University of Amsterdam
Faculty of Science

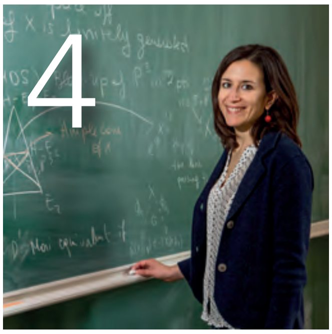
MEET OUR MACGILLAVRY FELLOWS 2019-2020

Introduction

In this booklet we introduce you to the seven new MacGillavry fellows, a programme designed by the University of Amsterdam's Faculty of Science to attract female scientific talent. Ten years ago, I was one of the three successful applicants in the first round of MacGillavry Fellowships. This fellowship gave me the unexpected opportunity to return to the university where I started my scientific journey. At first I was somewhat skeptical of the programme, as I didn't want to be hired because of my gender, but because of my scientific merit. Now, ten years later, I have come to realise that this programme has made the difference in pushing the gender ratio at the Faculty of Science from practically zero to a relatively decent number. The chance that this would have happened without this programme is minimal: even though 'positive action' was already in place when I started my studies in 1988, this never brought any change, especially not in the higher ranks. As an example, I became the first female full professor at IBED in 2017. Apparently 'good intention' is not enough for breaking existing patterns and preconceived notions.

That change can happen fast once existing patterns are broken is also apparent: within the last four years, the number of female full professors at my institute, IBED, has grown to six, including the institute director. The other obvious pattern that needs to be broken is the monoculture when it comes to cultural background at our Faculty. Even though it is less easy to define and place numbers on diversity, the difference in cultural background between the scientific staff and the cleaning crew at Science Park is obvious, while neither is a good reflection of the population. And where are the people with physical impairments? As my career has been given that boost through the MacGillavry programme, I hope that a similar programme will be developed to break more existing patterns so that we can become a truly inclusive scientific community. A diverse community at all levels inspires creative thinking, which is the basis for great scientific discoveries.

Astrid Groot
Professor of Population and Evolutionary Biology



'A diverse community at all levels inspires creative thinking.'

CONTENT

Diletta Martinelli

Classifying geometric shapes

'We care about geometric shapes, like curves and surfaces, but we use the tools that come from algebra to study them,' says algebraic geometer Diletta Martinelli about her field of research. She joined the Korteweg-de Vries Institute for Mathematics at the University of Amsterdam in the fall of 2019. 'For example, if you consider the circle, you have a geometric object that is defined by the algebraic equation $x^2 + y^2 = 1$. This is a simple example of the interplay between algebra and geometry.'

Three building blocks

Martinelli specialises in a branch of algebraic geometry called "higher dimensional birational geometry", a field that classifies geometric objects defined by polynomial equations. 'These geometric shapes can be incredibly complicated, but are fundamental objects in many areas of mathematics and science,' she explains. 'The goal of an algebraic geometer is to understand their properties and to achieve a complete classification of these important objects. For the classification to be meaningful, we want to have a finite amount of classes. But since there are infinitely many objects, we need to introduce some notion of equivalence. As an algebraic geometer, the first question that you should ask yourself is: when are the properties of two objects similar enough to put both of them in the same class? There is a technical notion that is called "being birationally equivalent", which means that one object can be obtained by a small modification of the other. For example, if two surfaces are exactly the same, up to a bunch of curves or points, then they are birationally equivalent.' As an illustration, she mentions a cylinder and a cone. 'Take the cylinder, wrap a string around it and squeeze towards the centre: you obtain the cone. This is an example of two surfaces that are birationally equivalent.'

How many classes are there? Martinelli: 'The guiding conjecture of the research field says that there are only three classes. We call them building blocks. It is possible to reconstruct the geometry of any geometric object starting from the geometry of these three building blocks. We can distinguish these building blocks using the notion of curvature: they can have positive curvature - like a sphere, they can be negatively curved - like horse saddles, or flat - like a plane.'

Becoming an algebraic geometer

Going back to the beginning of her career, Martinelli was not sure what to study after high school. But when she attended a popular science talk by algebraic geometer Marco Andreatta, she knew it had to be mathematics. 'He talked about non-Euclidean geometry,' she remembers. 'Euclid was a famous mathematician from ancient Greece, who wrote books called the Elements. They were long seen as some kind of Bible, and perceived as an universal truth. But in the 18th century people started to question his assumptions and especially his 5th postulate. In this postulate he says that the sum of the internal angles of a triangle is always 180 degrees. Several mathematicians realised that if you contradict this statement you still end up with a completely coherent geometry describing not the three-dimensional Euclidean space we know from our daily life, but more complicated objects. This observation really prompted a revolution in geometry, opening up several research fields, from hyperbolic geometry to Einstein's theory of general relativity.'

During this talk she had the feeling that geometers describe different realities from the one that we're used to. 'I was fascinated by abstraction and I liked the idea that you could describe spaces that behave in different ways than the three dimensional space we're familiar with. It reminds me of how Ursula Le Guin, a famous science fiction writer, described herself when she said she was "a realist of a larger reality".'

Walking on ice

After finishing her Master's at the University of Pavia in Italy, Martinelli obtained a PhD from Imperial College London, followed by two postdocs at the University of Edinburgh and the Mathematical Science Research Institute in Berkeley. Though she loves her field, it can sometimes be quite intimidating that her area of research has such a long history. Martinelli clearly remembers that during the first year of her PhD a professor asked how she was doing. 'I answered that it felt like walking on ice all the time. There is so much knowledge, that I neither had time nor capacity to read everything. The professor said that this was quite normal, since it is such an ancient subject. If you want to try to do something new, you cannot understand everything that came before you, there is simply too much. You just have to accept that.'

Nevertheless, her commitment to the science doesn't waiver. And she has an ambition to inspire others too. She has travelled to countries like Cameroon, Kenya and South-Africa, to give masterclasses about algebraic geometry to students there. Martinelli: 'The African Institute for Mathematical Studies in Cameroon is a centre that runs a one-year Master's programme for students coming from all over Africa. As a teacher, you live and work in one building together with the students. It is a very immersive and enriching experience, because you share much more with the students than lecture time. It was truly fascinating to listen to all their different life experiences.'

Closing the gender gap

And now, she joined the UvA, thanks to the MacGillavry Fellowship programme. Martinelli is very happy she managed to obtain one of these quite exclusive fellowships. Martinelli: 'Professionally it is a good fit. It is a famous group, my colleagues are very nice, and Amsterdam is a great city to live in.' Besides that, she believes the fellowship helps closing the gender gap in her research community. 'There are still very few women in my field. So I believe that these hiring schemes are very much needed.'

