Deutsche Mathematiker-Vereinigung

“So little time, so much to do!”

Interview with Cédric Villani, professor of mathematics at Lyon University (France), Director of Institut Henri Poincaré, Paris, and fields medalist of the year 2010. Cédric Villani gave the interview on occasion of the “Mathemacher-Award” of the German Mathematical Society and before he held the Euler Lecture at Potsdam University (Germany) on May 22, 2015. Questions by Thomas Vogt and professor Günter M. Ziegler of DMV (German Mathematical Society).

What was your first (positive or negative) experience with mathematics as a child that you remember?

I cannot remember my first experience with mathematics – for as long as my memories go back, I was interested in geometry and numbers. Filling out huge magic squares (when the number of subsquares is odd, there is this very simple recipe which I learnt and was glad to apply) and watching "Donald in MathMagic Land". I also remember that my father had bought at the flea market some books about mathematics for children, with nice illustrations; among other things it contained the golden ratio, Fibonacci sequence, life of Gauss, platonician polyhedra, and an attempt to make children understand all kinds of numbers. I read and re-read the paragraphs explaining complex numbers, which was attempting at an analogy with electrical current, but I could not, for the sake of me, understand what it was about.

When (at which age) did you start to love mathematics? And how did this love look like?

Interest in math was there from the start, it turned into tender love when I was initiated to proof making, in my teens. In those days I had small notebooks in which I would write down axioms, theorems, formulas and so on, learnt from school or from textbooks, as precious bits of knowledge. Looking back, I think that there were three defining periods: the first was the age of searching proofs (13-15 years old, dominated by geometry), the second one was the beginning of higher education, with the intensive training from preparatory school in Paris (17-19 years old, with particular inclination for algebra), the third one was the PhD (22-25 years old, definitely in analysis). At that point it was real passion.

Did your parents support you to do mathematics or was it rather a teacher at school who inspired you to do mathematics?

While my parents were quite supportive of my going into higher education in sciences, they were themselves unable to help me after I became 12 years old or so. Without hesitation the two teachers who were most influential were those of my 13-15: many exercises, definitely out of the official guidelines, and they had a clear passion. From those days I remember two highlights: elementary linear programming, and barycenter-based geometric proofs. One particular story I remember: our teacher had given us a geometry exercise (not a particularly easy one – I think it was that exercise which I learnt at that age: take an arbitrary 4-gone, draw isosceles right triangles on all sides, and join the four outer vertices, opposite to opposite; then the resulting two lines cross at right angles and have the same length, although they need not cross in their middle) and the goal was to prove it in several different ways; you can do it with Cartesian coordinates but I was also given the task to get a proof in classical style, like the

ancient Greeks would have done. I worked hard, day after day, to nail down this argument – I was proud to solve it eventually, but vexed when the teacher pointed out that my solution was unnecessarily complicated! Anyway, while this kind of theorems has obviously never been of any use to me, looking back to it, it is clear that this was my very first initiation to mathematical research.

Where and how did you receive the information that you would get awarded a Fields medal?

I received the Fields Medal information through a phone call at my office in Institut Henri Poincare, 6 months before the ICM in Hyderabad. In my book "Théorème vivant" (Das lebendige Theorem) I recount how it was: I was in the middle of a photo session for some magazine, in my office, picked up the ringing phone in a nonchalant way, and my blood froze when I heard that this was the President of the International Mathematical Union calling me; then my heart stopped when he told me "I have good news for you". After receiving the good news I started to shout in a very excited way over the phone, speaking of the most wonderful day of my life or whatever stupid thing you say in those moments, and promising to keep absolute secrecy. But on putting down the phone, I realized that the photographer was still in my office and had heard all of our conversation!! Fortunately, it seems that he did not listen or did not understand English, for he seemed unphazed, continued his work preparing for the next photoshoot, and asked me whether the rumor was true that I could get the Medal (to which I replied that I had no idea, for the sake of me).

How has your life changed after the announcement – during the first seconds, during the first years afterwards?

