# New eyes on **the universe**

One does research on black holes, another on distant galaxies. But all four of these young researchers passionately pursue the secrets of our universe.

Text: Peter de Jong
Photos: Bram Belloni

None of them are tied to their home country. Tanja Hinderer is German but lived in the United States during her studies and eventually ended up in Utrecht via Potsdam, Nijmegen, and Amsterdam. Spanish researcher Guadalupe Cañas Herrera settled down in Leiden and teaches Zumba classes in addition to her scientific work. And Evita Verheijden and Jaco de Swart, although Dutch with a strong connection to Amsterdam, are moving to America later this year for new research positions.

The four have another thing in common: each has indicated that their research benefits from the principle of Delta ITP, the exchange of knowledge between Amsterdam, Utrecht, and Leiden. Collaboration is the magic word, because why keep what you know to yourself?

Evita Verheijden

## ‘String theorists know how to party’

**Evita Verheijden** (1993) is one of the whiz kids at Delta ITP. She graduated cum laude in theoretical physics from the University of Amsterdam. After completing her dissertation later this year, she will move to Harvard to work at the Black Hole Initiative.

‘More and more women are studying physics: the intake of female students is now one in five,’ she says. ‘That’s very positive, but there still is a bottleneck higher up the academic ladder: only 10 percent of professors at the University of Amsterdam’s Faculty of Science are women.’

Within the string theory research group, she is working on black holes. More specifically: can you deduce what has disappeared into a black hole from the Hawking radiation it produces? Verheijden is also in search of the holy grail of theoretical physics: the Theory of Everything. She is optimistic: ‘I assume we’re going to find it during my lifetime. There is fresh determination to take up the issue; more and more good scientists are working on it.’

Leading string theorist Robbert Dijkgraaf has opted for politics. ‘He is the right man in the right place,’ Verheijden believes. ‘He has always argued for more attention and money for fundamental research. As a minister, he can now make a real difference. The fact that he also studied at the Rietveld Academy works in his favour. Art and science are a logical combination; they both require a great deal of creativity.’

On Delta ITP: ‘It is a wonderful breeding ground within theoretical physics. We have very good research groups; you would be crazy not to take advantage of them. In addition, it is very nice to meet people from other universities. String theorists may be nerdy, but they also know how to party.’

Guadalupe Cañas Herrera

## ‘I was positive I would be a physicist when I grew up’

Madrid native **Guadalupe Cañas Herrera** (1993) had her first encounter with the Netherlands in 2013. ‘I came here to study for a year as part of the Erasmus exchange programme,’ she says. ‘A fantastic initiative. Later, I did my master’s in physics at Leiden University, and this summer I hope to get my PhD in cosmology there.’

The Dutch are nice and direct, she thinks. ‘I have become part Dutch by now. My dear parents in Cantabriä had to get used to it a little. In Spain, it is customary to make things clear via something of a detour, with a tactical approach.’

‘As a child, I was enchanted by the vacuum and electricity experiments during public Saturdays at the University of Cantabria. I was positive I would be a physicist when I grew up. I am now a cosmologist with the Euclid Consortium, named after the satellite that is expected to be launched in 2023. Euclid looks beyond the Milky Way; it will photograph a million galaxies. With all those data, we will be creating a new catalogue of space, so that we can learn even more about the positions and movements of galaxies, and the expansion of the universe. Super cool.’

In her spare time, she enjoys listening to the music of Bach (‘he’s a genius!’). And she is a Zumba teacher. Laughing, she says: ‘I was quite nerdy as a student; I got tired after only five minutes of running. So, then I started doing Zumba. I love music and dancing. During the lockdowns, I did an online course and now I teach.’

In conclusion: where is the ever-expanding universe going? ‘There is nothing to be said about that yet. First, let’s learn a little more about dark energy. Maybe Euclid will take us a step closer.’