When she started her PhD in London, she was the only female PhD student in the large geometry group at Imperial College. Martinelli: 'This was definitely tough at times. You keep asking yourself whether you really belong there and if you are good enough to stay.' She recalls the first time that she was invited to speak at an international conference in China. 'I was the youngest speaker and the only woman. I remember seeing these groups of old male professors talking together during coffee breaks. It felt hard to interact with them. This can really have a negative impact, because networking at conferences is as important as the technical talks you give.'

Building a support network

But slowly it's getting better, Martinelli experiences. 'Conferences put more emphasis on having female speakers and they organise networking events to help you create your own support network. At Berkeley we had a weekly women's lunch where we talked about different things, we shared experiences of being women in maths, but also chatted about restaurants in Berkeley and things to visit in California.'

Martinelli keeps looking out for great female scientists as source of inspiration and guidance. But at the same time she realises that she is starting to become a role model herself for younger students. 'For example, when I was in Cameroon a few female students told me that they were so happy I had come, because I was the first female lecturer they had in the whole academic year.'

She also joined the diversity sounding board, that reflects on issues of diversity at the Faculty of Science. Martinelli: 'We have a monthly diversity journal club in which we read and comment articles on different topics. Recently, I co-hosted a session of the journal club dedicated to cultural biases in maths. Mathematics is often seen as culture-free. But if you start reflecting on the history of the subject, you realise that, instead, it's deeply intertwined with history and different power dynamics in the world. I believe that we should put an effort into making the field more inclusive. Highlighting the work of researchers coming from underrepresented communities and having more awareness on the cultural history of the subject could be a way to start. We should really change the idea that mathematics is an "exclusive boys club". We should make sure that everybody feels welcome and believes they can be a successful mathematician.'

Going back to Africa

For the coming years, Martinelli will continue her work on the classification of geometric objects. 'I am currently working on several projects to better understand the properties of the three building blocks,' she says. And she hopes to return to Africa in the near future. 'I hope to go back as soon as the pandemic is over.' ◀

CV

- ▶ **2008 – 2010:** BSc, University of Ferrara, Italy
- ▶ **2010 – 2012:** MSc, University of Pavia, Italy
- ▶ **2012 – 2016:** PhD in Algebraic Geometry, Imperial College London, United Kingdom
- ▶ **2016 – 2018:** Postdoctoral researcher, University of Edinburg, United Kingdom
- ▶ **2019:** Postdoc, University of Berkeley, United States
- ▶ **2019:** Postdoc, University of Glasgow, United Kingdom
- ▶ **2013 – 2021:** Co-organiser of workshops in Algebraic Geometry at various universities in the UK and Kenya
- ▶ **2018 – 2020:** Several grants and a Research Fellowship to give workshops in Kenya, Cameroon and South Africa
- ▶ **2019:** Assistant professor and MacGillavry fellow, Korteweg-de Vries Institute, University of Amsterdam, the Netherlands

Iris Groen

Studying vision in humans and computers

'You might think that seeing the world is a really easy matter,' says psychobiologist Iris Groen. 'But it's actually a complex process that involves a large part of the brain.' In September 2020 she was appointed as a MacGillavry fellow at the Informatics Institute of the University of Amsterdam. The big question she aims to answer with her research is: How does the human brain convert the rays of light that fall on your retina into the image in your mind?

Fascination for human biology

Groen works on visual perception. This means she studies how people actually see. 'Each side of the brain has four lobes, one of which is devoted completely to visual perception,' she explains. 'The brain comprises a mass of cells that communicate with each other via electric impulses. I study how people's brains respond to simple tasks in which they see images. Some areas of the brain become active when you see lines or black and white images, other areas react to parts of objects, and yet others to entire objects, such as faces or houses. But how do these areas know what they are seeing? That's what I find so fascinating.'

The first time she started wondering about the functionality of brains was at secondary school, when she was writing an essay about the chemicals that are released when one falls in love. Groen recounts: 'People often find it unromantic to think that being in love is something biological, because they feel this makes it less magical. But to me, the fact that being in love has a biological cause actually makes it more real.' After this essay she became interested in philosophy-of-mind questions, such as 'what does it mean to think about something?' and 'what is consciousness?' So Groen decided to enrol in the interdisciplinary Natural & Social Sciences bachelor at the UvA, with a major in Psychobiology, followed by a Master's degree in Brain and Cognition Sciences.

Real world images

For her PhD project – conducted at UvA's Psychology department – Groen studied what happens in the brains of test subjects when they see images. She did this while using photos with scenes from the real world. This was a new approach in her field; until then, it was customary to present the test subjects with simplified images. Groen: 'Generally speaking, images in this kind of research are reduced to lines or are cut out or set against a neutral background. The researchers can then adjust certain elements of these drawings to see whether this makes a difference for the brain. But I always felt that this simplification wasn't correct when compared to the real world, because you never see a face floating in front of a grey background. You always see things in a context.' It turned out that using these more complex images was indeed useful. 'My main research finding was that crowded images are predictive for much higher activity in the brain. If an image is chaotic and unstructured, it takes the brain longer to react. I developed a computational model that, based on the structure of an image, can predict what the brain responses will be,' says Groen.

Two body problem

After her PhD Groen was confronted for the first time with the "two body problem", something many couples face when both work in academia. It's often difficult for the two partners to find research positions that are close together, meaning they are forced to maintain a long-distance relationship. Groen and her partner – an astronomer – both wanted to do a postdoc in the United States, but also be able to live together. 'Towards the end of our respective PhD projects we did a tour of labs on the East and West coast in search of post-doc positions. We visited people we knew from conferences and we wrote to labs, asking if we could give a presentation of our work.'

Their efforts were not in vain: they found jobs near one another. Groen took on a postdoc position at the National Institute of Mental Health, a research institute run by the US government in Bethesda, Maryland. Here, too, her work involved presenting test subjects with images and studying the response in the brain using EEG and fMRI; just like she did during her PhD research. But now, her research involved brain stimulation with magnetic pulses, also known as Transcranial Magnetic Stimulation (TMS).

TMS and ECoG

With TMS magnetic pulses are transmitted to a certain area of the brain which is then temporarily disrupted. It is regarded as a promising therapy against depression and other neuropsychological disorders – but exactly how it works is still a question mark for scientists. Groen set out to try and solve part of this puzzle by studying what effect TMS has on the parts of the brain that we use for visual processing. Groen: 'We wanted to know how well TMS can target specific neural processes. Against expectations, the experiment showed that it didn't matter which area of the visual cortex was stimulated: activity was reduced in all areas. Groen: 'This shows that the type of stimulation we used spreads further through the brain than we originally thought.'

