The MATH+ “Hanna Neumann Fellowships”

Hanna Neumann Fellows 2022: Interview with two women mathematicians Katharina Jochemko and Ana Djurdjevac

[The interview was conducted online by Beate Rogler, Public Relations Manager at MATH+]

Katharina Jochemko is an assistant professor at the Department of Mathematics at KTH in Stockholm. She obtained her PhD in 2014 at FU Berlin as a Hilda Geiringer scholar of the Berlin Mathematical School. After that, she held postdoctoral positions at TU Wien, KTH, and the Simons Institute for the Theory of Computing at Berkeley before joining KTH as an assistant professor in 2019. Katharina’s research interests lie in discrete and convex geometry, algebraic and geometric combinatorics, as well as their interactions. She is a faculty member of the Wallenberg AI, Autonomous Systems and Software Program and the PI of her project „Alcoved polytopes — a pathway between geometry and combinatorics“ funded by the Swedish research council. In 2020 she received a Göran Gustafsson prize for younger researchers at KTH.
More information

Ana Djurdjevac currently holds the position of the young investigator within CRCSFB1114: Scaling cascades in complex systems at FU Berlin. After her Master studies in mathematics at the University of Belgrade, Serbia, she was awarded the Hilda-Geiringer scholarship by the Berlin Mathematical School and completed her PhD studies at FU Berlin in Prof. Kornhuber's group. Then, she worked as a postdoctoral researcher at TU Berlin, in Prof. Friz's group, as part of the MATH+ project AA1-3 “Stochastic analysis of particle systems: Langevin dynamics and the Dean-Kawasaki mode”. Her research interests are primarily in the analysis and numerical analysis of stochastic partial differential equations (PDEs), uncertainty quantification, and surface PDEs on time-dependent domains. In particular, she is interested in mathematical problems that arise from the connection of mathematics with other sciences such as biology, physics, and life sciences.
More information

Interview:

How are you dealing with the Corona crisis? Has it affected your work?

Ana: The Corona crisis has definitely changed many things. I used to go to conferences, present my work, meet new people. In the last two years, I haven’t met many new people or started new collaborations outside of Berlin. Working from home is new, and online teaching demands another style of teaching.

Katharina: I can only agree with that; particularly collaborations have been affected. Zoom conferences have the advantage of making it easier to meet people from the other side of the planet.

Still, you cannot interact in such a productive way as you can at in-person meetings. The breaks in between, the small talk, and the spontaneous conversations are so important, and they are missing.

The Fellowship that MATH+ awarded you is dedicated to the mathematician Hanna Neumann. Do you know anything about Hanna Neumann?

Katharina: I learned that she grew up in Berlin-Steglitz, in the same borough where I lived during my PhD studies. She had a remarkable life doing a PhD as a woman at that time. Later, she became the first female professor of mathematics in Australia. And she had five kids.

Ana: Though I like to read about mathematicians, I didn't know anything about her before applying for the fellowship. The same was with Hilda Geiringer, whom I only got to know when I applied for the BMS Hilda Geiringer scholarship.

Why did you decide to study mathematics? How did you get interested in that field?

Ana: I come from a family of mathematicians; my parents, most of their friends, my godfather and godmother are mathematicians. My mother works at the university in Serbia as a professor of geometry. I started with competitions in elementary school. I always liked the idea of solving problems. When I attended the Mathematical Grammar School (High School for gifted students), it became more serious, and it was very natural to continue studying math. Later, I had PhD offers from the US, Canada, and other countries. Through my older sister, Nataša Djurdjevac Conrad, who is also a mathematician, I found out about the Berlin Mathematical School (BMS), where she was one of the first PhD students. After obtaining the Hilda Geiringer scholarship, I decided to come to Berlin. However, the drawback of coming from a mathematician family is that you are supposed to know everything. Despite this, it was very important for me to find my own way. Now, we sometimes even work together.

Katharina: I got interested in mathematics at the age of 10 or 11 years because of very dedicated teachers. They made math classes exciting by also asking trickier questions. Later, I had a teacher involved in math competitions he introduced me to. Sometimes, he even gave me private lessons on problem-solving strategies. Through the competitions, I got to know many like-minded people, some of which are still among my best friends even today.

What does mathematics mean to you? When I listen to podcasts about women mathematicians, they often describe their feelings towards mathematics in a very enthusiastic way.

Katharina: For me, mathematics is definitely a passion. I believe some passion is necessary for doing research in mathematics; without it, one might give up trying to solve more complicated problems too easily. I have a very aesthetically driven and visual approach to mathematics; I find beauty in clear argumentation and especially like to think about geometric objects and questions related to them. This has always been the case for me, also while I was still attending school, when I was drawn to geometry problems.