‘Delta ITP is a wonderful breeding ground within theoretical physics’

## ‘I’m Delta ITP’s in-house philosopher’

Rock hero and scientist in one: that is **Jaco de Swart** (1989) in a nutshell. In addition to being a PhD student at Delta ITP, he is the bassist for the successful hard rock band X-Raiders. ‘Music satisfies my primal urges. On stage, I’m like an animal; I let myself go completely.’ That won’t stop him from leaving for Boston this summer for two years, where he will work as a postdoc at MIT. ‘We’ll find a solution for the band. Maybe I’ll come back a few times for gigs,’ is his down-to-earth comment. De Swart says he was not brilliant at school, but mainly curious. ‘I wanted to know how nature works, but I also asked philosophical questions, like “how did discussions

Jaco de Swart

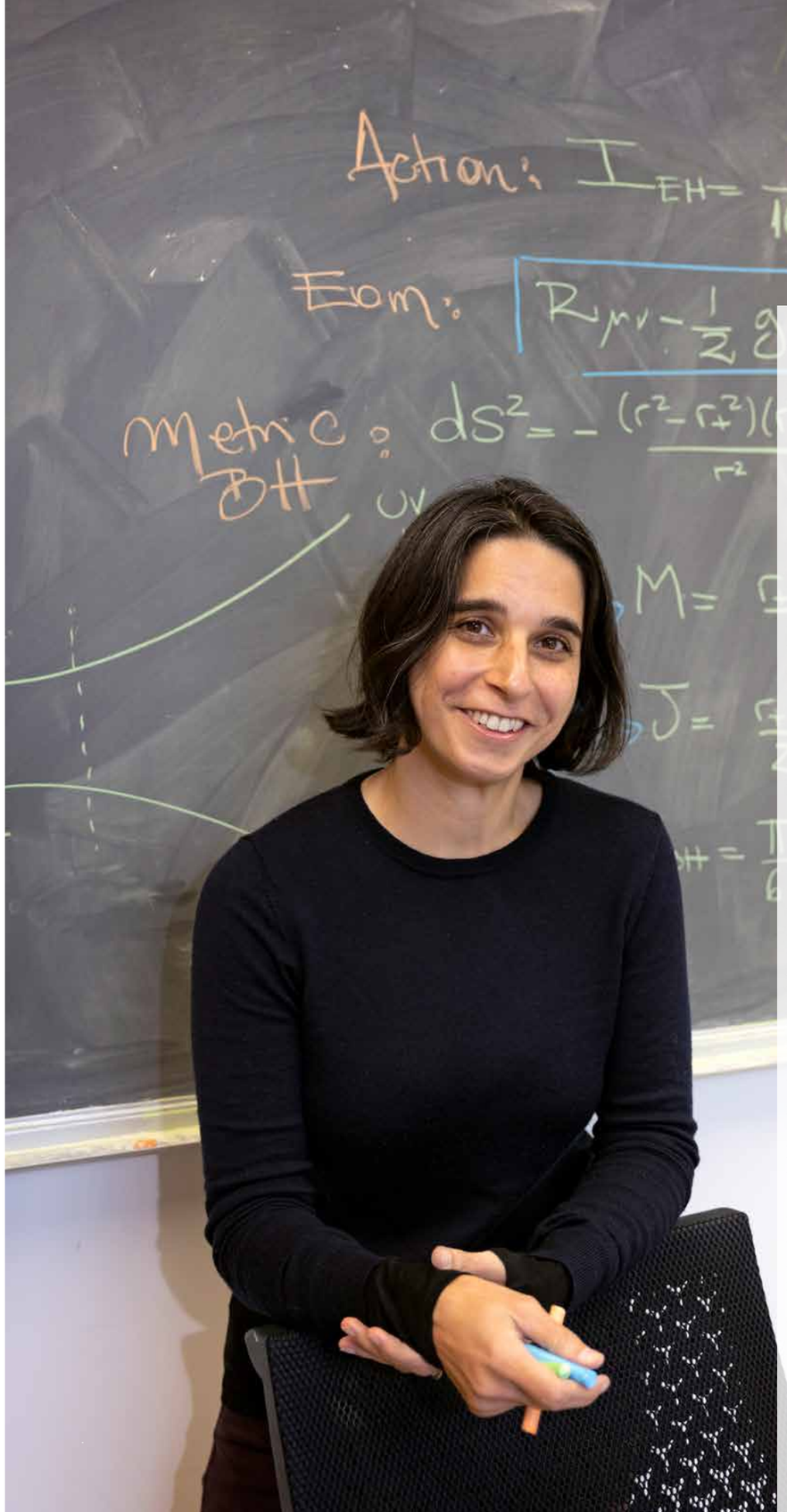
about the Big Bang actually start?" That's why I started studying philosophy alongside physics. I'm Delta ITP's in-house philosopher,' he says, laughing.
His doctoral research on cosmology bridges the gap between philosophy and physics. 'I show that our current way of thinking and acting with regard to cosmology began in the 1970s, influenced by the Space Race between the US and the Soviet Union. A lot of money was put into the development of space travel and new technologies. A new understanding of matter in the universe emerged. It was concluded that 85 percent of the universe was "missing", and, with that, dark matter was born.'
'At MIT, I will be working on developments in cosmology in the 1980s, when astroparticle physics emerged. Is that all? Well, I also like to talk about physics. I will be writing a book about the history of dark matter, and we will soon be recording an episode of *Het Klokhuis* that is also about this mysterious stuff. Great!'