Three years later Groen took up a post at New York University. Here she had the opportunity to work with Electrocorticography (ECoG), a technique whereby electrodes are placed in the brain of test subjects. 'Patients with very serious epilepsy sometimes receive a brain operation if no drugs work for them,' explains Groen. 'A surgeon makes a small hole in their skull and places a number of electrodes on the brain. It takes some time before they know which part of the brain is affected by the epilepsy, after which they take out the electrodes again and proceed to surgery. Meanwhile, the patients spend a week or more in the hospital with this bundle of electrodes in their head. This is a unique opportunity for us researchers. If the patients were feeling bored, I asked them if they would like to take part in my research.' Again, she showed patients images and observed how their brains responded to them, acquiring a new type of information on visual processing in human brains. Groen: 'The electrodes measure the brain responses with very high resolution, without the distortions that we have with EEG or fMRI. Because of this, the neural responses to the visual images are extremely clear and reproducible, meaning that they look exactly the same when you show the image for a second time. This makes these data very special and exciting, just beautiful to see.'

Algorithms that can see

At the UvA Faculty of Science, Groen has now joined the Informatics Institute (IvI). This might sound like a surprising career switch, but Groen explains why it isn't: 'The artificial intelligence researchers in my new department are creating computer algorithms that should be able to "see". Think of, for example, algorithms that are used in self-driving cars or that are used to translate a visual image into a sentence, which can be useful for vision-impaired people. One important question for these researchers is: how do you translate information from the world into code? By showing how the human brain does this, I want to contribute to the further development of these algorithms.' Part of her research at IvI is funded by a Veni grant from NWO, which she received just after she accepted the position at the UvA. This project focuses on how the brain computes action affordances of the environment, for example where roads and pathways are that you can use to move yourself forward.

Groen is very happy with her MacGillavry Fellowship because she had hoped to return to the Netherlands. It did mean that once again the two body problem raised its head. This time, she negotiated that her partner would also receive an academic post at the University of Amsterdam (although he ended up accepting another position at Leiden University). Groen: 'The aim of the MacGillavry Fellowship is to get talented women on track to a professorship. If, as university, you want to recruit and retain women then I think you should try to facilitate that their academic partner also gets a post. That may sound unfair, but it's reality that this issue plays an important role in women's career choices. When I look at other academic couples around me, I often see that the man is already further up the academic ladder than the woman, for various reasons. And this often results in women leaving their academic position, or the academic world, in order to follow their male partner.'

Groen hopes to be a role model for other women in her specialist field. 'As a student I knew in cognitive terms that a woman could become a professor. But I had very few female professors – I think only one in my first year of university – and I still had this stereotype image of a bearded man in a white lab coat fixed in my brain. I hope I can play an exemplary role for the next generation.' ◄

CV

- ▸ **2003 – 2006:** BSc in Psychobiology *(cum laude)*, University of Amsterdam, the Netherlands
- ▸ **2006 – 2009:** MSc in Brain and Cognition Sciences *(cum laude)*, University of Amsterdam, the Netherlands & University of Cambridge, United Kingdom
- ▸ **2009 – 2014:** PhD in Visual Perception *(cum laude)*, Department of Psychology, University of Amsterdam, the Netherlands
- ▸ **2015:** PhD Thesis prize from the Dutch Society of Psychonomics
- ▸ **2015:** Rubicon postdoctoral fellowship grant, Dutch Research Council (NWO)
- ▸ **2014 – 2017:** Postdoctoral fellow, National Institutes of Health, Laboratory of Brain and Cognition, Bethesda, United States
- ▸ **2017 – 2019:** Postdoctoral associate, New York University, Department of Psychology, United States
- ▸ **2019:** Veni grant from the Dutch Research Council (NWO)
- ▸ **2020 – now:** Assistant professor, University of Amsterdam, Informatics Institute, the Netherlands

Flavia de Almeida Dias

Hunting for elusive particles at the Large Hadron Collider

Particle physicist Flavia de Almeida Dias has had a fascination for fundamental scientific questions ever since she was a child growing up in Brazil. 'I was a highly curious kid. It wasn't always possible for me to play outside, so I was home a lot, reading books', she recalls. 'My grandfather likes science and gave me a book about the universe. After reading that book, I wanted to become a scientist, and nothing could change my mind.'

De Almeida Dias went on to study physics at the University of São Paulo. As a student there, she worked on a project that involved using a proton beam as a non-destructive method to determine the chemical composition of paintings and archaeological artefacts. She also took part in applied research at the Brazilian Synchrotron Light Laboratory, studying the electroactivity of cellulose. For her PhD she switched to a less applied field of study that also involves proton beams: she joined the hunt for elusive fundamental particles at the European particle accelerator known as the Large Hadron Collider (LHC) at CERN, in Switzerland.

Building blocks

'The most mundane objects in our daily lives and the distant galaxies are made from the same building blocks,' De Almeida Dias explains her fascination. 'However, there are still aspects of these building blocks we don't fully understand. That is what we study at the LHC. We do this by accelerating protons to a very high speed and then making them collide. This high energy collision causes the protons to fall apart, and creates new particles. Those are the ones we are interested in. We work with a theory called the Standard Model of particle physics, that tries to explain all known fundamental particles and how they interact with each other. The Higgs particle, discovered in 2012, was the last missing piece predicted by this model. All these pieces together work very well, but they still only represent about five percent of what the universe is made of. The rest of the universe consists of what we call dark matter and dark energy. So there are still many things that we cannot explain with the Standard Model. At the LHC we try to find what else is missing.'

De Almeida Dias has worked at CERN throughout her career, but as is common for physicists working there, she was always affiliated with another institution. She obtained her PhD at the State University of São Paulo in association with the California Institute of Technology, followed by two postdocs at the University of Edinburgh and the Niels Bohr Institute in Copenhagen. De Almeida Dias: 'Over the years I spent a lot of time at CERN to look for new phenomena, which could either be new particles or deviations that the Standard Model cannot explain. I worked on analyses searching for new particles in the dark matter sector, new force carriers, gravitons from extra dimensional models, and extra Higgs particles predicted by theories that say there is not one Higgs boson, but five.'

Highly international

In addition to the research at CERN being at the forefront of physics, De Almeida Dias also enjoys the unifying nature of conducting research in such a highly international environment. 'You work with people with different backgrounds from all over the world. You meet people with different ideas and different ways of working. This exchange fosters creativity, for example when encountering scientific problems. It is beautiful that science can be so unifying when you work towards the same goal, no matter where you're from or what you believe.'

Since the beginning of 2020, she divides her time between Switzerland and Amsterdam, where she obtained a MacGillavry Fellowship. She is now associate professor at the UvA's Institute of Physics. 'I am very happy that I got this fellowship, it allows me to continue

CV

▶ **2005 – 2008:** BSc in Physics, University of São Paulo
▶ **2007:** Summer scholarship at Brazilian Synchrotron Light Laboratory
▶ **2008:** Summer scholarship at CERN
▶ **2009 – 2012:** PhD in particle physics from the São Paulo State University's Institute for Theoretical Physics, in association with the California Institute of Technology and CERN
▶ **2010:** Marie Curie short-term researcher at University College London, United Kingdom
▶ **2013 – 2016:** Postdoctoral Research Associate at the University of Edinburgh, United Kingdom
▶ **2017 – 2020:** Postdoctoral Research fellow at the Niels Bohr Institute, University of Copenhagen, Denmark
▶ **2020 – now:** Assistant Professor at the University of Amsterdam, researcher at the National Institute for Subatomic Physics (Nikhef), and member of the ATLAS Collaboration at the LHC, CERN

my work at the LHC and join a wonderful group. The UvA's Institute of Physics and Nikhef colleagues are very reputable within the CERN community, and the Netherlands has an interesting scientific landscape with different kinds of funding you can apply for.'

