot of fight to get here, but there it is, as I love what I do, looking back I can only say it was great!