In the first seconds, or minutes, or days after the call, nothing changes and you even start wondering if that phone call was not a dream or a hoax. But then come the written email confirmations, and a few colleagues are in the know. Six months to prepare and get psychological reinforcement for what was going to come... The big change has been in the amount of public engagement, and the relation to the world outside the mathematical community; inside the mathematics community, there is not much change. But for the politicians, businessmen, journalists, students, schoolkids... before the award you were anonymous for them, after it you are all in the light and your opinion counts for them. (In my case, part of this world already knew me because of my job at Institut Henri Poincaré; but it came to a full different dynamics with the award.) The ceremony itself, in the ICM, is all loaded with emotion and again, after it has happened you wonder if it was for real. Just being in the ceremony makes an impact, the whole world is watching in some sense; interviews flow in during that day.
But then the public outreach fades quickly and it is only slowly and progressively that the public relation starts again. Interviews, suggestions for projects, invitations, etc. This is fueled by events which you are asked to comment on or take position (such as new school math programs), and also by projects of your own. People hear you in a local event and have you invited in a global one; and vice versa. The more you get expert at communicating, the more you will be invited. (I somehow failed in convincing media to regularly invite some of my colleagues; they go the secure way, inviting somebody who already has media experience.) In my case, one special date was the broad-audience book which I already mentioned; it really got

me into a lot of public outreach, in a country which reveres books and intellectuals. I also wrote for newspapers, recorded radio broadcasts, participated in cultural festivals. The result now is several invitations coming in every day, requests for taking position on any possible subject, television every month or so, and an enormous amount of projects in which I have been asked to take part. I have only accepted a small proportion of those invitations, but still it may look enormous. For me it reveals the enormous expectations that society places in scientists. Over the past few years, besides my activity as director of Institut Poincare and the hundreds of public lectures which I have been giving, I have been active in two cooperation projects with Africa, involved in two political actions, recruited as spokesperson for France's World Fair application, participated in five movies or long documentaries, written three broad-audience books, become a member of the scientific advisory board of a big company, been involved in two entrepreneur projects (both revolving around art and technology), and in a couple of dozens of committees.
Let me insist that for the first four years after the Fields Medal, I did not do any of these on my own initiative: all I did was accept some of the projects suggested to me, and try and do my best. Of course this resulted in major changes in my life: many more projects to handle at a time, enormous publicity, and even more work than ever... The good part is the warmth that you feel when people ask for book-signing or photographs for their children or parents; or when you are helping a beautiful project to come of age; or when math-lovers write to you to say how much they loved your book or broadcast. Some encounters and stories have been EXTREMELY moving for me. The less good part is the anxiety when there is a misunderstanding or a manipulation in the media, and the enormous fatigue that I have gone through at times. (I remember going through periods of up to 4 consecutive weeks with less than 4 hours of sleep per night...) Currently things are more under control and the biggest rush is over, I feel.

A few years ago I wrote an article about this experience, "De la Mathémédiatique" (for the Web site Images des Mathématiques) which was intended to the broad audience as well as to my colleagues (who were at times wondering what the hell I was doing).

Did you like and want to communicate to a general public all your life or is that a wish that developed only during the last few years?

It is an irony that I became such a communicating person, having been considered a "monument of shyness" in my youth and teens. But during all my higher education years, I was very much communicating with other students, including non-scientists at Ecole Normale Superieure. My training was strong in literature (both my parents taught french literature, so there was an influence there). Very importantly, I did the most significant part of my career in Lyon, where there was an atmosphere like 'scientists have a duty to communicate to the outer world and to do this seriously', under the dominant influence of Etienne Ghys, who was my neighbor in ENS Lyon. (It certainly is no accident that the two current french mathematicians who encountered most success in communicating mathematics have been office neighbors for 9 years.) Plus, 10 years ago, I did a specific training in communication (again, upon the suggestion of Ghys), organized by CNRS, for 2 days, with an excellent specialist of media; there I learnt some fundamental principles. So when the media attention came in, I was ready to dive in and learn more, and I improved month after month.

Communication is not only something you do to meet the request of the audience, it is also something good for you – to reflect upon your work, to help getting your own thoughts on track, etc. Plus, there is nothing like the feeling of a lecture in front of hundreds of schoolkids when the contact has been well established, and the crowd is still asking questions for 40 minutes or more after having listened to a full one-hour talk... It is strong emotion, for you, the kids, and their teachers alike.