Non-standard

De Almeida Dias believes it is a good thing that programmes like the MacGillavry Fellowship, that are specifically for women, exist. 'It is a pro-active way to change the gender gap, instead of solely educating people that they have unconscious gender biases when they hire people. And this was not an easy position to get,' she says. 'The MacGillavry Fellowship is open for all topics in science instead of just my own field. I had to compete with over 400 other highly talented applicants from every field of science. Being a woman in the scientific world is an extra burden to carry, being the non-standard. As a woman in this profession you have to prove yourself all the time. You continuously have to prove that you are good, and that you belong. Of course it is different in every country. Compared to Brazil – which is a sexist country – Denmark was equal-ish. I hope to find a good balance in the Netherlands as well.'

When asked to give examples of how women are treated differently in science, De Almeida Dias shares some of her experiences: 'It happens from a young age on. If you are a girl who is interested in science, everybody always asks you "Why?". But if you're a boy, no one asks you that question. And even now, when I tell people I am a physicist, people are surprised. They say that I don't look like one.' She also mentions men being taken more seriously: 'This has happened so many times. I or my female colleagues are ignored when we say something during a meeting, but when a man says the same thing five minutes later, people say he is brilliant.' Worse still, she has encountered harassment at work too. 'Especially when I was a student, there have been incidents which made me feel unsafe and I wondered if it was worth dealing with it all for the love of science.'

How can things change for women, according to her? De Almeida Dias: 'I am very thankful that female pioneers made it possible for me to be here. I had a couple of female professors that I could look up to. I always thought: "How can I become that person?" Role models are very important. I am part of an outreach programme in Brazil for women only. We organise events with all-female scientists for lectures and discussion panels. This is how we show girls from high schools that there are possibilities for them.'

Double the amount of data

What will the next couple of years look like for De Almeida Dias? 'At the moment the LHC is undergoing maintenance. The restart is scheduled to happen next year. We will run the accelerator for a few more years, resulting in double the amount of data compared to what we have now by 2025. With more data, it is possible to uncover more subtle deviations from the behaviour predicted by the Standard Model. You could compare it with taking a picture of the night sky in a split second or using a camera with a very long exposure time. The first picture will look black, but on the second one you might see many stars, the Milky Way, and far away galaxies. So in the next five years we can expect more precision in what we see, and maybe new physics will shine a light in our experiment.' ◀

Verena Schoepf

Studying 'super corals'

'Everything was white.' Marine biologist Verena Schoepf describes the first time she saw a mass bleaching event of corals. The event did not just occur at her study site in Western Australia, but all around the world – the third documented global mass bleaching (2015-16). 'I saw the real impact when I came back six months later: much of the reef had died. And a year later, in the famous Great Barrier Reef, this happened again.'

Coral reefs around the world are under threat by a number of influences. There are natural dangers, like cyclones. But many major threats are human in origin. Think of pollution and overfishing. And then there's climate change, which causes warming of the oceans and ocean acidification; both major causes of concern for these fragile ecosystems. Oceans are a well-known heat sink, absorbing a large part of the heat produced by CO_2-driven global warming. Schoepf explains: 'Corals live in symbiosis with microscopic algae that provide them with most of their energy and nutrients through photosynthesis. Heatwaves associated with ocean warming lead to the breakdown of this symbiosis. Under influence of heat corals expel the symbiotic algae living inside their tissue. Without them, the corals not only lose their color – turning white or 'bleached' - but are also deprived of their primary source of energy. If the heat stress lasts for too long, the corals will starve and die.' At the same time, part of the excess CO_2 in the atmosphere dissolves in the oceans, making the water more acidic. This increase in seawater acidity makes it more difficult for corals to build their skeletons and therefore to build reefs.

Schoepf's fascination for ocean life started with seeing nature documentaries on tv in her native Austria while she was still a child. 'I got inspired by the documentaries of the underwater pioneer Hans Hass, who is the Jacques-Yves Cousteau of Austria,' recalls Schoepf. 'His documentaries inspired me to snorkel in the Mediterranean Sea for hours. When I was twelve I saw coral reefs for the first time. There, in the Red Sea, I knew that coral reefs were the marine ecosystems that I was most interested in. I was absolutely mesmerised by the diversity of colours, forms and shapes. Coral reefs are biodiversity hotspots and essentially bustling underwater cities. You could compare them to a city like New York, there is so much going on in so many dimensions.'

Acidification versus heat stress

After studying Biology at the University of Innsbruck in Austria, Schoepf moved to the United States for a PhD at Ohio State University. There she studied how reef-building corals are impacted by multiple climate change stressors: acidification and repeated bleaching events. She investigated four different species of coral in a simulated environment in the lab. Schoepf found that the coral species she studied were more resistant to acidification than expected. 'These species also didn't consume their energy reserves in order to maintain calcification rates, so that was good news! It highlights that ocean warming is a much bigger threat to coral reefs than acidification,' she comments.

But, she did find that consecutive bleaching events took their toll, albeit differently in different species. Schoepf: 'One of the species I studied was quite resistant to the first heat stress event, but then became increasingly susceptible to the second one a year later. A second coral species showed the opposite pattern. This challenged the traditional view that we can easily predict the winners and losers of coral bleaching, because higher stress frequency dramatically changes coral stress tolerance. Back then there were almost no reefs that had bleached two years in a row. So we didn't expect this to happen on a larger scale until 2030 or 2050. But within five years after completing my PhD, this already became a widespread reality. For example, the Great Barrier Reef experienced back-to-back bleaching for the first time in 2016 and 2017.'

Extreme environment

After her PhD, Schoepf continued her research career as a postdoc and later on research programme co-leader – the youngest ever – at the ARC Centre of Excellence for Coral Reef Studies at The University of Western Australia in Perth. There, she studied reefs in the Kimberley region, which is a naturally extreme environment for corals due to the world's largest tropical tides (up to 10 metres tidal range). Schoepf became fascinated with corals in this region, that she sometimes refers to as 'super corals'. Schoepf: 'These corals are able to survive in shallow pools, that can heat up to temperatures that would kill most other corals, making them ideal organisms to study for a better understanding of how corals can cope with warming oceans. The conditions there were not just hard for the corals, but also for us as researchers. It is very hot and humid up there. There are saltwater crocodiles, deadly jellyfish and snakes. And if something happens, the nearest hospital is three hours away by four-wheel drive. I had to walk on the reefs at low tide. You don't want to swim or dive there, since there are also very healthy shark populations. This was next-level fieldwork; challenging, but also very rewarding.'