Ana: It's definitely a passion and demands a lot of patience. I like that you can ask questions, which is often essential for math. But I also like the people in math and how the discussions go. I also enjoy the abstraction of mathematics and how the proof shows whether something is correct; it is not about opinions. I study the equations that describe different processes in the world around us. And for me, modeling and analyzing the world around us using mathematics is fascinating. Furthermore, I also like to read about the history of mathematics and how some terms and problems developed over time.

Which experiences did you have during your study and your later career path? Was there significant support, or did you meet some obstacles? Do you have any role models?

Ana: Since I was a child, my mother has been a person I looked up to. She is a math professor with two kids who somehow manages everything. She works very hard to succeed and always tries to think positively about a math problem and how she can solve it. I worked mainly with my father for the competitions and usual math problems as a child. Apart from my family, there are other role models like my professors and other pupils from Mathematical Grammar School that I have attended. Many of them are now professors at distinguished universities around the world. Of course, university professors, advisors, and co-authors have played a big role in my development as a scientist. But then there are the exceptional mathematicians you have read about, like Terence Tao. His knowledge is so broad, and everyone adores his blog. Recently, I read a very motivating book about Sophia Kovalevskaya that introduced her impressive biography with her private life and how she fought for her position.

Katharina: I don't think I had an actual role model, but I have felt supported. I am very grateful to my former PhD and postdoc advisors, who I can always ask for advice. It is very helpful to have somebody you can shoot questions to. I was also very fortunate to be able to pursue a PhD in a fantastic environment in Berlin; not only did the Hilda Geiringer Scholarship that I was awarded by the BMS allow me to focus on my research. The large graduate school made it very easy to get to know and interact with peers and researchers from different groups. There was always a lot going on in Berlin! Looking back, the time of my PhD was one of the most exciting times of my life so far. Even though I was not sure if I should pursue a PhD in the first place, having had a role model in the form of a female professor as an undergraduate student would have made it easier to overcome some doubts I had. I am hopeful that there will be many more female professors in the near future.

What would you recommend to young students concerning a career in mathematics?

Ana: It is essential to change your mentors for the Master, PhD, and Postdoc phases. It is sometimes hard because you constantly change environments, people, and subjects. But with these changes, I learned a lot and became more open-minded. I learned that the approach is often project-oriented here in Germany, and there are applications and connections with physics, biology, or other fields. So, I got used talking with other people than pure mathematicians. It was also important to go outside the courses you have, participate in summer schools, interact with other PhD students. You should attend many seminars; being in this atmosphere with researchers is different than studying. That was very helpful for me.

Katharina: As I mentioned earlier, I very much enjoyed the advantages of getting a PhD within a graduate program. It's good to be in an environment with other peers to connect with. There is also usually some funding for conferences, which is important, as Ana said. Having several professors and supervisors, you can relate to is also very helpful. Most importantly, follow your passion and interests when deciding on a PhD. In Berlin, there also exists the possibility to already start after the bachelor, which can be helpful as it gives you additional time to explore your interests and find a possible supervisor.

Ana: I agree that starting the BMS at Phase I is better because one has time to meet possible supervisors and fields. Otherwise, you only read the papers of potential supervisors and check the websites. So, you decide more according to the topic you are interested in and go for the department to choose the supervisors. Moreover, some topics are not studied so much in Serbia. Thus, when I came to Berlin, I had to take many additional courses. But it was great to pick from all of the offered courses at the three universities as a BMS member, and I went from one university to the other and traveled around. In the beginning, it was hard to come to a new country, a new city, and to speak another language. The BMS office staff were also often a big help. The whole BMS atmosphere helps very much to feel supported and be part of a community.

Coming to your research: can you describe your current research topics as if you were explaining them to a child?

Katharina: The main objects of my research are polytopes. Those are geometric objects that have vertices, edges, and faces, such as squares, triangles or pyramids, and cubes. This concept can also be generalized to higher dimensions, and this is where it usually gets interesting. One research interest of mine are so-called valuations on polytopes, which are measure-like functions on polytopes. So, the area of a polygon is a valuation, but there are many more. For example, you could count the number of grid points contained in a polytope. The number of grid points inside polytopes, in turn, can often be used to model certain counting problems in combinatorics, another research interest of mine.