Was your book Théorème vivant (2012) your first book for a general audience and do you plan (or write already) another one?

"Théorème vivant" was my first book, and certainly the first really bold project which I did after 2010. Even that one was not a personal initiative: it was intended to answer the suggestion of Olivier Nora at the Grasset Editions. Alone, I would never had had the idea to write such a book. The fact that it presents research as an adventure novel while remaining completely true (so my colleagues also take part in the book...), the fact that I put so many raw formulas inside, the fact that it was entirely written in LaTeX, the fact that it was addressed to an audience of non-mathematicians, and even targetted to people who had no interest in mathematics – all that made it a very special project, which made me particularly anxious. I remember the tension the first day the book is published: I could not really sleep, getting so disappointed to see a couple of very bad opinions on Internet... But these were just the first few bad mood readers who did not find the mathematical explanations they were hoping for. In the end the book, advertised as a literature work, did find its audience, it was a critical and commercial success in France. Translations were prepared in 12 languages; success abroad depended enormously on the local culture but also on the promotion strategy – since it is easy to misunderstand the book. As I said, the most common mistake is to believe that this book is intended to explain mathematics: it is not, and the reader closes the book knowing close to nothing about the subject of my research. But it tells about all the rest – community, social habits, way of working, emotions, the complicated research process, my work environments and habits...
The book was a success in Germany, Japan, Korea, and especially the UK. (The English made a triumph to the book, with several excellent reviews in broad-audience newspapers, a BBC reading over a whole week, a large-audience radio talk show and a night news event.) But of course it is in France that it was the biggest hit. I received hundreds and hundreds of comments by readers.

I have been involved since then in several other broad-audience books, in particular "La Maison des Mathématiques", an institutional book which I co-authored with Jean-Philippe Uzan (deputy director of Institut Poincaré); this is a book about our institute, viewed from the point of mathematical research in all its dimensions; it is illustrated with beautiful pictures, full of emotion, taken by Vincent Moncorgé, and a number of testimonies from other people in relation to IHP. This book also worked well, actually last Christmas we topped the french sales in the category of "science books for everybody". The other big project which I have worked on, for the past two years, is a graphic novel written in collaboration with the amazing graphic artist Edmond Baudoin; the book is called "Les Rêveurs lunaires" and it stars physicists Heisenberg and Szilard, mathematician Turing, army general Dowding, all of them involved in highly important, highly confidential, highly technical projects during WW II. They are shown as innovators and scientists, but before all as human beings, with doubts, fears, difficulties,

emotions, and the dilemmas associated with the science-society responsibility. It is at the same time a book about history. The book was first met with surprise, but now is doing quite well, with generally enthusiastic reviews both regarding the contents and the association between the text and the art.

Let me insist that none of these books is really about communicating mathematics – they are all about the human side of science, about science in dialog with society. So far I have not written any outreach mathematics book, while this was my priority a few years ago. However, I have played the "godfather" (more or less chief scientific editor) for the french reedition of a series of broad-audience mathematics book ("Le Monde est mathematique"), which was initiated in Spain; also that encountered a big, unexpected success.
At a more personal level, I am currently working on a project of a series of 8 public lectures held in a theater, with large audiences, professional editing and production (a whole team). These lectures will be a kind of synthesis of my experience of giving hundreds of public lectures over the past years, and are intended to meet the needs of the general public.

Today you are very active in popularizing math. Please tell us about your activities you like the most.

Doing a public lecture for schoolkids is an absolute joy, when this works well. But writing is also thrilling. In a book you are able to transmit much more complete and subtle information and emotions than in any lecture or media appearance. When it comes to media, my favorite medium is radio: it is well adapted to my preferred style of long and carefully constructed sentences. Television most often requires to get into another mood with fast pace; it also has stronger impact. I also love to write short articles about science news; I did this for two years on a 6-week basis for Le Monde, when you avoid the traps (length constraint, crazy modifications by editors, etc.) it is wonderful. I was invited 3 or 4 times as a "guest editor" in mainstream newspapers, these are great memories. Blogging is also a good way to inform, pay tribute to people or events; my blog entries are always long and carefully illustrated; as a consequence, I do not write often. Still, in the past few years, maybe the single best experience I had was with my graphic novel; partly because this is one of the rare which was on my own initiative, partly because this was like a child's dream, partly because the collaboration with the artist was extraordinary – we interacted on an almost daily basis for nearly two years, and became close friends.