Ever since, Schoepf's focus has been on gaining a better understanding of the mechanisms that increase the resistance of corals to warming and acidifying oceans. Her main message though, is not to think of 'super corals' as a solution to all problems that coral reefs face today. Schoepf: 'This is such a new field, there is so much we don't know yet. How long has it taken these corals to develop this resilience? Will they maintain this resilience if you put them in a slightly different environment? And are they any trade-offs? We don't know yet.' And even though the super corals are more resilient, they are not completely immune to heat stress. The corals at her Kimberley site, for instance, did experience bleaching in 2016. 'The good news is that they also recovered much faster, at least this time. That gives reason for hope', says Schoepf. 'However, we really need to accept that there is no safe place for corals as the oceans continue to warm – if we want our children to be able to see healthy coral reefs, we urgently need to reduce greenhouse gas emissions.'

MacGillavry Fellowship

In November 2019, Schoepf joined the Institute for Biodiversity and Ecosystem Dynamics at the University of Amsterdam as a MacGillavry fellow. After having studied coral reefs in Australia, Mexico and the Red Sea, she will now switch her focus to the Dutch Caribbean. Yes, there are potential super corals there too. For instance in the shallow inland bays on Curaçao, where corals are not only subject to heat stress but also to several other stressors. Schoepf says she was excited to join the UvA: 'There is a strong tradition of coral reef research in the Dutch Caribbean here in the Netherlands. In my new department, there are several people that study coral reefs and other freshwater and marine ecosystems from different angles, which makes it a very stimulating research environment. I am also very happy with this fellowship. It allows me to start my own research group, be more independent and develop my own research lines.'

The fact that the fellowship was established to attract female talent was not her primary motivation to apply, but she does support this idea. Schoepf: 'It is well established that women in STEM often experience discrimination. Things are a bit better in Biology compared to other STEM fields, but especially when you look at the number of female associate or full professors, there is still a lot to be done. Also here at the UvA. It is critical to not only attract female STEM students, but also to retain them and offer longer-term perspectives. This is where fellowships like the MacGillavry play an important role.'

Science outreach

Back in Australia, Schoepf was actively involved in bringing science to the public and setting an example as a female role model in science. 'I was part of the prestigious "Superstars of STEM" programme, which aims to smash society's gender assumptions about scientists and increase the public visibility of women in STEM. It provided a select group of women with special media and public outreach training. We also visited local schools to talk about our work. My goal is to raise awareness for climate change and coral reefs, and at the same time be visible as a female scientist,' says Schoepf.

She wants to continue these efforts here in the Netherlands. 'I want to improve my Dutch, to visit schools again,' says Schoepf. She has also joined the diversity sounding board at the UvA Faculty of Science. 'We meet regularly and discuss with the Diversity Officer how we can improve diversity, equity, and inclusion at the Faculty, not only for women but for all underrepresented groups.' ◄

CV

- ▶ **2008:** MSc, Zoology, University of Innsbruck, Innsbruck, Austria, with distinction
- ▶ **2009 - 2013:** PhD, Geological Sciences, Ohio State University, Columbus, Ohio, United States
- ▶ **2013:** Presidential Fellowship from the Ohio State University
- ▶ **2013 – 2019:** Postdoctoral Research fellow, Oceans Graduate School, University of Western Australia, Perth, Australia
- ▶ **2016 - present:** Multiple interviews on TV, radio, newspapers and magazines, including a starring role in the prize winning Arte documentary Ocean Heroines
- ▶ **2017 – 2019:** Research Programme Co-Leader & Member of the Scientific Management Committee, ARC Centre of Excellence for Coral Reef Studies, Australia
- ▶ **2018:** Young Tall Poppy Science Award, Australian Institute of Policy and Science
- ▶ **2019:** Superstar of STEM, Science and Technology Australia
- ▶ **2019 – present:** Assistant Professor and MacGillavry fellow, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, the Netherlands

Antonija Oklopčić

Modelling the atmospheres of exoplanets

'Twenty-five years ago scientists still expected that planets in other solar systems would look like the ones we have in our own system. But we were in for some big surprises', says astrophysicist Antonija Oklopčić. Oklopčić is an expert in modelling the atmospheres of planets in other solar systems, which are known as exoplanets. She has recently left her prestigious NASA fellowship at Harvard University to join the University of Amsterdam's Anton Pannekoek Institute for Astronomy as a MacGillavry fellow.

This is her first faculty position, and Oklopčić comments she is 'very happy and excited' that she managed to get it. 'Dutch astronomy is globally regarded to be very strong. There are many excellent Dutch astronomers and they participate in big European projects like the Extremely Large Telescope and the European Space Agency. So it is a great opportunity to be part of this community.'

Oklopčić research field is still quite new, which is one of the reasons she finds it so exciting. 'It was only after the development of precise spectrographs and dedicated space telescopes, such as the Kepler mission, that astronomers started to find planets outside of our solar system in large numbers.' These exoplanets are often very different from the ones in our own system. 'For instance, our solar system lacks planets with a size in between that of the Earth and Neptune. But planets of such a size are incredibly common around other stars,' Oklopčić explains. 'Many exoplanets also orbit their stars very closely, making their climates extreme. There are for example planets we call "ultra-hot Jupiters", with temperatures of a few thousand degrees Kelvin. This means they are as hot as some stars.'

Million questions

Although her area of interest may sound as a niche topic, Oklopčić has always had a strong drive to understand how the entire universe works. Growing up in Croatia she liked science, space and astronomy, and was determined to become a physicist since she was thirteen or fourteen years old. Throughout her Physics studies at the University of Zagreb, she did research projects that focused on cosmology, the early universe and galaxy evolution. Oklopčić: 'It is not one single question that drives me. All topics of astronomy are fascinating and beautiful to me. There are still a million questions to answer.'

The work she did during her PhD at the California Institute of Technology in the United States also reflects her broad interest. While there, Oklopčić wrote a series of papers on various astrophysical topics. 'It might be different in the Netherlands, but in the US it is quite common to explore various topics during your PhD programme,' she explains. 'But the common thread throughout my PhD was the interaction between light and matter in different astrophysical media. And how we could use

spectroscopy to study different astrophysical objects.'

Galaxy evolution & atmospheres

One of her PhD projects had to do with galaxy evolution, and especially with a period when star formation in galaxies was at its peak, which occurred 10 billion years ago. 'I used simulations to study why galaxies in that epoch looked much clumpier than the beautiful disc shape that many galaxies have today,' says Oklopčić. 'These galaxies had much more gas in them, which fragmented into clumps. The key question was how these clumps affect the evolution of their host galaxy. I found that the clumps disperse quite rapidly, after about twenty million years, which means that they do not live long enough to have a significant impact on the galaxy as a whole.'