Ana: I like to have some equations. First, we need to understand what an equation is? Everyone has around themselves different types of processes and things that are happening. I am interested in some particular items about this process. For example, you have a metal wire that you warm up, and you want to measure the temperature of this wire at every point. The temperature of the wire will change over time, which depends on which place of the wire you measure the temperature. This change of the temperature can be described by something called an equation, here, in particular, heat equation because it represents the heat of this wire. Then, I'm interested in the different types of processes and how you can describe them. But everything is often very uncertain, which means that many randomnesses come into play. There is the so-called Brownian Motion discovered by the botanist Brown who examined the pollens of the flower under a microscope and how they are moving. It showed that they move very randomly and chaotic. So, I always put some randomness effects in my equations and study this process which dynamics is given by an equation.
The whole process has different steps. First, I need to post my equation. What is the diffusivity of my wire? What type of material will this wire have? Then in the middle part, I set up my playground and make sure that my setup is correct in the mathematical sense of having a solution. After getting an answer, I will describe some solution properties. The last part is to do some numerics to be able to simulate this process in a controlled way. Eventually, I can show some simulations of what I did.

Most of our everyday life is based on mathematics and its support of other disciplines and fields. What do you think which role mathematics will be playing in the future?

Ana: One answer will probably be machine learning. This is a very popular topic, developing with great speed. The demand of mathematicians who want to do machine learning is quite significant, and it is a fascinating field. Another answer lies in the connection to the social sciences. With my sister Nataša, I work on this agent-based modeling. It means you have some agents, for example, people, and we write models for their interactions; what kind of opinions do they have, are they sick or not? That always depends on how close they are and how they interact, which also goes in the direction of studying the spread of a disease. Math is developing quite a lot, and in this way of modeling and predicting something, math is beneficial and has got a more substantial role, particularly during the pandemic. It is always hard to measure something, but it can give a strong level of certainty when you have a mathematical background and proof of something. And of course, there are the standard connections, like between math and physics or math and the numerical discretization in how you discretize, model, and simulate something. This will be important for the future.

Katharina: I agree with Ana. Our world is getting more and more digitalized and automized. Many aspects of our life are governed by complex algorithms. For example, our smartphones: almost everybody has one of these powerful mini-computers in their pocket with many apps for different purposes. There is a lot of demand for developing these systems further. At the same time, we have to understand and predict better what they are doing, for example, algorithms for social media. There are a lot of challenges and open questions that need answers. I think the demand for mathematicians in this area will only increase, in academia but in particular in industry.

Finally, a question concerning MATH+, what do you think is the most vital challenge and the most significant advantage of having such an extensive research center?

Ana: The advantage is collaborating with people from different fields that might not naturally collaborate otherwise. The biggest challenge is understanding the math language from various areas, from applied to pure. You know the terms of your field, but maybe others do not. There are, for example, many events and presentations at MATH+ like "*What is…?*" seminars or *Spotlight Talks* on basic topics with successful attempts to understand the language of the presenter's field. But it is also an advantage to see the same things from different math fields in different ways when you connect with MATH+ members.

Katharina: Many important challenges are multi-disciplinary in nature. They cannot be solved by experts from a single discipline but need to be approached in a collaborative way across research areas. Having an extensive research center with a broad spectrum of researchers fosters interdisciplinary collaborations by getting people together to talk and think about innovative solutions.

Ana: The benefit is that many pure mathematicians also study problems coming from applications because application problems are usually very hard to solve. That's why they need to be simplified. But the applications are also an amazing source of ideas. It is a great inspiration to see the problem

you want to describe and know what you want to get. Then you try to formulate this in a math language. How to formulate and interpret a problem is something that the pure mathematicians of this vast research center can achieve.

Katharina: I think that the line between “pure” versus “applied” mathematics gets more and more blurred. A multi-disciplinary research center brings people with different backgrounds together to talk and work with each other and thereby also helps overcome barriers that existed at some point.

What kind of relationship do you have to MATH+?

Ana: I’m a MATH+ member, and I was part of a MATH+ project during my postdoc at TU Berlin. I still work with the project group within MATH+ but not as a PI or funded. And I’m also part of the MGDC (Mentoring Gender Diversity Committee) within MATH+. Additionally, I’m connected to the BMS (Berlin Mathematical School) to act as a mentor, pre-mentor, or to support BMS students when there are BMS Days and so on.

Katharina: I am a former BMS student, and I obtained my PhD at FU Berlin. This time, as a Hanna Neumann Fellow, I will be visiting TU Berlin; my host will be Michael Joswig. I am very excited to re-connect with Berlin’s mathematics community and explore and establish new collaborations.

Thank you very much for your time and the interesting insights about your connection to mathematics and how you have developed your career!