Which activities for the general public take place at Institut Henri Poincaré already and what are the plans for a math museum next to it?

At IHP we do: public lectures, visits of the Institute, and special events such as Science Fair. We have ambitious plans for a museum in the coming years, and we have the right amount of funding, the right people and the right partners to achieve that. We do not have so many square meters, but we will have an extraordinary building, 90 years old, which has been host of many science stories and haunted by such people as physicists Albert Einstein and Jean Perrin, or poet Paul Valéry. There will be play for visitors and kids, like in the museums of Gießen and Dresden, but we shall also insist on exhibitions, stories, demonstrating in some sense. We are building partnerships with a number of high-profile companies which use a lot of mathematics in

their R&D: this will allow us to enrich our presentation and ideas. This is a long-term story, the museum should not open before 2019. (For any ambitious project you need time, this I learnt!)

What is the secret or story behind your spiders?

I never explain the reason for the spider – partly because it is private, partly because it is better to let people find their own interpretation. In any case, it has become a signature asset. Putting together the spider brooches that I found in shops, the ones that I ordered to various artists, and the ones that were offered to me, I now have a collection of more than 30, coming from various parts of the world and with various styles. Let me share a few anecdotes about them:

- Ecole Normale Superieure of Lyon had a special commemorative medal made for my Fields Medal, on which they had a spider engraved.

- Once I had to be interviewed for a cinema magazine, by a spider-phobic journalist. Not only did I have to put my brooch away for the time of the interview, but also, an hour before her arrival, two of her colleagues came to my office and concealed each every single representation of spider which they could find (there are quite some...)

- Once for a public event in a private place, the organizers had bought a number of spider pins, so that everybody in the audience could wear one in my honor.

- One of my spiders once belonged to the famous Russian mathematician Olga Oleinik, and was passed to me by a friend of hers.

- At the past ICM, among a few unlikely missions, I had to chair an auction sales for the profit of mathematics in developing countries; and one of the items for sale was the spider which I wore during the Fields Medal ceremony in 2010. The sale used a system devised by the president of the ICM, partly based on randomness, which is fair yet allows one to have a change to get the item even with a small amount of money. By coincidence (or destiny), the person who was chosen by chance to get my spider is a gifted and successful "mathematical outreacher"!

Is there any time left to you to do mathematical research?

Essentially no time left for research. To some this may seem like a horrible perspective, since an active researcher should practice every day or so. Others may think that this is a betrayal of the spirit of the Fields Medal, which is in the first place an encouragement for further research. On the other hand, I have learnt one thing in research, and learnt it again in administration: when you have a project and an opportunity, you'd better throw all your forces in the project, even if this means putting aside some other projects which are dear to you. Right now I have an opportunity for mathematical outreach, and I feel it my duty to exploit it fully. A number of colleagues have been extremely supportive in this.

Let me add that, even more than research, I miss the activity of synthesis writing, as I could do when I was writing lecture notes or my book "Optimal transport, old and new" (I was so proud when this book was awarded the Doob Prize for mathematical research exposition). Since the

Fields Medal, most of the time which I could save for research was actually devoted to the preparation of the revised edition of that book. But again, one cannot do everything at the same time, and I will have to wait for a bit more time before the rush is over and I can complete that revision. I tend to think that a mathematical life is long, and that being temporarily short of research time is a mild curse when you compare it to the much worse condition of being short of motivation.

One thing which I still save time for, on the other hand, is teaching. Even though my current position does not involve any teaching duty, every year I teach in at least a couple of continents – University of Lyon, AIMS project in Africa, graduate courses in Asia or America... This year I put together my first MOOC, on differential equations – a joint project with my senegalese colleague Diaraf Seck. It was a tricky operation which ate up vast amounts of times and caused a lot of organizing complexity, with a team of about 10 people on the whole; but it was so interesting to experience this new formula. The best part was going through the forum to answer questions of participants! I have plans for three forthcoming MOOCs in the next few years. "So little time, so much to do."

Interview published by
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