Another of her projects concerned the extreme environment of exoplanet's atmospheres. 'I studied how a particular type of light scattering in the atmosphere of planets – called Raman scattering – leaves signatures behind in the spectra of planets that we observe. I analysed what these signatures could tell us about the composition of atmospheres and whether there are clouds or whether it's clear.'

In 2017 Oklopčić moved to Harvard University as a postdoctoral fellow, and in 2019 she was awarded a NASA Hubble Fellowship at the same university. Here she continued to study the atmospheres of exoplanets. More specifically, she studied the process of atmospheric escape on various exoplanets, including a planet called WASP-107b. Oklopčić: 'WASP-107b is a "warm Saturn". In terms of size it is similar to Saturn, but it is much closer to its star. Due to high levels of radiation, its upper atmosphere can get heated to very high temperatures and, as a result, evaporate and escape from the planet. My colleagues and I were the first to find evidence of gas escaping from WASP-107b by tracing helium atoms in its upper atmosphere.'

Closing the gender gap

The MacGillavry Fellowship at the University of Amsterdam was established to attract highly talented female scientists from all over the world. Special tenure programmes like these are one of the ways in which universities are trying to close the gender gap, which is still a problem in many scientific fields, including astrophysics. Oklopčić mentions a study that was published in scientific journal PLOS One a few years ago: 'In this study, the researchers extrapolated the speed with which the gap closes for different fields of science. For astronomy it will take another 130 years before the male-female ratio will be equal. That is awful! If we would just sit around and wait, even my great grandchildren will experience this gender gap when they start their careers. I think that is unacceptable. We need to do something about it, it is not going to happen on its own.'

When asked about her own experiences of being treated differently as a woman in science, Oklopčić shares an example of what she experienced during her studies. 'When I did really well on a test in Croatia, a professor would act surprised and shout out: "Oh, look at that. A girl has the highest mark! You should be ashamed of yourselves, boys." I got upset and tired about things like that, because it happened so often. Nowadays I would not keep silent but say something. The lack of women is still noticeable in my field, although it depends on the career stage. The student population is close to achieving gender parity, but it gets worse at more senior levels.'

Oklopčić is a member of a couple of social network groups designed for women in astrophysics. 'Many institutions have mentoring groups for women in science, and I've participated in several of such programmes throughout my career, including meetings with other MacGillavry fellows. These meetings offer a great opportunity for networking. In these groups we don't just talk about "being a woman in science". Mostly we talk about the usual academic issues, like writing grant proposals and mentoring students.'

Future plans

The next couple of years at the UvA will be exciting for Oklopčić, since the Extremely Large Telescope (ELT) is currently being built in Chile and the James Webb telescope will be launched in 2021. 'Many telescopes that we now use to study exoplanets were built before exoplanets were discovered. So they were not designed with this purpose in mind. The new ELT and James Webb Telescope will be real game changers for our field, since these telescopes will be much bigger than the ones we use now. In the next couple of years, I will focus on developing 3D models of exoplanet atmospheres to interpret the data that we'll get from these new observatories.' ◄

CV

▸ **2006 – 2011:** MSc in Physics, University of Zagreb, Croatia
▸ **2011 – 2014:** Fulbright International Science and Technology Fellowship
▸ **2011 - 2017:** PhD in Astrophysics, California Institute of Technology, United States
▸ **2017 – 2019:** Fellowship at the Institute for Theory and Computation, Center for Astrophysics, Harvard University, United States
▸ **2019-2020:** NASA Hubble Fellowship Program Sagan fellow, Center for Astrophysics, Harvard University, Unites States
▸ **2020 – now:** Assistant Professor and MacGillavry fellow, Anton Pannekoek Institute for Astronomy, University of Amsterdam, the Netherlands

Annemieke Petrignani

Searching for the fundamental building blocks of life

'I am an experimentalist in heart and soul,' says Annemieke Petrignani. Her main research topic changed a number of times during her career. She roughly switched from studying very small molecules in the earth's atmosphere to large, organic ones in outer space and their role in prebiotic chemistry. And even though she studied physics and has worked at hard-core fundamental physics institutes, she now works at chemistry institute HIMS. But what remained throughout her career is her love for practical experiments: every time she talks about them, her face lights up and you can hear the excitement in her voice.

For instance when she talks about her PhD in atmospheric photophysics at AMOLF. Petrignani: 'There, we used this really cool technique where you collide small ions with electrons at very high speed, close to the speed of light, but standing still relative to each other. We were able to perform highly sensitive measurements of what happens when the ions recombine with the electrons. That is what makes my heart beat faster: experimental physics, figuring out how to do things, and exploring the limits of what is possible. Back then, it used to take us a year to set up an experiment. The feeling it gives you when such an experiment succeeds is amazing, it feels like such an accomplishment.'