'In science, it's important to exchange ideas; it stimulates new thought'

## 'Teaching students keeps you on your toes'

**Tanja Hinderer** (1979), from Hofheim, Germany, is an associate professor of gravitational wave theory at Utrecht University. A globetrotter, you might say. During her physics studies, she moved to the United States, where she received her PhD and later worked as a postdoc at universities in California and Maryland. Via the Max Planck Institute in Potsdam, Radboud University Nijmegen, and the University of Amsterdam, she ended up in Utrecht.
'I am curious and enjoy getting to know new places,' she comments.
'As a university lecturer, I not only do research but also teach students. It's very refreshing. They can be very uninhibited and ask really good questions, which keeps you on your toes.'
'Black holes were already immensely interesting to me at school,' she says. 'They are not normal objects. If you throw something in, it never comes out, not even light. I study the gravitational waves that black holes produce when they collide or move past each other. We are also looking at neutron stars, which contain half a million times the mass of Earth but are only about 20 kilometres across. One teaspoon of a neutron star weighs more than the whole of Mount Everest.'
On Delta ITP: 'In science, it's important to exchange ideas; it stimulates new thought. That's why it's good that the three universities that make up Delta ITP are working together. It only makes us stronger in the search for the answers to the great challenges of modern physics.' ■

Tanja Hinderer




BOB BRONSHOFF

**CROWN JEWEL**

## 'I want to see holography in the sky'

'Gravity is like a bad boyfriend. You love it, but it never meets your expectations,' says Alejandra Castro, theoretical physicist at the University of Amsterdam. She researches gravity at a fundamental level. For example, she looks at ideas about quantum gravity, combining quantum mechanics, which describes the behaviour of small particles and light, with Einstein's laws of gravity, which deal with the movements of large objects such as falling apples and stars circling each other.

'Einstein's general theory of relativity is a beautiful and elegant way to describe gravity, but the theory also raises questions,' Castro says. 'One of the things we struggle with is how to apply our understanding of gravity to the quantum world. One successful way of uniting these two important branches of physics is based on the holographic principle.' According to this principle, you can find all the information about a volume in its edges; in the shell around it. Like a hologram, it is a two-dimensional representation of a three-dimensional image. 'The idea is that the shell can be understood with quantum mechanics and the volume with Einstein's theory of relativity. The power of the holographic principle is that it connects the two.'

Anyone researching quantum gravity soon encounters black holes. These objects exert a great deal of gravity in a small space. They force you to combine gravity and quantum mechanics. 'One of my goals is to establish a link between theoretical holographic ideas and observations of black holes by astronomers. I want to see holography in the sky.'

*Text: Dorine Schenk*