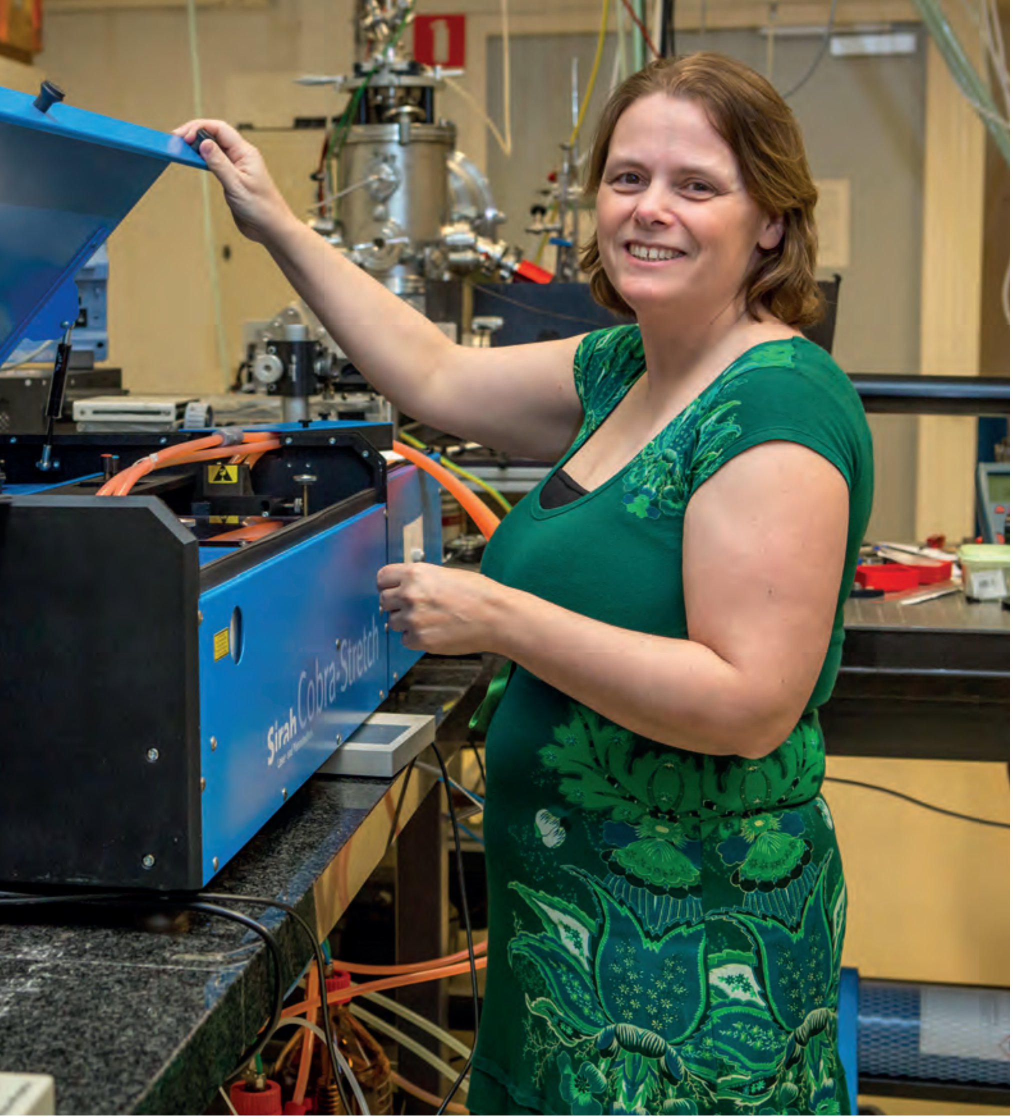
Pushing the limits

For her postdoc Petrignani and her husband moved to Heidelberg, Germany. At the Max Planck Institute she performed experiments involving quantum states of very cold small molecules. 'Among other techniques, this involved ion storage rings and advanced action spectroscopy, laser spectroscopy. We again tried to push the limits of what's possible. We managed to get very weak transitions in the state of the molecules, and we designed a very sensitive method and custom equipment to achieve this.'

During this postdoc Petrignani experienced that being a woman in science can be challenging. 'I was the first female scientist in the research group, and the first that got pregnant. As it turned out, there was nothing in place for that. Nothing on getting back to work after pregnancy leave, nothing on facilitating breastfeeding, for instance. In Germany it is very common for women to go on leave for a full three years. And many women quit their job. But I did not want that. So I had to design the protocols around having children myself. All this was only ten years ago. It wasn't bad intent; it was mainly that the situation had never come up.
I pioneered there, and many of the protocols I initiated are still in place at the institute. Now, it even has a day care facility on its grounds.'

Switch to astronomy

In 2011 Petrignani and her young family moved back to the Netherlands, where she obtained a position at the Leiden Observatory within the research programme of the Dutch Astrochemistry Network. Suddenly she found herself among astronomers and chemists instead of fundamental physicists. 'It was a bit hard to again have to adapt to a different field, and to have to leave the equipment I developed behind. But I had a lot to offer. Astronomers use spectroscopy to detect the fingerprints of molecules in space, so my experience with laser spectroscopy was very useful. And the small molecules I studied in Heidelberg are important in the cold molecular clouds in space where planet formation takes place, so my research already had a link with astronomy. But now I started to study the fingerprints of larger, aromatic molecules.'



The switch turned out to be a happy and fruitful one. Petrignani: 'I discovered that I really liked working within a multi-disciplinary team. I love locking myself up inside a laboratory and not emerging from it until an experiment works. But I started to combine this with challenging myself through having discussions with people from other research fields. Exploring other points of view, trying to bring different worlds together, the strong social components in a multidisciplinary field like astrochemistry; all that turned out to also be something that really suits me.'

How to design an alien

After a few years Petrignani therefore decided to apply for a Vidi grant from the Dutch Research Council (NWO), in order to start her own research group within the field of astrochemistry. She received the grant and relocated from Leiden to her current place at the University of Amsterdam. 'I chose for HIMS because of the expertise and equipment that is present here in the Laser Lab. More specifically, I wanted to work with professor Wybren Jan Buma for his expertise and use the available state-of-the-art equipment on gas-phase spectroscopy.' At the UvA her work became even more interdisciplinary. She was asked to help design the student course How to design an alien, which involved her working together with biologists. 'In essence my work now also includes the search for the building blocks of life or alien life. Biologists look at life on earth and try to reason back, how can this have originated from a molecular basis. I approach the question bottom up: I look at the organic molecules that are present in space, and work from there.'
Receiving the MacGillavry Fellowship meant Petrignani now finally has a permanent contract and can settle down. 'It also means that I can expand my research, hire extra people for my group. We now focus on a number of big questions. Which organic molecules are present in space? What are their physical properties, how do they evolve under the influence of factors in their environment? And is there perhaps such a thing as fundamental building blocks of life, building blocks that are truly essential, not just here, but on other planets? And why these? These building blocks may well involve molecules similar to natural amino acids, sugars, and RNA. But what's interesting is that life here on earth has incorporated only specific organic building blocks out of many possibilities. Why is that? Dedicated experiments investigating these questions are needed. So that's what I would like to do.'

Career impact of having children

Petrignani believes initiatives like the MacGillavry Fellowship are important for female scientists, because there are still many biases in place that hold women back in their scientific career. 'Let me put it this way: there are very few female scientists at my level, even less who have multiple children. In grant applications, you can correct for your "scientific age" for each child. But it's more complicated than that. The impact goes beyond grants and the backlash is cumulative. You will have less first author publications than your direct peers. You will probably also have given less conference talks. Because you can't fly across the world with a small child you are breastfeeding.

And if you decline a couple of times, people stop asking you. You become less visible and your H-index is probably also lower. I have experienced this myself when I applied for other positions. I often came in second or third place with commentary given about my prolonged career stagnation. The way we assess the quality of scientists is still very much based on an out-dated system with traditional gender roles. So I am happy that there are programmes like the MacGillavry that look beyond that.' ◂

CV

- ▸ **1993 – 2000:** MSc in Applied Physics, Delft University of Technology, the Netherlands
- ▸ **2000 – 2005:** PhD at AMOLF, Amsterdam, the Netherlands
- ▸ **2005 – 2011:** Postdoctoral researcher, Max Planck Institute for Nuclear Physics, Heidelberg, Germany
- ▸ **2011 – 2016:** Postdoctoral researcher at Radboud University Nijmegen, the Netherlands
- ▸ **2011 – 2016:** Postdoctoral researcher at Leiden University and Leiden Observatory, the Netherlands
- ▸ **2015:** VIDI grant awarded by the Dutch Research Council (NWO)
- ▸ **2016 – now:** Assistant professor and MacGillavry fellow, University of Amsterdam, the Netherlands

Bahareh Afshari

A God-like view over maths

'Logicians in my field consider themselves above mathematicians,' jokes Bahareh Afshari. She is a logician, who started her MacGillavry Fellowship at the Institute for Logic, Language and Computation in the beginning of 2019. 'Not to sound arrogant, but logicians have a God-like view over what is going on in maths. They analyse how mathematicians work, how they reflect on things, and establish new theorems.'

She clarifies the field of logic with a comparison: 'When you consider mathematics as consisting of different languages, the language of algebra, the language of analysis and the language of number theory, then logic would be the science of languages. So a logician could say: "I know an infinite number of languages because I can abstractly look at them and say something amazing or useful about it." But you might get a different answer if you ask a mathematician.'

The science behind proofs

Afshari mainly works in the mathematical field called Proof Theory. 'Which means I study the correctness of arguments in different mathematical languages. I check what kind of arguments are acceptable and which are faulty. Every step should click together to a conclusion.'

In 2017 she published a breakthrough paper on "cyclic proofs", which answered a question that had been open for over two decades. 'Cyclic proofs are arguments that go round and round,' Afshari explains. 'It is a phenomenon that often occurs in mathematics when you want to prove something. You first reduce the problem into something else, and then to something else again, and after a while you come back to the same problem you started with. You can then ask yourself: "Did I make any progress in this argument?" Surprisingly, sometimes you do. We call these cyclic proofs.'

Afshari's work is theoretical and has no immediate applications. But her work could be used to analyse the underlying mathematical structures of reactive computer systems. Reactive computer systems are systems that engage with the environment and it is critical to ensure their correctness for safety reasons. Afshari: 'Take for example the computer systems that are used for managing railways. Obviously there should be only one train on a track at a time. In this case logic expresses the safety and efficiency properties: is the system operating correctly? Are there any faults? With the help of logic one can ensure that no two trains are allowed on the same track at the same time and a train waiting at a signal will eventually be permitted to pass.'

The pattern of mathematics

The process of problem solving is what's driving Afshari in her work. 'I constantly think about my work. On the train, while cooking, walking or stroking my cat on the sofa. It is hard to put the problems down. It feels so good when you solve a little bit of it.'

'I had a hard time memorising things at school,' Afshari tells about her youth in Iran. 'But mathematics had a pattern, and that I could remember.' So it was a simple decision for her to study maths. And as soon as she followed some logic classes, she fell in love with it. 'It enables me to have an abstract view of things. I really liked that it wasn't specialised and it gave me a perspective on many areas at the same time. I like that level of abstraction. It makes me feel in control.'

Making proofs simpler

She moved to the UK to pursue a PhD in Leeds, a postdoc in Edinburgh and another one in Oxford. After that Afshari worked at the mathematics department in Vienna, where she worked on making proof arguments simpler and shorter. Afshari: 'Proof compressions, as we call it, is a key step in the automatic generation of proofs. The latter has wide applications ranging from Philosophy –understanding different reasonings – to Artificial Intelligence – generating proofs not by humans but by programmes.'

Is it a fair position?

When she got the MacGillavry Fellowship at ILLC, Afshari was thrilled. 'And I am still thrilled. I cannot ask for more. It is a heaven for logicians,' she says. 'The institute is absolutely unique, it is the only institute in the world that contains all branches of logic: philosophy, computer science and mathematics. It is very inspiring because there are so many researchers you can talk to. The level is very high. I love the students, they are so clever and they approach you very easily, which brings the classroom to life. And I also love my colleagues, who are very collaborative and inspiring.'

Afshari had mixed feelings about the MacGillavry Fellowship itself, being for women only, but now is happy that the programme exists. 'I must say I didn't like the fellowship in the beginning. I asked myself: did I get this job because I am this good or because I am female? I also doubted whether it was fair to the men who could not apply. But when I talked with other MacGillavry fellows, I realised that women lose many opportunities due to bias. So if this position helps us to overcome these biases at a certain point in our careers, I feel okay about it.'

CV

▸ **2004 – 2008:** PhD in Mathematics, University of Leeds, United Kingdom
▸ **2009 – 2016:** Postdoctoral Researcher:
• Laboratory for Foundations of Computer Science, University of Edinburgh, United Kingdom
• Department of Computer Science, University of Oxford, United Kingdom
• Institute for Discrete Mathematics and Geometry, TU Wien, Austria
▸ **2017 – now:** Associate professor, University of Gothenburg, Sweden
▸ **2019 – now:** MacGillavry fellow, ILLC, University of Amsterdam, the Netherlands
▸ **2021:** Member of The Royal Swedish Academy of Sciences

Female presence in logic

She does not feel like talking too much about what it is like to be a woman in her field of research. 'There are very few women in my field. If you look at the ILLC list of staff, there's only a handful of us, most work in philosophy rather than maths or computation. I would like to have more female colleagues. I'm used to working with men, but I would like the experience of collaborating with women.'

Afshari does feel that she is in the position to raise her voice when it comes to female presence in logic. Therefore, she is actively trying to motivate female students, put more women on stage during conferences and makes committee members aware of their biases while hiring staff. 'I mentor a number of female students. These students are so good, with some encouragement I can see them flourish into very capable researchers.'

A fashionable topic

Afshari now shares her time between Sweden and Amsterdam. She is also a researcher at the University of Gothenburg, where she works on logics of time and space. 'I am assessing the limits of these logics in terms of their expressive capabilities so the work has a more philosophical and mathematical flavour.' In Amsterdam she is busy with setting up her own research group in computational logic. 'I want to stay at the frontier of this cyclic proof research. I am hiring PhD students and organising a workshop on cyclic proofs which will be held in Amsterdam next year. It is a fashionable topic, and it's nice to be at the heart of it.' ◂

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Carolina Henriëtte MacGillavry
1904-1993

Carolina Henriëtte MacGillavry, born and raised in Amsterdam, was professor of Chemical Crystallography at the University of Amsterdam.

She studied chemistry at the University of Amsterdam where she went on to take her doctoral degree in 1937. For many years she was head of the Chemical Crystallography Laboratory in Amsterdam.

Her pioneering research brought her international repute. She co-authored a range of standard works in the field of Crystallography. She also laid the foundation for the 'direct method', a new mathematical theory. In 1950 she was the first woman to become a member of the Royal Netherlands Academy of Arts and Sciences. She also held positions on the boards of various organisations outside of academia.

A detail worth mentioning is that she gave the initial impetus to graphic artist M.C. Escher's international breakthrough. MacGillavry was intrigued by the symmetry in the Dutchman Escher's work, which shows some similarities with her own work. In 1960, this prompted her to invite him to exhibit his work at the International Union of Crystallography's conference in Cambridge. She also published a book on Escher's drawings.

You can find MacGillavry in Amsterdam to this day, as the main access road to the Science Park Amsterdam, home to the Faculty of Science, was named after Carolina MacGillavry.